The effect of combinations of crop row spacing, seedbed utilisation and pre-emergence herbicides on ryegrass management in barley (Minnipa, SA)

Abstract

The herbicide treatment had a significant effect on annual ryegrass (ARG) plant density (P<0.001) in this field trial at Minnipa. Favourable rain events in May were highly suitable for the activity of both pre-emergent herbicides investigated in this trial. Averaged across the row spacing and seed boot treatments, Trifluralin and Boxer Gold reduced ARG plant density by 20% and 90%, respectively. The density of ARG spikes was significantly influenced by the row spacing (P<0.001), seed boot treatment (P=0.027), and the herbicide treatment (P<0.001). The 25cm row spacing had 20% lower ARG spike density than the 37.5cm row spacing treatment. The splitter seed boot treatment had 12% lower ARG spike density than the narrow seed boot treatment. Trifluralin only reduced ARG spike density by 20% compared to the untreated control, whereas Boxer Gold caused a 73% reduction in ARG spike density. ARG seed production was also significantly affected by the row spacing (P=0.003), seed boot (P=0.01), and the herbicide treatment (P<0.001). The normal (25 cm) row spacing set 38% less seed than the wide row spacing. The splitter seed boot treatment also had 32% lower ARG seed set compared to the narrow seed boot. ARG produced 4792 seeds/m^2 in the untreated control, which was reduced by 11% by Trifluralin and 69% by Boxer Gold. Presence of ARG at 262 plants/m^2 in the untreated control, reduced barley grain yield by 8% compared to Trifluralin or 16% compared to Boxer Gold. However, it was still profitable to control ARG with effective herbicide treatments. Based on cash grain price of Feed Barley of $250/t in 2019, Trifluralin would be expected to increase the gross margin by $32/ha as compared $71/ha increase for Boxer Gold.

Introduction

As a general principle, large inter-row space tends to encourage weed invasion in field crops. At the start of the trend towards no-till, many growers adopted wider row spacing of crops as a way of achieving stubble retention. There is large variation in the row spacing used by growers for seeding crops across the southern region. In wider row configurations, crop canopy closure is either delayed or not achieved, which allows weeds to compete with crops and set large amounts of seed. In a review of research gaps by Widderick et al. (2015), crop row spacing was identified as a priority area of research for the southern region. Seedbed utilisation (SBU) as a concept has been used by Australian agronomists to achieve safer use of fertilisers at crop sowing. Greater SBU reduces the concentration of fertiliser close to crop seed which improves safety. The same concept has relevance for increasing the inter-row space occupied by crop plants, which has the potential to improve crop's competitive ability with weeds. Greater SBU by crops can be achieved by altering seed boots that provide greater lateral spread of crop seed. Some growers have been using 'Ribbon seeders' such as Concord or retro-fitting splitter boots to increase SBU and resource utilisation by their crops.

Methods

This field trial investigated combinations of the following management tactics.

Row spacing x splitter boots (4): 25 cm (10") and 37.5 cm (13") – with and without DBS v2 / ground hog style splitter boots

Herbicides treatments (3):

(i) Control (knockdown treatment only)
(ii) Trifluralin 1.5 L/ha incorporated by sowing (IBS)
(iii) Boxer Gold L/ha incorporated by sowing (IBS)

Variety: Compass

Trial design: split plot design

Replicates: 4

Trial Management

Table 1. Key management operations undertaken.

Operation	**Details**
Location	Minnipa, SA
Seedbank soil cores	11 April, 2019
Plot size	1.5 m x 10 m
Seeding date	20 May, 2019
Fertiliser	At sowing – DAP (18:20) @ 60 kg/ha
Variety	Compass barley
Seeding rate	180 seeds/m^2
Herbicides	20 May, 2019 (applied just before seeding) Boxer Gold® (800 g/L prosulfocarb + 120 g/L s - metolachlor) @ 2.5 L/ha IBS Trifluralin® (480 g/L trifluralin) @1.5 L/ha IBS Control (knockdown treatment only)

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

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. Additional information on rainfall pattern for 2019 can be found in the report for the time of sowing x barley seed rate x herbicide trial undertaken in the same paddock.

Results and Discussion

Barley plant density

Even though the same seed rate was used in the normal (25 cm) and wide row (37.5 cm) treatments, barley plant density was greater (17%) in the normal row spacing ($P<0.001$). Barley plant density was significantly affected by the seedbed utilisation (SBU) treatment ($P<0.001$), with higher crop establishment in the splitter boot treatment (13%). Herbicide treatment had a significant effect on barley plant density, however herbicide treatments did not differ significantly from the untreated control. The average barley plant density in the trial was 131 plants/m^2, which is highly suitable for this agro-ecological environment.

Seedbed utilisation (SBU)

SBU was significantly influenced by the crop row spacing ($P<0.001$), seed boot treatment ($P<0.001$), and there was a significant interaction between row spacing and seed boot treatments ($P<0.001$). The SBU percentage ranged from 6% for wide row spacing with narrow seed boot to 29% for the normal row spacing with the splitter seed boot (Figure 1).

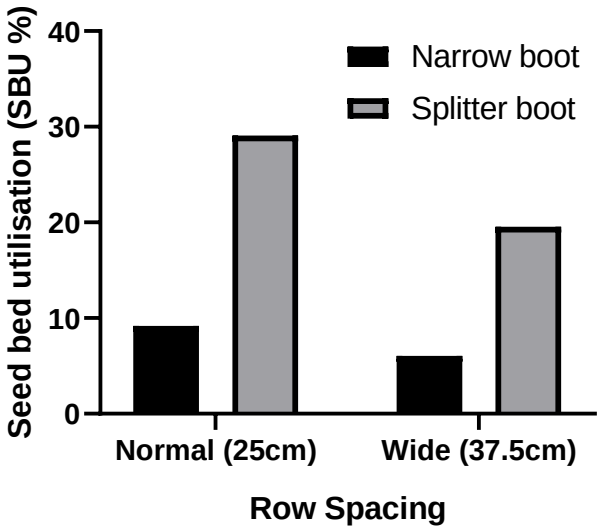

Figure 1. The effect of row spacing and seed boot treatments on seed bed utilisation (%). The LSD (P=0.05) is 0.93% SBU.

Annual ryegrass seedbank and plant density

Assessment of soil cores for ARG seedbank showed that the average seedbank at the trial site was 2680 ± 263 seeds/m^2. This level of ARG seedbank would be regarded as a moderate to heavy infestation. There was a significant variation in ARG seedbank identified across the replicates, where replicate 4 was significantly higher than rep 1 and 2. The blocking of the replicates at the site was able take account of this variation in ARG seedbank and it didn't have any adverse effect on the results.

As expected, herbicide treatment had a significant effect on ARG density (P<0.001). There was also an interaction between herbicide and row spacing treatments (P=0.026) (Figure 2). Averaged across the row spacing and seed boot treatments, Trifluralin (210 ARG plants/m^2) and Boxer Gold (26 ARG plants/m^2) reduced ARG plant density by 20% and 90%, respectively compared to the untreated control (262 ARG plants/m^2). The interaction between row spacing and herbicide treatments shown in Figure 2 indicate that row spacing only had a significant influence on trifluralin where significantly higher ARG control (24%) was achieved in the normal row spacing compared to the wide row spacing treatment. This is likely due to increased soil disturbance in the normal row spacing resulting in better incorporation of trifluralin in the soil. Trifluralin relies on effective soil incorporation to reduce herbicide losses from volatility and photodegradation. Though not significant, other treatments trended towards slightly higher ARG plant density in the normal row spacing treatments, this is also likely to be due to increased soil disturbance favouring ARG establishment.

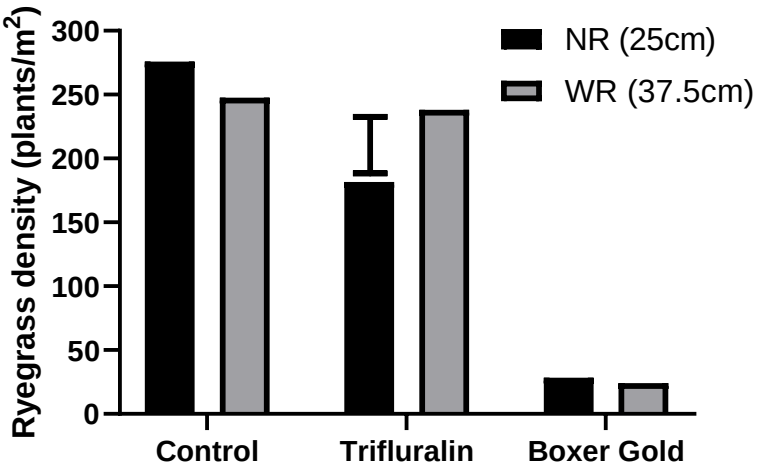

Figure 2. The effect of herbicide treatments and row spacing on ryegrass plant density. The vertical bar represents the LSD (P=0.05).

Annual ryegrass spike density and seed production

The density of ARG spikes was significantly influenced by row spacing (P<0.001), seed boot treatment (P=0.027), and the herbicide treatment (P<0.001). However, there was no interaction between these management factors. The 25cm row spacing had 20% lower ARG spike density than the 37.5cm row spacing treatment (Figure 3). The splitter seed boot treatment had 12% lower ARG spike density than the narrow seed boot treatment (Figure 3). Trifluralin reduced ARG spike density by only 20% compared to the untreated control, whereas Boxer Gold caused a 73% reduction in ARG spike density (Figure 4).

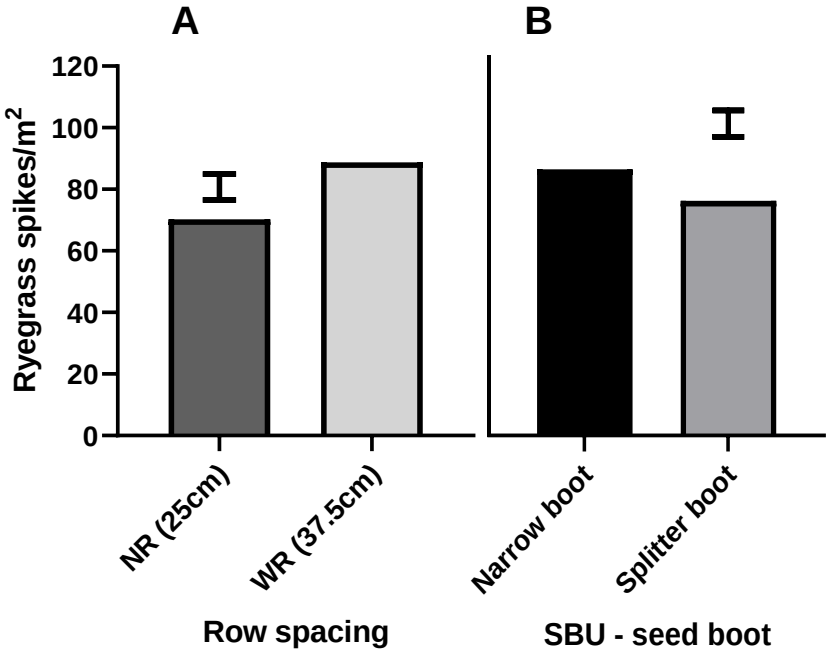

Figure 3. The effect of crop row spacing (A) and seed boot treatments (B) on ryegrass spike density. The vertical bar represents the LSD (P=0.05).

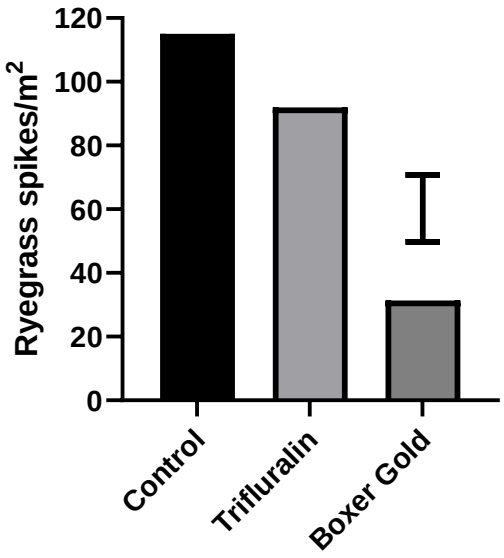

Figure 4. The effect of herbicide treatments on ryegrass spike density. The vertical bar represents the LSD (P=0.05).

Consistent with the spike density data, row spacing treatment (P=0.003), seed boot treatment (P=0.01), and the herbicide treatment (P<0.001) had a significant effect on ARG seed production. The normal row spacing set 38% less seed than the wide row spacing. The splitter seed boot treatment also had 32% lower ARG seed set compared to the narrow seed boot. These main effects were consistent for seed boot within row spacing treatments and vice versa, and can provide an additive effect when combined. The best performing treatment of normal row spacing and splitter boots set 2186 seeds/m^2, compared to the wide row spacing with narrow seed boot treatments that produced 5166 seeds/m^2 (Figure 5). This is a 2.4 fold difference in weed seed set between these treatments. ARG produced 4792 seeds/m^2 in the untreated control, which was reduced by 11% by Trifluralin and 69% by Boxer Gold (Figure 6). Only the Boxer Gold treatment produced significantly lower ryegrass seed than the untreated control. The poor performance of trifluralin suggests presence of a level of trifluralin resistance at this site. Seed collected from this site will be tested in 2020 to assess resistance to trifluralin. These results also highlight the difficulty of eliminating ARG through the use of pre-emergence herbicides alone. Even in the most expensive and effective treatment of Boxer Gold (>$30/ha), ARG was able to produce 1495 seeds/m^2. This moderate level of ARG seed production would be more than adequate to allow problematic weed establishment in crops grown next year. Therefore, growers need to consider integration of harvest weed seed control or other management tactics such as narrower row spacing and splitter boots to further reduce injection of ARG seeds into the seedbank.

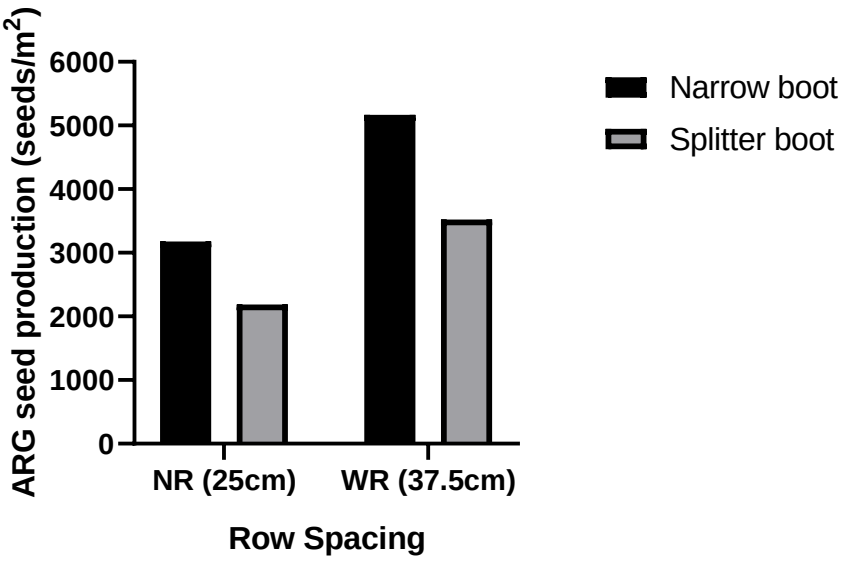

Figure 5. The effect of row spacing and seed boot treatments on ryegrass seed production across all herbicide treatments, columns are mean values (ARG seeds/m^2)

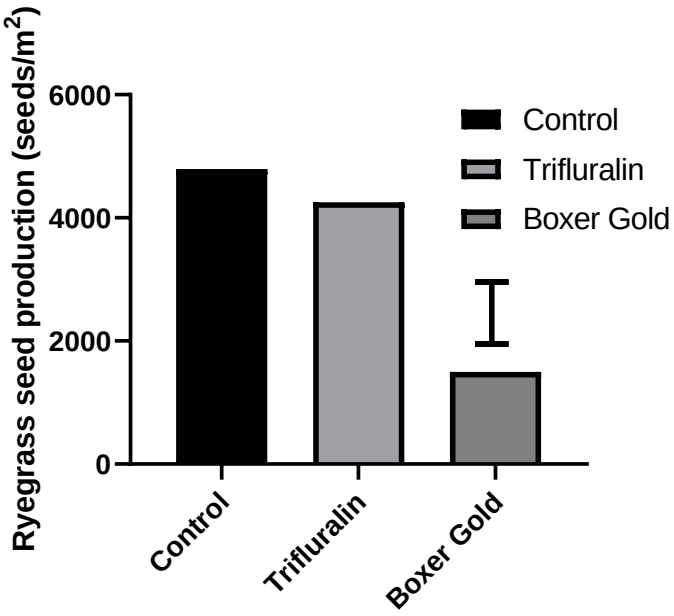

Figure 6. The effect of herbicide treatments on the density of ryegrass seed production. The vertical bar represents the LSD (P=0.05).

Barley grain yield

Barley grain yield was significantly influenced by crop row spacing (P=0.012) and herbicide treatments (P<0.001) but not by the seed boot design or by the interaction between these management factors. In 25 cm rows barley produced 2.784 t/ha grain yield, which was significantly greater than yield in 37.5 cm rows (2.617 t/ha). Even though the difference between the row spacing

treatments was only 6%, it was significantly different. Screenings were low in this trial, however screenings declined as weed control with herbicide treatments improved (P=0.001).

Barley grain yield increased significantly in response to ARG control with Trifluralin or Boxer Gold (Figure 7). These results also highlight the point that ARG is not highly competitive in barley. Presence of ARG at 262 plants/m^2 in the untreated control, only reduced grain yield by 8% compared to Trifluralin or 16% compared to Boxer Gold. However, it was still profitable to control ARG with herbicide treatments. Based on cash grain price of Feed Barley of ~$250/t in 2019, Trifluralin would be expected to increase the gross margin by $32/ha as compared $65/ha increase for Boxer Gold.

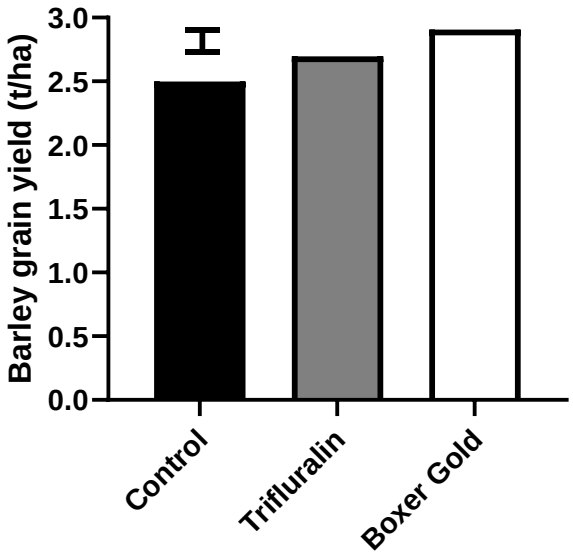

Figure 7. The effect of herbicide treatments on barley grain yield. The vertical bar represents the LSD (P=0.05).