The effect of combinations of crop row spacing, seedbed utilisation and pre-emergence herbicides on ryegrass management in wheat (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 soil moisture in early May was suitable for the activity of both pre-emergent herbicide treatments investigated in this trial. Averaged across the row spacing and seed boot treatments, Boxer Gold + Trifluralin and Sakura + Avadex reduced ARG plant density by 71% and 72%, respectively. The density of ARG spikes was significantly influenced by the row spacing ($P<0.001$), seed boot treatment ($P=0.002$), and the herbicide treatment ($P<0.001$). The 25cm row spacing had 43% lower ARG spike density than the 37.5cm row spacing treatment. The splitter seed boot treatment had 35% lower ARG spike density than the narrow seed boot treatment. Boxer Gold + Trifluralin reduced ARG spike density by 68% compared to the untreated control, whereas Sakura + Avadex caused a 70% reduction in ARG spike density. ARG seed production was also significantly affected by the row spacing ($P<0.001$), seed boot ($P=0.003$), and the herbicide treatment ($P<0.001$). The normal (25 cm) row spacing set 53% less seed than the wide row spacing. The splitter seed boot treatment also had 39% lower ARG seed set compared to the narrow seed boot. There was a 73% reduction in ARG seed production in the normal row spacing and splitter boot treatment compared to wide row spacing with single seed boot treatment. ARG produced 15483 seeds/m^2 in the untreated control, which was reduced by 62% by Boxer Gold + Trifluralin and 67% by Sakura + Avadex. This 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 for ARG management. Presence of ARG at 76 plants/m^2 in the untreated control, reduced wheat grain yield by 29% compared to Boxer Gold + Trifluralin or 30% compared to Sakura + Avadex.

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 wheat 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 (15”) – with and without DBS v2 / ground hog style splitter boots

Herbicides treatments (3):

(i) Control (knockdown treatment only)
(ii) Boxer Gold 1.5 L/ha + Trifluralin 1 L/ha incorporated by sowing (IBS)
(iii) Sakura 118 g/ha + Avadex Xtra 2 L/ha (IBS)

Variety: **Scepter**

Trial design: split plot design

Replicates: 4

Trial Management

Table 1. Key management operations undertaken.

Operation	**Details**
Location	Minnipa, SA
Seedbank soil cores	April, 2020
Plot size	1.5 m x 10 m
Seeding date	8 May, 2020
Fertiliser	At sowing – DAP (18:20) @ 60 kg/ha
Variety	Scepter wheat
Seeding rate	180 seeds/m^2
Herbicides	(i) Control (knockdown treatment only) (ii) Boxer Gold 1.5 L/ha + Trifluralin 1 L/ha incorporated by sowing (IBS) (iii) Sakura 118 g/ha + Avadex Xtra 2 L/ha (IBS)

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

All data collected during the growing season was analysed using the Analysis of Variance function in GenStat version 20.0.

In 2020, annual rainfall received at Minnipa was 12.6% above the long-term average and the growing season rainfall was 7.7% above the long-term average. The rainfall received in February, April and October was greater than the long-term average with all other months being well below the long-term average. Additional information on rainfall pattern for 2020 can be found in the report for Trial 7, undertaken in the same paddock.

Results and Discussion

Wheat plant density

Even though the same seed rate was used in the normal (25 cm) and wide row (37.5 cm) treatments, wheat plant density was 21% lower in the wide row spacing ($P<0.001$). Wheat plant density was significantly affected by the seed boot treatment ($P=0.019$), with 9% higher

crop establishment in the splitter boot treatment than normal boots. Herbicide treatment did not have a significant effect on wheat plant density (P=0.482), indicating good crop safety of pre-emergent herbicide treatments applied. The average wheat plant density in the trial was 123 plants/m^2, which is suitable for this agro-ecological environment.

Seedbed utilisation (SBU)

Seed bed utilisation was not measured at this site in 2020 but was measured in detail in 2019 in a trial with identical row spacing and seed boot treatments. In the previous trial, 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.

Annual ryegrass seedbank and plant density

Assessment of soil cores for ARG seedbank showed that the average seedbank at the trial site was 1218 ± 361 seeds/m^2. This level of ARG seedbank would be regarded as a moderate to heavy infestation.

As expected, herbicide treatment had a significant effect on ARG plant density (P<0.001). There was also a trend towards an interaction between herbicide and row spacing treatments (P=0.069) (Figure 1). Averaged across the row spacing and seed boot treatments, Boxer Gold + Trifluralin (22 ARG plants/m^2) and Sakura + Avadex (21 ARG plants/m^2) reduced ARG plant density by 71% and 72%, respectively compared to the untreated control (76 ARG plants/m^2). The interaction between row spacing and herbicide treatments shown in Figure 2 indicate that row spacing only had an influence on pre-emergent herbicides where higher ARG control (18 - 22%) 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 herbicides in the soil. This is particularly important for Trifluralin and to a lesser extent Avadex that rely on effective soil incorporation to reduce herbicide losses from volatility and photo-degradation.

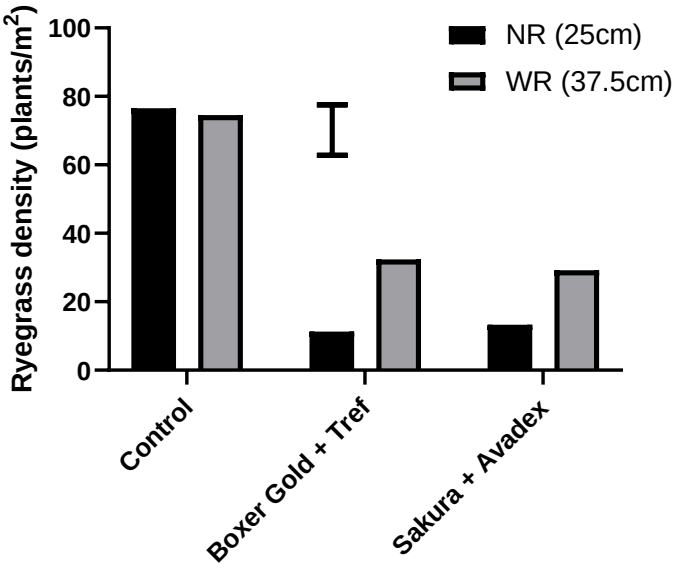

Figure 1. The effect of herbicide treatments and row spacing on ryegrass plant density. The vertical bar represents the LSD (P=0.05).

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=0.002), and the herbicide treatment (P<0.001). However, there was no interaction between these management factors. The 25cm row spacing had 43% lower ARG spike density than the 37.5cm row spacing treatment (Figure 2). The splitter seed boot treatment had 35% lower ARG spike density than the narrow seed boot treatment (Figure 3). Boxer Gold + Trifluralin reduced ARG spike density by 68% compared to the untreated control, whereas Sakura + Avadex Xtra caused a 70% reduction in ARG spike density (Figure 3).

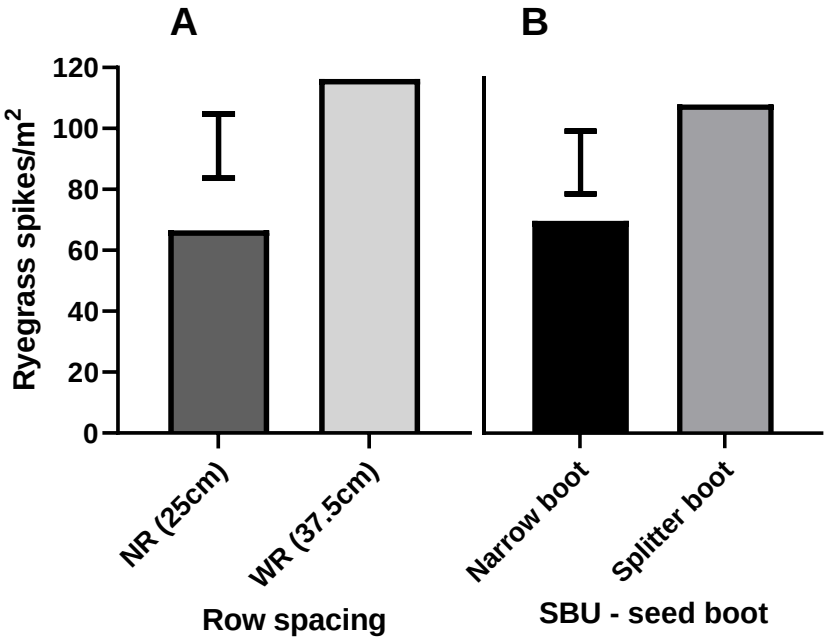

Figure 2. The effect of row spacing (A) and seed boot (B) treatments on ryegrass spike density. The vertical bar represents the LSD (P=0.05).

Consistent with the spike density data, ARG seed production was significantly affected by row spacing treatment (P<0.001), seed boot treatment (P=0.003), and the herbicide treatment (P<0.001). The normal row spacing set 53% less ARG seed than the wide row spacing. The splitter seed boot treatment also had 39% 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 allowed ARG to set 3865 seeds/m^2, compared to the wide row spacing with single seed boot treatments that produced 14471 seeds/m^2 (Figure 4). This is a 73% reduction in ARG seed production in the normal row spacing and splitter boot treatment compared to wide row spacing with single seed boot treatment. ARG produced 15483 seeds/m^2 in the untreated control, which was reduced by 62% by Boxer Gold + Trifluralin and 67% by Sakura + Avadex (Figure 5). Both herbicide treatments had significantly lower ryegrass seed set than the untreated control. These results highlight the difficulty of eliminating ARG through the use of pre-emergence herbicides alone. Even in the most expensive and effective treatment of Sakura + Avadex (>$50/ha), ARG was able to produce 5219 seeds/m^2. This 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.

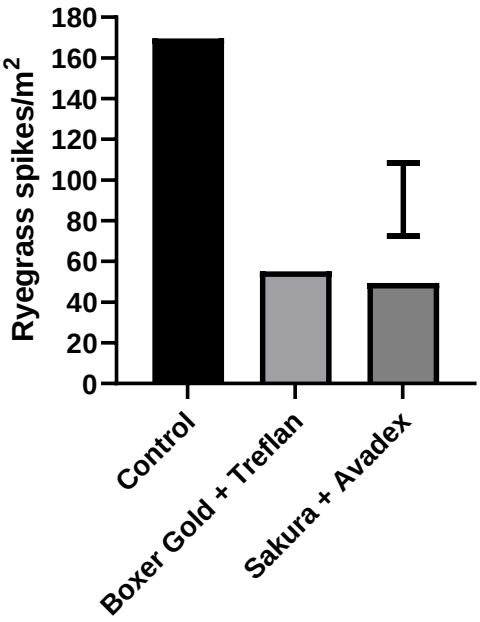

Figure 3. The effect of herbicide treatments on ryegrass spike density. The vertical bar represents the LSD (P=0.05).

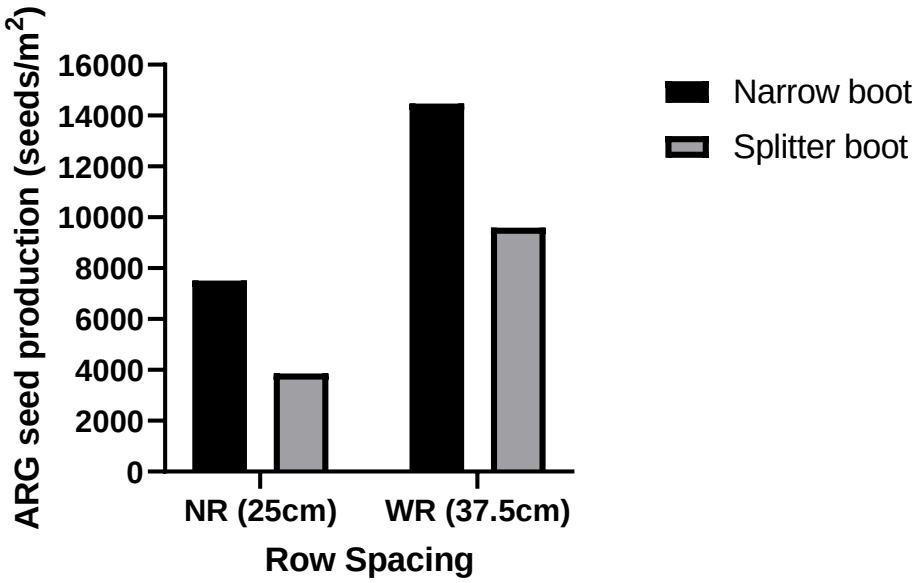

Figure 4. The effect of row spacing and seed boot treatments on ryegrass seed production across all herbicide treatments.

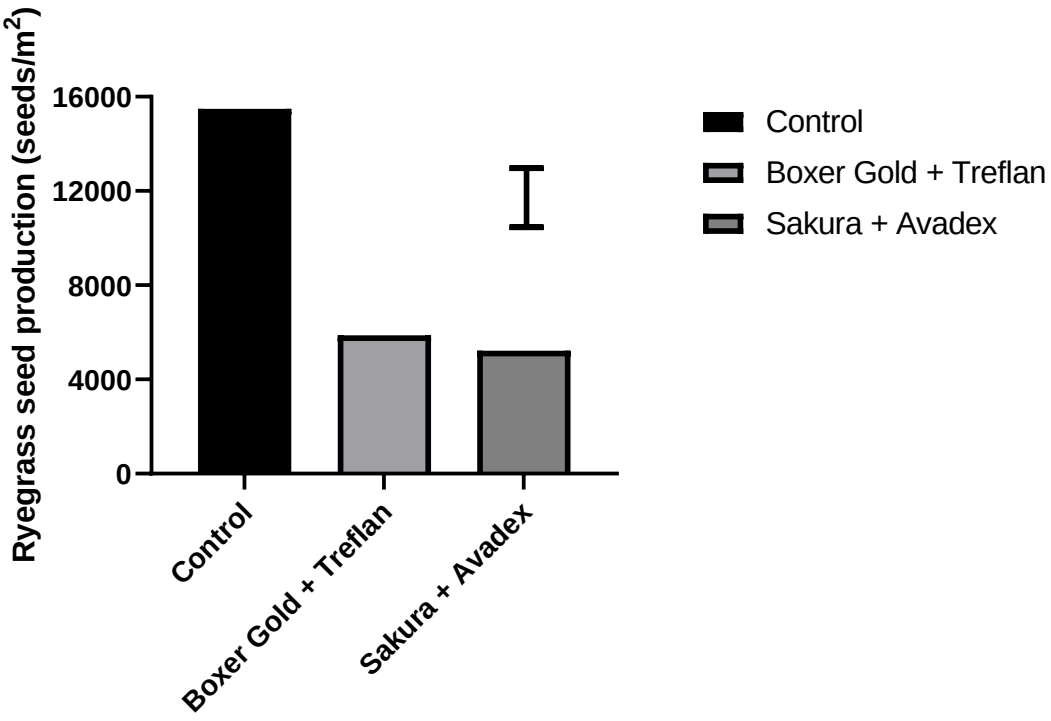

Figure 5. The effect of herbicide treatments on the density of ryegrass seed production. The vertical bar represents the LSD (P=0.05).

Wheat grain yield

Wheat grain yield was significantly influenced by crop row spacing (P=0.010), seed boot design (P=0.016) and herbicide treatments (P<0.001). There were no interaction between these management factors. In 25 cm rows wheat produced 2.870 t/ha grain yield, which was significantly greater (18%) than the yield in 37.5 cm rows (2.426 t/ha). The splitter seed boot treatment yielded 2.849 t/ha, which was significantly greater (16%) than the single seed boot treatment (2.447 t/ha). While there was no interaction between these main factors, like with ARG suppression, the effect on yield was additive (Table 2). The 25 cm spacing with the splitter boot yielded 3.072 t/ha of wheat, whereas the 37.5 cm spacing with single seed boot yielded 28% lower (2.226 t/ha).

Table 2. The effect of row spacing and seed boot on wheat yield (t/ha).

	Wheat grain yield (t/ha)	
Row spacing (cm)	**Splitter seed boot**	**Single seed boot**
25	3.072	2.668
37.5	2.627	2.226

Wheat grain yield increased significantly in response to ARG control with Boxer Gold + Trifluralin or Sakura + Avadex (Figure 6). Presence of ARG at 76 plants/m^2 in the untreated control, reduced grain yield by 29% compared to Boxer Gold + trifluralin or 30% compared to

Sakura + Avadex. This indicates how even a low to moderate ARG population can cause a significant yield penalty in wheat.

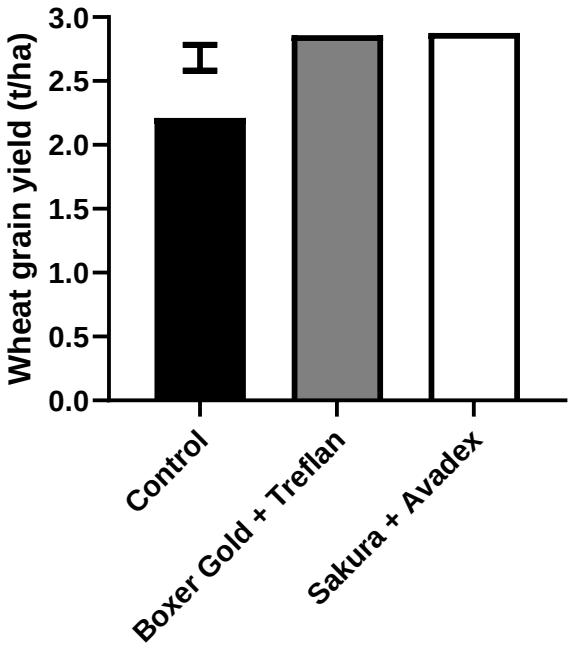

Figure 6. The effect of herbicide treatments on wheat grain yield. The vertical bar represents the LSD (P=0.05).

Wheat grain quality

Screenings percentage in wheat grain was significantly reduced by herbicides (P<0.001) but none of the treatments had a significant effect on grain protein (P>0.05). Grain size (1000 grain weight) was significantly affected by herbicide treatment (P=0.015), where Boxer Gold + Trifluralin (42.95 g/1000 grains) significantly increased grain size compared to the untreated control (39.80 g/1000 grains).