Effect of combinations of sowing time, seed rate and herbicides on ryegrass management in wheat (Washpool, SA)

Abstract

A field trial was undertaken at Washpool in 2019 to investigate combinations of wheat sowing time, seed rate and herbicide treatments to control annual ryegrass. The average seedbank of annual ryegrass (ARG) at the site was 2249 ± 284 seeds/m^2. There was no evidence at this site of any reduction in ryegrass infestation in wheat by delaying sowing by three weeks between TOS 1 (77plants/m^2) and TOS (74plants/m^2). This result suggests the Washpool ARG population likely has a high level of seed dormancy, reducing the rate of ryegrass germination after the opening rainfall events. Herbicide treatment had a significant influence on ARG plant density ($P<0.001$). Boxer gold and Sakura + Avadex reduced ARG plant density by 45% and 73% from the untreated control (125 ARG plants/m^2). Wheat was much more competitive against ARG when it was sown early. This was made evident by the large increase in ARG seed production when seeding was delayed. When averaged across all other treatments TOS 1 produced 1634 ARG seeds/m^2, which was 73% lower than 5974 ARG seeds/m^2 produced in TOS 2 ($P=0.013$). Wheat seed rate had a significant influence on ARG seed production ($P=0.005$), with the high wheat seed rate supressing ARG seed production by 37% when compared to the lowest wheat seed rate (100 seeds/m^2). Wheat grain yield at this site was significantly influenced by the time of sowing ($P=0.001$), seed rate ($P=0.001$), herbicide treatments ($P=0.001$), and the interaction between the time of sowing and herbicides ($P=0.011$). Wheat was much more tolerant to ryegrass competition when sown early (TOS 1) as shown by the small increase in grain yield in herbicide treated plots. In contrast, there was a significant increase in wheat grain yield in herbicide treatments in TOS 2. The results of this study clearly show that delayed sowing of wheat allows for greater seed set by ryegrass and is also associated with a large yield penalty.

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

Methods

This field trial investigated combinations of the following management tactics.

1. **Sowing time (2)**: mid 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) Nil (knockdown treatment only)
(ii) Boxer Gold 2.5 L/ha IBS
(iii) Sakura 118 g/ha + Avadex Xtra 1.6 L/ha IBS

Variety: Scepter

Trial design: split plot design
Replicates: 3

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

Trial Management

Table 1. Key management operations undertaken.

Operation	**Details**
Location	Washpool, SA
Seedbank soil cores	18 April, 2019
Plot size	2 m x 10 m
Seeding date	TOS 1: 15 May, 2019 TOS 2: 5 June, 2019
Fertiliser	At sowing – DAP+Zn+Impact (18:20:0:2) @ 75 kg/ha, Post application of Urea 7 August
Variety	Scepter wheat
Seeding rate	100 seeds/m^2 150 seeds/m^2 200 seeds/m^2
Herbicides	15 May and 5 June, 2019 (applied just before seeding) 1. Control (knockdown only) 2. Boxer Gold ((800 g/L prosulfocarb + 120 g/L s-metolachlor) 2.5 L/ha IBS 3. Sakura (pyroxasulfone 850 g/kg) 118 g/ha + Avadex Xtra (500 g/L tri-allate) 1.6 L/ha IBS

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 Washpool was 39% below the long-term average and the growing season rainfall was 28% 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 Washpool (Spalding SA) 2019 and the long-term average for the site.

	Rainfall (mm)	
Month	**2019**	**Long-term rainfall**
Jan	0.0	19.7
Feb	9.2	20.2
Mar	3.8	17.9
Apr	2.2	27.2
May	**59.2**	45.8
Jun	**58.8**	51.2
Jul	28.4	51.9
Aug	46.2	53.3
Sep	29.6	49.3
Oct	4.2	40.8
Nov	10.0	29.8
Dec	12.0	26.1
Annual total	263.6	433.4
GSR total	228.6	319.5

Results and Discussion

Wheat plant density

As expected, wheat seed rate had a significant effect on wheat plant density (P<0.001). There was a trend towards reduced crop establishment (%) with increasing crop seed rate. Despite this three clear crop density treatments were achieved (Figure 1).

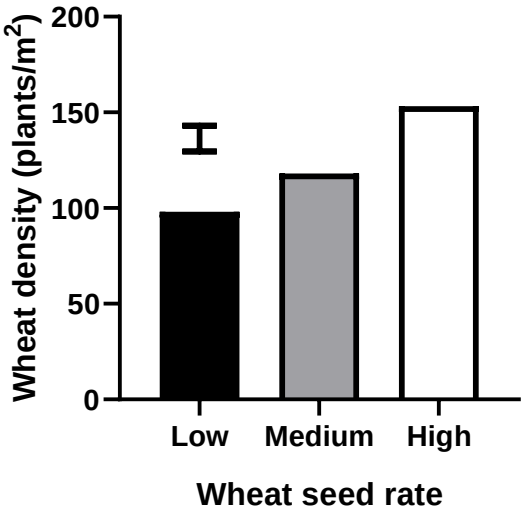

Figure 1. The effect of seed rate on wheat plant density. The vertical bar represents the LSD (P=0.05).

Annual ryegrass plant density and seedbank

The average seedbank of annual ryegrass (ARG) at the site was 2249 ± 284 seeds/m^2. ARG plant density was significantly influenced by the herbicide treatment (P<0.001). Boxer gold and Sakura + Avadex reduced ARG plant density by 45% and 73% from the untreated control (125 ARG plants/m^2).There was no evidence (P=0.917) at this site of any reduction in weed infestation by delaying sowing of wheat by three weeks between TOS 1 (77plants/m^2) and TOS (74plants/m^2). Weed populations are known to differ greatly in seed dormancy. It's quite likely that the Washpool population has a high level of seed dormancy, which reduces the rate of ryegrass germination after the season opening rainfall events.

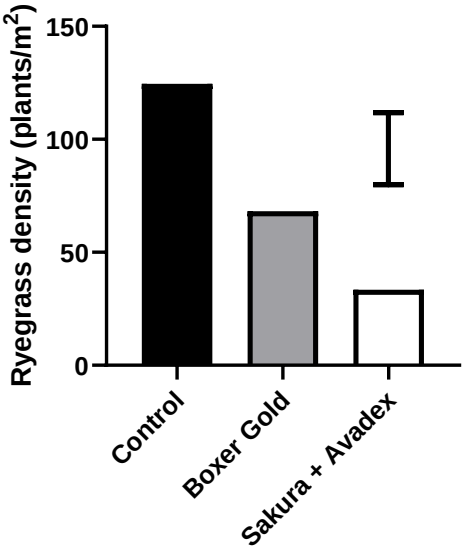

Figure 2. The effect of herbicide treatment on ARG plant density (P=0.001). The vertical bar represents the LSD (P=0.05).

Annual ryegrass spike density and seed production

ARG spike density was significantly influenced by the time of sowing (P=0.013), with TOS 2 (109 ARG spikes/m^2) having 65% more ARG seed spikes than TOS 1 (38 ARG spikes/m^2). This result suggests that earlier sown wheat was more competitive against ARG at Washpool. This can be clearly seen below in Figure 3, where earlier sown wheat is much larger and vigorous than the later sown wheat. Herbicide treatments had a significant influence on ARG spike density (P<0.001). Boxer gold and Sakura + Avadex treatments suppressed ARG spike density by 42% and 68% respectively compared to the untreated control (117 ARG spikes/m^2).

Figure 3. Wheat from Washpool site on 25 July 2019, TOS 2 sown 5 June (left) and TOS 1 sown 15 May (right).

Consistent with the trends observed for ARG spike density, ARG seed production was also significantly influenced by the time of sowing (P=0.013), wheat seed rate (P=0.005), herbicide treatments (P<0.001) and the interaction between the TOS and the herbicide treatments (P=0.016). Wheat was much more competitive against ryegrass when it was sown early (TOS 1; Figure 4). Even in the Control (knockdown only), ryegrass seed production was significantly lower in TOS 1 than in TOS 2. This trend of superior crop competitive ability against ryegrass was also evident in Boxer Gold and Sakura + Avadex treatments. As in-crop ryegrass density was quite similar between TOS 1 and 2, it can be argued that on a per plant basis, ryegrass was much more competitive against wheat sown under cold conditions of TOS 2 than the warmer conditions conducive for the early crop vigour in TOS 1. The combination of early sown wheat (TOS 1) and Sakura + Avadex treatment suppressed ARG seed set from 8638 ARG seeds/m^2 in the untreated control with delayed seeding (TOS 2) to 450 ARG seeds/m^2. This equates to a 95% reduction in ARG seed production. Wheat seed rate had a significant influence on ARG seed production (P=0.005), with the high wheat seed rate supressing ARG seed production by 37% when compared to the low wheat seed rate (Figure 5).

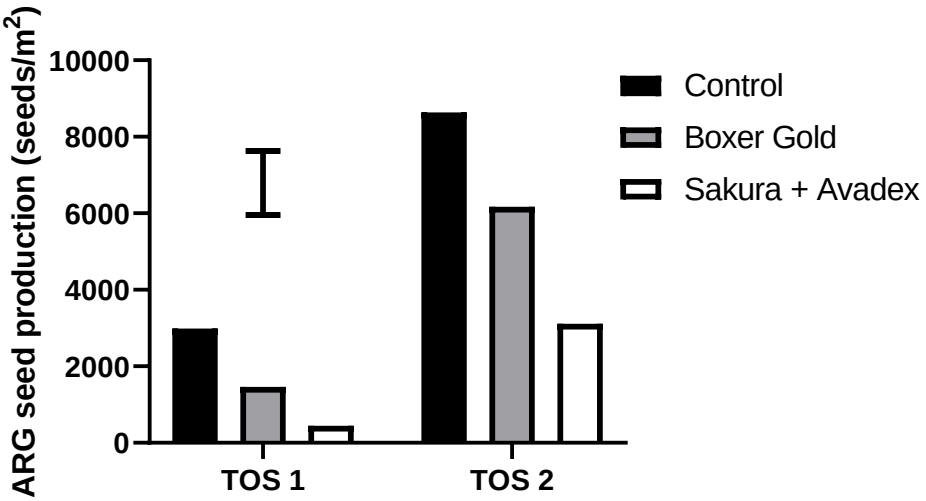

Figure 4. The effect of interaction between the time of sowing and herbicide treatments (P=0.016) on ARG seed production. The vertical bar represents the LSD (P=0.05).

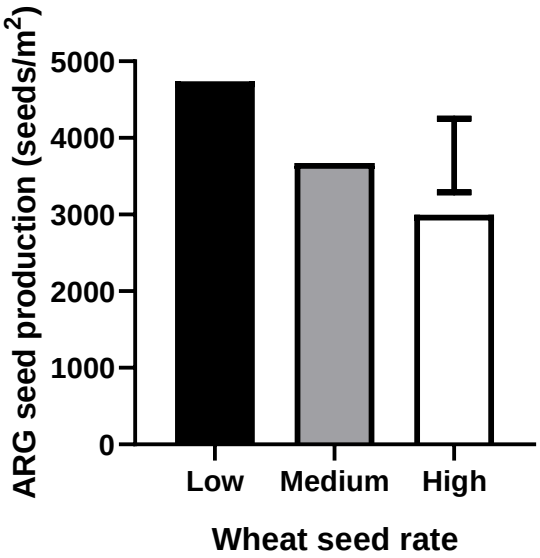

Figure 5. The effect of wheat seed rate (P=0.016) on ARG seed production. The vertical bar represents the LSD (P=0.05).

Wheat grain yield

Wheat grain yield at this site was significantly influenced by the time of sowing (P=0.001), seed rate (P=0.001), herbicide treatments (P=0.001), and the interaction between the time of sowing and herbicides (P=0.011). Wheat seed rate had a small, but significant effect on wheat grain yield. The highest wheat seed rate (2.866 t/ha) produced 9% more grain yield than the lowest seeding rate (2.638 t/ha). Wheat grain screenings percentage was low at the site and not influenced by the crop seed rate or any other treatments. Wheat was much more tolerant to ryegrass competition when sown early (TOS 1), which was reflected in the small (non-significant) increase in grain yield in herbicide treated plots. In contrast, there was a significant increase in wheat grain yield in herbicide treatments in TOS 2. The yield gap between TOS 1 and TOS 2 in herbicide treatments ranged from 45% in the Control to 40% in Boxer Gold and 32% in Sakura + Avadex. The yield gap between the two sowing dates ranged from 1.14 to 1.52t /ha. The results of this study clearly show that delayed sowing of wheat allows for greater seed set by ryegrass and is also associated with a large yield penalty. If delayed sowing is to be considered as a weed management strategy an understanding of the weed

seed dormancy is needed to determine its likely impact on future weed populations, let alone the potential yield losses from any delay in sowing.

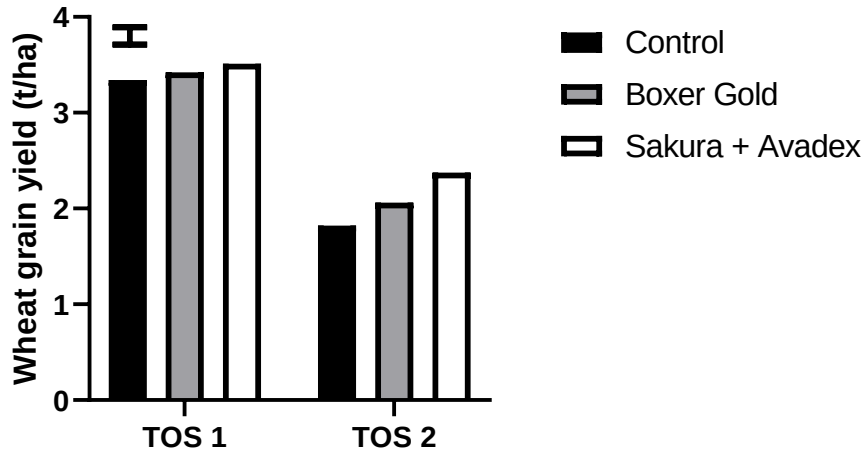

Figure 6. The effect of interaction between the time of sowing and herbicide treatments (P=0.011) on wheat grain yield. The vertical bar represents the LSD (P=0.05).