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

Abstract

A field trial was undertaken in 2020 to investigate combinations of wheat sowing time, seed rate and herbicide treatments to control annual ryegrass. Increase in wheat seed rate from 100 to 200 seeds/m^2 caused a significant reduction in ARG spikes and seed set. The level of additional weed suppression from higher wheat seed rate ranged from 30-35%. As expected, both pre-emergent herbicides caused a significant reduction ARG plant density, spikes and seed production. Even though there was a general trend for Sakura to be slightly more effective than Boxer Gold, these differences were non-significant. It is somewhat disconcerting to note that even with the use of the tank mix of Sakura + Avadex Xtra, ARG was able to set more than 34,000 seeds/m^2. These results highlight the need for integrating multiple weed control tactics to drive down the populations of this resilient weed. Wheat grain yield at Roseworthy ranged from 1.85 t/ha to 3.48 t/ha and with a site mean across all treatments of 2.773 t/ha. Time of sowing wheat did not have a significant effect on wheat grain yield in 2020 (P=0.168). However, wheat grain yield was significantly influenced by crop seed rate (P=0.023) and herbicide treatments (P=0.001). There was no interaction between these management factors. As seed rate increased from 100 to 200 seeds/m^2, wheat grain yield steadily increased by 15%. Herbicide treatments had a highly significant (P<0.001) effect on wheat grain yield in this trial, which was not surprising considering the high ARG seedbank and weed density. Application of Boxer Gold and Sakura + Avadex Xtra increased wheat yield by 41% and 54% compared to the untreated control.

Introduction

Change in crop sowing time can have multiple effects on crop-weed competition. Delayed sowing provides 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.

This field trial at Roseworthy 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)**: early May and late May
2. **Seed rate (3)**: Low (100 seeds/m^2), Medium (150 seeds/m^2), High (200 seeds/m^2)
3. **Herbicides (3)**:

(i) Untreated control (knockdown herbicide only)
(ii) Boxer Gold 2.5 L/ha IBS
(iii) Sakura 118 g/ha + Avadex Xtra 2 L/ha IBS

Trial design: split plot design with 3 replications

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 19.0.

Trial Management

Table 1. Key management operations undertaken.

Operation	**Details**
Location	Roseworthy Campus, SA
Seedbank soil cores	April, 2020
Plot size	1.5 m x 10 m
Seeding date	TOS 1: 6 May, 2020 TOS 2: 29 May, 2020
Fertiliser	At sowing – DAP + zinc (18:20:0:2) @ 100 kg/ha GS30 – 110 kg/ha urea on 17 July to TOS 1 and 5 August to TOS 2
Variety	Wheat cv. Scepter
Herbicides	Pre-Emergent herbicides 5 May and 28 May, 2020

Rainfall received at Roseworthy during the growing season was almost identical to the long-term average for the site. However, annual rainfall was 50 mm lower than the long-term average, which indicates a below-average summer rainfall (Table 2).

Table 2. Rainfall received at Roseworthy in 2020 and the long-term average for the site.

	Rainfall (mm)	
Month	**2020**	**Long-term rainfall**
Jan	9.6	17.0
Feb	20.2	19.7
Mar	1.6	17.9
Apr	61.2	30.4
May	32.6	38.7
Jun	29.4	45.2
Jul	15.6	43.8
Aug	44.8	45.9
Sep	49.8	46.1
Oct	51	30.1
Nov	9	25.7
Dec	12	25.7
Annual total	336.8	386.3
GSR total	284.4	280.2

Results and Discussion

Wheat plant density

There was a significant interaction between time of sowing and seed rate, which was reflected in 16 to 27% lower crop establishment in TOS 1 than TOS 2 (Table 3). An extended period of dry conditions at Roseworthy after seeding of the TOS 1 treatment is likely to responsible for the significantly lower crop establishment in TOS 1 than TOS 2. Still plant density increased with crop seed rate but target wheat densities were only achieved in TOS 2.

Table 3. The effect of wheat seed rate and time of sowing (TOS) on wheat plant density (P<0.001).

Seed rate (seeds/m^2)	**Wheat density (plants/m^2)**	
	TOS 1	**TOS 2**
100	88.9	107.4
150	129.3	153.7
200	143.4	197.3
LSD (P=0.05)	14.5	

Annual ryegrass seedbank, plant density, spike density and seed production

The average seedbank of annual ryegrass (ARG) at the site was 3670 ± 902 seeds/m^2. The time of sowing wheat did not have a significant effect on ARG plant density (P=0.292), ARG spikes/m^2 (P=0.739) and ARG seed production (P=0.193). Even though there was a gap of more than 3 weeks between the two sowing dates, it did not lead to a significant depletion of ARG seedbank. The period between the two sowing dates (23 days) was fairly dry as the trial site only received 17.8 mm rainfall over that time, which was inadequate to cause substantial seedling emergence of ARG.

Increase in wheat seed rate from 100 to 200 seeds/m^2 caused a significant reduction in ARG spikes and seed set (Table 4). The level of additional weed suppression from higher wheat seed rate ranged from 30-35%. As expected, both pre-emergent herbicides caused a significant reduction to ARG plant density, spikes and seed production (Table 5). Even though there was a general trend for Sakura to be slightly more effective than Boxer Gold, these differences were non-significant. It is somewhat disconcerting to note that even with the use of the tank mix of Sakura + Avadex Xtra, ARG was able to set more than 34,000 seeds/m^2. This result highlights the need for integrating multiple weed control tactics to drive down the populations of this resilient weed.

Table 4. Effect of wheat seed rate on annual ryegrass (ARG) spike density and seed set. Means followed by a different letter within a column represent significant (P=0.05) differences.

Wheat seed rate (seeds/m^2)	**ARG Spikes/m^2**	**ARG Seeds/m^2**
100	1129 ***b***	54232 ***b***
150	1022 ***ab*** (9%)	47872 ***b*** (12%)
200	785 ***a*** (30%)	35367 ***a*** (35%)

Table 5. Effect of herbicide treatments on annual ryegrass (ARG) plant density, spike density and seed set. Different letters within a column represent significant (P=0.05) differences in treatment means.

Herbicides	**ARG plants/m^2**	**ARG spikes/m^2**	**ARG seeds/m^2**
Untreated Control	686 ***b***	1267 ***b***	57636 ***b***
Boxer Gold	334 ***a*** (51%)	919 ***a*** **(27%)**	45324 ***a*** (21%)
Sakura + Avadex	226 ***a*** (67%)	751 ***a*** **(40%)**	34510 ***a*** (40%)

Wheat grain yield

Wheat grain yield at Roseworthy ranged from 1.85 t/ha to 3.48 t/ha and with a site mean across all treatments of 2.773 t/ha. Sowing time of wheat did not have a significant effect on wheat grain yield in 2020 (P=0.168). However, wheat grain yield was significantly influenced by crop seed rate (P=0.023) and herbicide treatments (P=0.001). There was no interaction between these management factors. As seed rate increased from 100 to 200 seeds/m^2, wheat grain yield steadily increased by 15%.

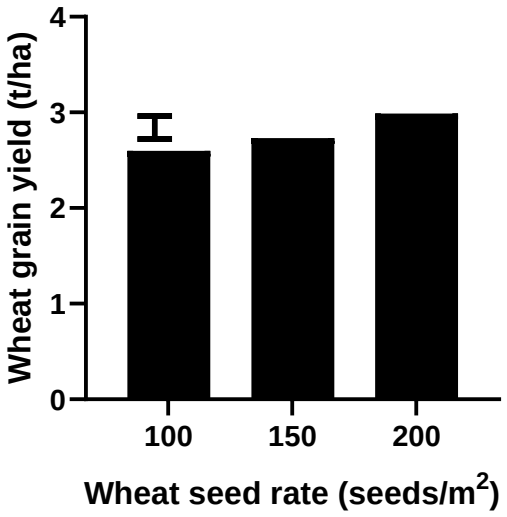

Figure 1. The effect of wheat seed rate on grain yield (P=0.023). The vertical bar represents the LSD (P=0.05).

Herbicide treatments had a highly significant (P<0.001) effect on wheat grain yield in this trial, which was not surprising considering the high ARG seedbank and weed density. Application of Boxer Gold and Sakura + Avadex Xtra increased wheat yield by 41% and 54% compared to the untreated control (Figure 2). As there was no interaction between herbicide treatments and other management factors (sowing time and seed rate), combined effects of these treatment factors have been presented.

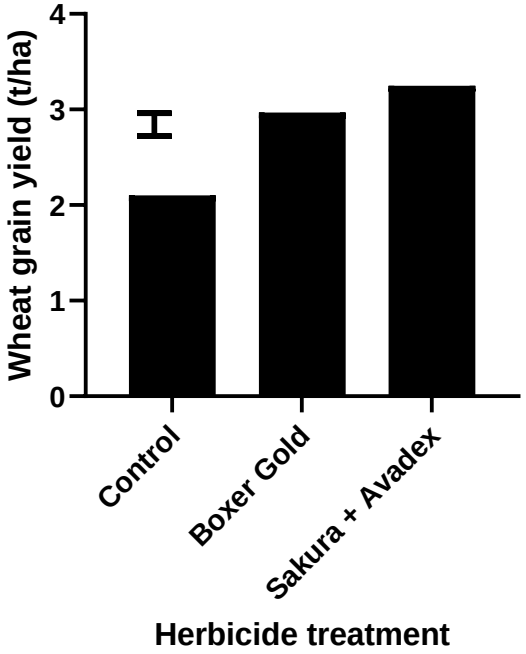

Figure 2. The effect of herbicide treatments on wheat grain yield (P=0.001). The vertical bar represents the LSD (P=0.05).

Grain size of wheat was significantly influenced by the interaction between time of sowing and herbicide treatments (Table 6). TOS 2 had larger grain size than the earlier sown crop (TOS 2), which may be associated with good rainfall received in October. The earlier sown crop had already completed its grain filling and may not have benefitted from these late rainfall events. In TOS 1, Sakura + Avadex treatment produced larger grain size than the untreated control and Boxer Gold, which may be associated with its superior weed control.

Table 6. The effect of the interaction between wheat time of sowing and herbicide treatments on 1000-grain weight of wheat (P=0.043). Different letters within a column represent significant (P=0.05) differences in treatment means.

Time of sowing	**Wheat 1000-grain weight (g)**		
	Control	**Boxer Gold**	**Sakura + Avadex**
1 (May 6)	39.14 c	39.83 c	42.34 b
2 (May 29)	44.77 a	46.45 a	45.85 a