Effect of wheat seed rate and pre-emergent herbicides in annual ryegrass control (Roseworthy, SA)

Abstract

Pre-emergent herbicide treatments had a significant effect on annual ryegrass (ARG) plant density (P<0.001), ARG spike density (P<0.001) and its seed production (P<0.001). Wheat seed rate on the other hand, did not have any effect on ARG spike density or ARG seed set. In this trial, the lowest target wheat density was 150 plants/m^2, which appears to be adequate for providing competition with ARG. Even with the use of the best pre-emergent herbicide treatments, ARG was able to produce more than 28,000 seeds/m^2. These results indicate that even with the best pre-emergent herbicides currently available, ARG seedbanks are likely to build-up after the wheat phase in problem paddocks. Therefore, integration of pre-emergent herbicides with tactics such as harvest weed seed control is extremely important. ARG was highly competitive with wheat in this trial, which was reflected in large yield increases in the effective treatments. For example, wheat yield increased by 70% (1.4 t/ha) in the Overwatch® treatment compared to the untreated control. In contrast Boxer Gold®, which had higher ARG spike density also provided a smaller increase in wheat grain yield.

Introduction

As a result of widespread resistance in annual ryegrass to post-emergent herbicides in Australia, growers are now relying heavily on pre-emergent herbicides. Boxer Gold® and Sakura® have been widely used by the growers in cereal crops for the control of annual ryegrass for several years. There are now some reports of ryegrass populations developing resistance to Boxer Gold. Industry has welcomed the release of two new pre-emergent herbicides Luximax® (cinmethylin) and Overwatch® (bixlozone) in Australia. These two herbicides belong to different mode of action groups and have widened the range of herbicides available for use in grain crops. Crop seed rate is an easy tactic for the growers to adopt provided they are convinced of its benefits to weed management and profitability. Many previous studies have shown the benefits of higher crop seed rates for weed suppression including ryegrass.

This field trial at Roseworthy was undertaken to investigate factorial combinations of wheat seed rate and pre-emergent herbicides on the management of annual ryegrass in wheat.

Methods

Table 1. Details of management practices used for crop and weed management.

Operation	**Details**
Location	Roseworthy, SA
Seedbank soil cores	April, 2020
Plot size	1.5 m x 10 m
Seeding date	15 May, 2020
Fertiliser	At sowing: DAP (18:20) @ 100 kg/ha In season: 110 kg/ha urea at GS30
Variety	Scepter wheat
Seeding rate	150, 200 and 250 seeds/m^2
Herbicides	All herbicides applied just before seeding

	1. Boxer Gold® 2.5 L/ha IBS 2. Sakura 118 g/ha 3. Luximax 500 mL/ha 4. Overwatch 1.25 L/ha 5. Untreated Control (knockdown treatment only)

Trial design: factorial randomised block design

Replicates: 4

Measurements: pre-sowing weed seedbank, crop density, weed density, ARG spike density, ARG seed production, wheat grain yield, wheat heads/m^2, 1000-grain weight.

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

Seed rate had a significant ($P<0.001$) effect on wheat plant density, which was expected. Crop establishment ranged from 92 to 97%, which was most likely related to excellent soil moisture at seeding and good seeder set up (Table 3). More importantly, none of the pre-

emergent herbicides reduced crop establishment due to phytotoxic effects (P=0.913). There have been previous reports of crop damage by Luximax in particular. This was however, not observed in this trial, which may be due good clay content of the soil as well as good depth control of the seeder. Furthermore, there were no heavy rainfall events straight after the seeding operation.

Table 3. Effect of increasing wheat seed rate on its plant establishment (P<0.001).

Seed rate (seeds/m^2)	Plants/m^2	Establishment (%)
150	145.8	97.2
200	183.5	91.8
250	228.8	91.5
LSD (P=0.05)	14.43	-

Annual ryegrass plant density and seedbank

The average seedbank of annual ryegrass (ARG) at the site was 6272 ± 591 seeds/m^2. ARG plant density in this trial was significantly affected only by the herbicide treatment (P<0.001; Table 4). ARG plant density in the Untreated Control was 1666 plants/m^2, which is equivalent to 27% of the autumn seedbank. All pre-emergent herbicides significantly reduced ARG plant density compared to the Untreated Control. Even though Overwatch provided greater control of ARG, there were no statistically significant differences between the herbicide treatments.

Annual ryegrass spike density and seed production

ARG spike density and seed production was only influenced by the herbicide treatment (P<0.001). Crop seed rate had no significant effect on ARG spikes (P=0.754) or seed production (P=0.357). This was somewhat unexpected because previous research has shown halving of ARG seed production with doubling of wheat seed rate from 100 to 200 plants/m^2. In this trial, the lowest seed rate was 150 seeds/m^2 not 100 seeds/m^2 in previous studies. Furthermore, favourable growing conditions in May could have resulted in greater tillering in wheat sown at the lowest seed rate, which allowed it to compensate for the lower plant density. As a result of the high ARG seedbank at the site, the untreated control had 1666 plants/m^2, which produced 1206 spikes/m^2. These results indicate mortality of some ARG plants due to inter- and intraspecific competition. Still ARG was able to produce a massive amount of seed set (Table 4). Even the best herbicide treatment (Overwatch) allowed ARG to produce more than 28,000 seeds/m^2. These results indicate that even with the best pre-emergent herbicides currently available, ARG seedbanks are likely to build-up after the wheat phase in problem paddocks. Therefore, integration of pre-emergent herbicides with tactics such as harvest weed seed control is extremely important. There was a strong linear relationship between ARG plant density and ARG spike density indicating that plants that survived the herbicide treatments were able to complete their life cycle and contributed to seed production (Figure 1).

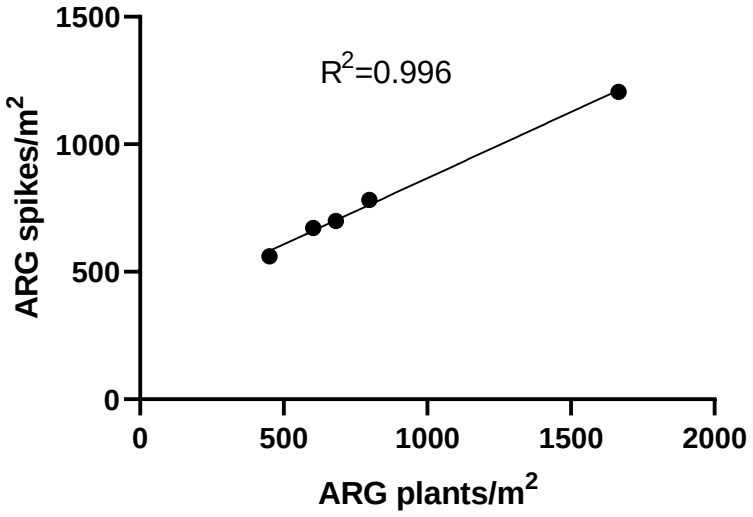

Figure 1. The linear relationship between ARG plant density and ARG spike production.

Table 4. Effect of herbicide treatments on annual ryegrass (ARG) density (P<0.001), number of spikes (P<0.001)) and seed production (P<0.001). Different letters within a column indicate statistically significant differences at P=0.05.

Treatment	ARG plants/m^2	ARG spikes/m^2	ARG seeds/m^2
Untreated Control	1666 a	1206 a	60564 a
Sakura 118 g/ha	682 b	699 b	35179 b
Boxer Gold 2.5 L/ha	798 b	782 b	39541 b
Luximax 500 mL/ha	603 b	672 bc	34866 bc
Overwatch 1.25 L/ha	450 b	561 c	28600 c

Wheat head density and grain yield

Wheat head density is usually considered a strong contributor to its grain yield. In this trial wheat head density was strongly influenced by the herbicide treatment (P<0.001) but not by the seed rate (P=0.365). ARG was highly competitive with wheat in this trial, which is reflected in large yield increases in the more effective treatments (Table 5). For example, wheat yield increased by 70% in the Overwatch treatment compared to the untreated control. In contrast Boxer Gold, which had higher ARG spike density also provided a smaller increase in wheat grain yield. The strong competitive effect of ARG can be clearly seen in the negative slope of the regression between ARG spike density and wheat yield (Figure 2).

Table 5. Effect of herbicide treatments on wheat grain yield (P<0.001), 1000-grain weight (P<0.001) and heads/m^2 (P<0.001). Different letters within a column indicate statistically significant differences at P=0.05.

Treatment	Grain yield (t/ha)	1000-grain wt. (g)	Wheat heads/m^2
Untreated Control	2.003 ***c***	38.76 ***b***	252.5 ***b***
Sakura 118 g/ha	3.320 ***a***	41.56 ***ab***	293.5 ***a***
Boxer Gold 2.5 L/ha	2.850 ***b***	40.23 ***b***	292.4 ***a***
Luximax 500 mL/ha	3.192 ***ab***	41.55 ***ab***	296.6 ***a***
Overwatch 1.25 L/ha	3.417 ***a***	41.99 ***a***	300.2 ***a***

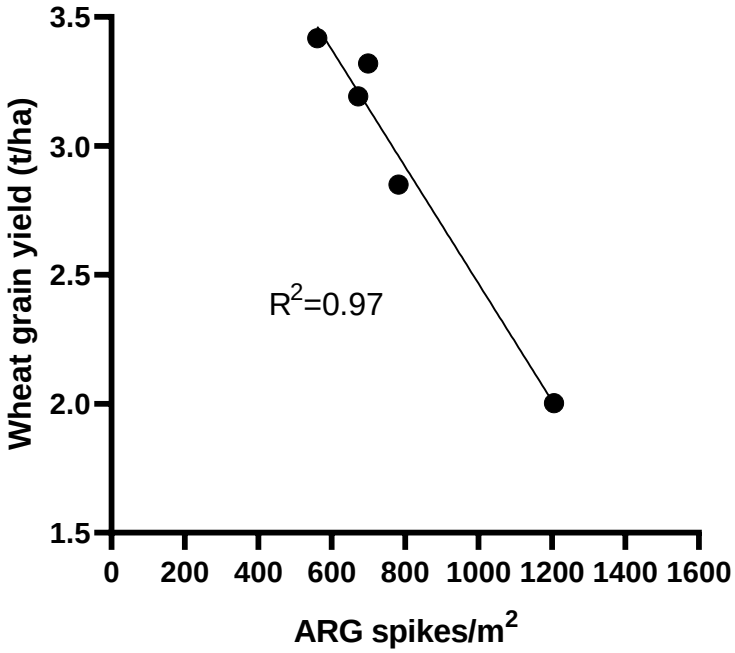

Figure 2. The relationship between ARG head density and wheat yield in different herbicide treatments. Strong negative linear relationship indicates negative effects on ARG competition on wheat. Each dot in the figure represents a different herbicide treatment.

In this field trial at Roseworthy in 2020, pre-emergent provided varying levels of ARG control, which was reflected in weed density and ARG spike density. Pre-emergent herbicides proved ineffective in preventing a build-up in ARG seedbank. This result highlights the need for integration of other management tactics such as harvest weed seed control to minimise the replenishment of ARG seedbank. Furthermore, there is a clear need to diversify crop and herbicide rotations to manage ARG infestations. Pre-emergent herbicides provided large benefits in wheat yield increases with yields increasing by up to 70% in the Overwatch treatment as compared to the untreated control.