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

Key messages

- The site mean for ARG plant density was 845 plants/m^2, which is a reflection of the high seedbank. Delay in sowing from TOS 1 to TOS 2, reduced ARG plant density by 27% in the control (knockdown only). Further delay in sowing (TOS 3), reduced ARG plant density by 39%. Among herbicide treatments, Overwatch + Avadex Xtra provided the greatest reduction ARG plant density in all TOS.
- As wheat seed rate was increased from 100 to 200 seeds/m^2, ARG spike density declined by 37%, which is quite similar to the previous results. Further increase in wheat seed rate had a marginal additional benefit for reducing ARG spike density.
- As wheat seed rate increased from 100 to 200 seeds/m^2, ARG seed set decreased by 41%. Further increase in wheat seed rate to 300 seeds/m^2 only had a small additional effect on ARG seed set.
- When only the knockdown herbicide was used to control ARG (control), wheat grain yield increased with delayed sowing, which is most likely due to improvement in ryegrass control. However when pre-emergent herbicides were used, wheat yield declined with delay in sowing. In these pre-emergent treatments, grain yield declined by >1 t/ha as crop sowing was delayed from 21 May (TOS 1) to 27 June (TOS 3).
- Yield improvements of more than 3 t/ha were achieved by combining early sowing with optimum wheat seed rate and effective pre-emergent herbicides.

Background

Delayed sowing can provide opportunities to exhaust the weed seedbank before seeding the crop. However, late sown crops can be less competitive with weeds due to cold and wet conditions and may allow weeds to set a large amount of seeds. Delayed sowing can also reduce crop yield so the gains made in weed control may be nullified by the yield penalty. In high rainfall environments, delayed sowing can lead to difficulties in getting back on to paddocks due to excessively wet soils and water-logging. The review of Widderick et al. (2015) on weed management recommended research on sowing time in many crops. Increase in crop plant density has also been shown to improve weed suppression. In research by Lemerle et al. (2004), doubling wheat plant density from 100 to 200 plants/m^2 halved ryegrass shoot biomass. Therefore, higher wheat plant densities can be an effective component of weed management and should be integrated with herbicides.

This field trial was undertaken at Roseworthy in South Australia, a medium rainfall environment, to investigate factorial combinations of sowing time, seed rate and herbicides on the management of annual ryegrass in wheat.

Methods

This field trial was established in a split plot design and investigated combinations of the wheat sowing time, seed rate and herbicides for annual ryegrass control.

Table 1. Management details.

Operation	**Details**
Location	Roseworthy, SA
Seedbank soil cores	April, 2021
Plot size	1.5 m x 10 m
Seeding date	TOS 1: 21 May, 2021; TOS 2: 3 June, 2021 TOS 3: 27 June, 2021
Seeding rate	100, 200 and 300 seeds/m^2
Herbicide treatments	1. Control (knockdown herbicide only) 2. Overwatch 1.25 L/ha + Avadex Xtra ~~Xtra~~ 2 L/ha IBS 3. Sakura 118 g/ha + Avadex Xtra 2 L/ha IBS 4. Trifluralin 2 L/ha + Avadex Xtra 2 L/ha IBS
Replicates	4
Variety	Scepter
Seeder	Knife points, press wheels, 25 cm row spacing

All data collected during the growing season was analysed using the Analysis of Variance function in GenStat version 19.0.

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

Roseworthy experienced extremely dry conditions during autumn in 2021 (Table 2). The month of April only received 11.4 mm rain as compared to the long-term average of 30.9 mm. Rainfall during winter months was well above-average, especially in July. September was quite dry with less than half the long-term average but the crop finished well with good rainfall in October and November. Rainfall received during the growing season and the year as a whole was about 6% greater than the long-term average for Roseworthy.

Table 2. Rainfall received at Roseworthy in 2021 and the long-term average for the site.

	Rainfall (mm)	
Month	**2021**	**Long-term average**
Jan	16.4	18.9
Feb	16.2	19.6
Mar	11.4	16.9
Apr	11.4	30.9
May	25.2	37.9
Jun	60.6	45.2
Jul	87.4	44.4
Aug	42.2	45.7
Sep	16.8	45.0
Oct	54.6	32.0
Nov	59.0	26.4

Dec	2.4	24.2
Annual total	403.6	379.5
GSR total	298.2	281.1

Results and Discussion

Wheat plant density

As expected wheat plant density was significantly influenced by the seed rate (P<0.001). Crop establishment was slightly higher (2-18%) than the target plant density. Plant density achieved was 118, 210 and 305 plants/m^2 in the three seed rate treatments. Establishment percentage ranged from 118% at 100 seeds/m^2 to 102% at 300 seeds/m^2. These plant densities were expected to provide clear differences in weed suppression in this trial.

Ryegrass plant and spike density

The trial site had a very large seedbank of annual ryegrass (20,251 ± 1992 seeds/m^2), which provided an excellent opportunity to investigate interactions between sowing time, seed rate and herbicides. The site mean for ARG plant density was 845 plants/m^2, which is a reflection of the high seedbank. ARG plant density was significantly affected by the interaction (P=0.002) between time of sowing and herbicide treatments (Table 3). This interaction appears to be largely associated with a significant reduction in ARG plant density in wheat within the control treatments, but there were weaker trends in the herbicide treated plots. In the control, a delay in sowing from TOS 1 to TOS 2, reduced ARG plant density by 27%. Further delay in sowing (TOS 3), reduced ARG plant density by 39%. Among herbicide treatments, Overwatch + Avadex Xtra provided the greatest reduction ARG plant density in TOS 1 and 2.

Table 3. Effect of herbicide treatments on annual ryegrass plant density in wheat. Means followed by different letters represent significant differences (P=0.05).

Herbicide treatment	**Ryegrass density (plants/m^2)**		
	TOS 1	**TOS 2**	**TOS 3**
Control (knockdown herbicide only)	3131 c	2297 d	1393 e
Overwatch 1.25 L/ha + Avadex Xtra 2 L/ha IBS	107 a	102 a	164 ab
Sakura 118 g/ha + Avadex Xtra 2 L/ha IBS	424 b	411 b	216 ab
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha IBS	775 b	560 b	559 b
P	0.002		

Increase in wheat seed rate had a significant effect on ryegrass suppression (Figure 1). As seed rate increased from 100 to 200 seeds/m^2, ARG spike density declined by 37%, which is quite similar to the results previously reported by Lemerle et al. (2004). Further increase in wheat seed rate only had a marginal additional benefit for reducing ARG spike density (Figure 1). From weed management perspective, wheat seed rate of 200 seeds/m^2 appears ideal for the management of ARG.

ARG spike density was also significantly (P<0.001) affected by the herbicide treatment (Table 4). Mixture of Overwatch or Sakura with Avadex Xtra reduced ARG spike density by 83% as compared to 55% reduction by Trifluralin + Avadex Xtra.

Table 4. Effect of herbicide treatments on ryegrass spike density. Means followed by different letters represent significant differences (P=0.05).

Herbicide treatment	**Ryegrass spikes/m^2**
Control (knockdown herbicide only)	2598 c
Overwatch 1.25 L/ha + Avadex Xtra 2 L/ha IBS	432 a (83%)[1]
Sakura 118 g/ha + Avadex Xtra 2 L/ha IBS	438 a (83%)
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha IBS	1178 b (55%)
P	<0.001

[1] Values in brackets represent %age reduction in ARG spikes compared to the control.

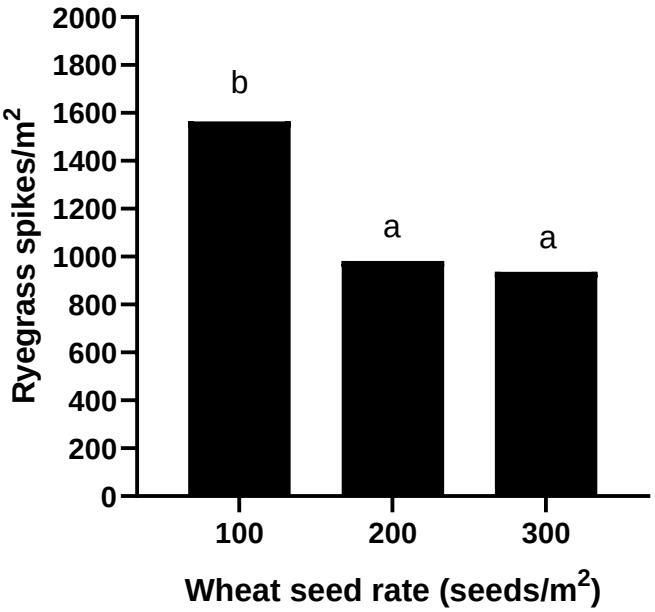

Figure 1. The response of ryegrass spike density to increase in wheat seed rate. Columns with a different letter are significantly different (P=0.05) from each other.

Ryegrass seed production

Seed set by ARG was significantly affected by wheat seed rate (P<0.001) and herbicide treatments (P<0.001). As wheat seed rate increased from 100 to 200 seeds/m^2, ARG seed set decreased by 41%. Further increase in wheat seed rate to 300 seeds/m^2 only had a small additional effect on ARG seed set (Figure 2).

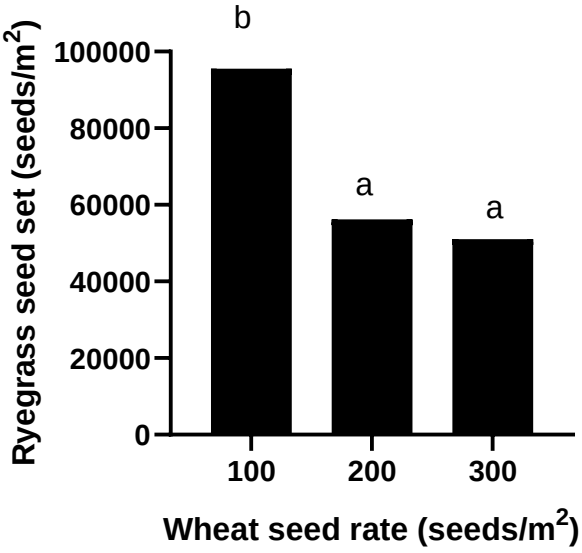

Figure 1. The response of ryegrass seed set to increase in wheat seed rate. Columns with a different letter are significantly different (P=0.05) from each other.

Large ryegrass infestation at this site was able to produce >140,000 seeds/m^2 when only the knockdown herbicide was used at crop sowing (Table 4). Even with the best pre-emergent herbicide option, ryegrass was able to produce >25,000 seeds/m^2. These results clearly highlight the need for integrating improved crop competitive ability and harvest weed seed control with herbicides for preventing replenishment of ARG seedbank when dealing with heavy infestations.

Table 4. Effect of herbicide treatments on annual ryegrass seed production in wheat. Means followed by different letters represent significant differences (P=0.05).

Herbicide treatment	**Ryegrass seed production (seeds/m^2)**
Control (knockdown herbicide only)	142938 c
Overwatch 1.25 L/ha + Avadex Xtra 2 L/ha IBS	27887 a
Sakura 118 g/ha + Avadex Xtra 2 L/ha IBS	25116 a
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha IBS	74468 b
P	<0.001

Wheat grain yield

Wheat grain yield was significantly influenced by the time of sowing wheat (P=0.001), seed rate (P<0.001) and herbicide treatment (P<0.001). There was also a significant interaction between time of sowing and herbicides (P<0.001) and between seed rate and herbicides (P=0.04). When only the knockdown herbicide was used to control ARG (control), wheat grain yield increased with delayed sowing (Table 4), which is most likely due to improvement in ryegrass control. However when pre-emergent herbicides were used, wheat yield declined with delay in sowing. In these pre-emergent treatments, grain yield declined by >1 t/ha as crop sowing was delayed from 21 May (TOS 1) to 27 June (TOS 3). It appears reduction in

resource utilisation by crop due to delayed sowing is greater than the impact of ryegrass competition when pre-emergent herbicides are used.

Table 4. The effect of interaction between time of sowing wheat and herbicides on wheat grain yield. Means followed by different letters represent significant differences (P=0.05).

Herbicide treatment	**Wheat grain yield (t/ha)**		
	TOS 1	**TOS 2**	**TOS 3**
Control (knockdown herbicide only)	3.263 f	3.747 e	3.886 e
Overwatch 1.25 L/ha + Avadex Xtra 2 L/ha IBS	6.813 a	6.583 ab	5.216 c
Sakura 118 g/ha + Avadex Xtra 2 L/ha IBS	6.699 a	6.161 b	5.354 c
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha IBS	5.591 c	5.212 c	4.440 d
P	<0.001		

The significant interaction between wheat seed rate and herbicide treatments was largely related to the differences between the control and pre-emergent herbicide treatments (Table 5). In the control, wheat grain yield increased significantly with increase in seed rate from 100 to 200 seeds/m^2. A similar trend was also observed in the weaker herbicide treatment Trifluralin + Avadex Xtra as well as in Sakura + Avadex Xtra. However, superior efficacy of Overwatch + Avadex Xtra was reflected in no significant increase in wheat yield with increasing crop seed rate. It is worth noting that early sown wheat treated with Overwatch + Avadex Xtra produced 6.9 t/ha grain yield, which is phenomenal considering the high density of ARG seedbank present in this paddock at Roseworthy.

Table 5. The effect of interaction between wheat seed rate and herbicides on wheat grain yield. Means followed by different letters represent significant differences (P=0.05).

Herbicide treatment	**Wheat grain yield (t/ha)**		
	SR100	**SR200**	**SR300**
Control (knockdown herbicide only)	2.964 f	3.874 e	4.058 e
Overwatch 1.25 L/ha + Avadex Xtra 2 L/ha IBS	6.056 ab	6.351 a	6.205 ab
Sakura 118 g/ha + Avadex Xtra 2 L/ha IBS	5.842 b	6.316 a	6.057 ab
Trifluralin 2 L/ha + Avadex Xtra 2 L/ha IBS	4.712 d	5.235 c	5.295 c
P	0.04		

Yield improvements of more than 3 t/ha were achieved by combining early sowing with optimum wheat seed rate and effective pre-emergent herbicides. At wheat grain prices around $400/t in 2021, such an improvement in wheat yield is going to cause a huge gain gross margins. Clearly, use of good agronomy and pre-emergent herbicides can protect crop yield as shown by >6 t/ha yields achieved in this trial. However, pre-emergent herbicides alone are inadequate to prevent build-up of ryegrass seedbank. Growers dealing with such heavy ryegrass infestations will need to seriously consider implementing a non-crop phase (e.g. oaten hay or grazing and spray-topping) to bring down seedbanks to manageable levels. When grain cropping phase resumes, it would be advisable to integrate improved crop competitive ability and harvest weed seed control with good agronomy and effective herbicide options to achieve high crop competition to minimise weed seed set.