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

Key messages

- There was no effect of a two-week delay in sowing (P=0.672) on in-crop ryegrass plant density with 390 plants/m^2 in TOS 1 and 401 plants/m^2 in TOS 2. The combination of dry autumn and high seed dormancy in this ryegrass population is likely to be the reason for the lack of sowing time effect on weed density.
- Combinations of pre- and post-emergent clethodim or clethodim + Factor failed to reduce ryegrass plant density below 200 plants/m^2. Such a high level of ryegrass plant survival is likely to be related to the presence of a high level of group A/1 resistance in this population of ryegrass.
- Ryegrass seed production was significantly affected by canola sowing time (P<0.001) with TOS 1 producing 35,757 seeds/m^2 as compared to 49,368 seeds/m^2 in TOS 2. Greater seed production with delayed crop sowing is likely to be the result of reduced competitive ability of canola with weeds when sown later.
- Superior early crop vigour in Trophy was reflected in 21% lower ryegrass seed set than in Bonito (37536 seeds/m^2 Vs 47,589 seed/m^2). Canola sown at the higher seed rate (50 seeds/m^2) resulted in a denser crop canola, which reduced ryegrass seed set by 38% (32,683 Vs 52,442 seeds/m^2).
- Combination of early crop sowing, higher seed rate, hybrid variety and herbicide treatments allowed canola to produce more than 2 t/ha yield at this site with a high seedbank of multiple herbicide resistant ryegrass. However, ryegrass population that survived management was able to produce up to 60,000 seeds/m^2. Future management of this trial paddock would require at least 3 years of effective ryegrass management before normal crop management programs can resume.

Background

Canola is known to grow much more vigorously under warm and sunny conditions in late autumn than in cold and wet conditions in winter. Therefore, sowing time of canola can have a large impact on crop yield and its ability to compete with weeds. Many farmers have adopted early sowing in canola including dry seeding because of its positive impact on early crop vigour and grain yield. The impact of early seeding on annual ryegrass management is not well understood. Another uncertainty is related to the negative effects of dry soil conditions in early seeding on the performance of pre-emergent herbicides. The review of Widderick et al. (2015) also recommended research on sowing time in many crops. There are many canola hybrid varieties available to growers but there is uncertainty about the contribution of crop vigour for weed suppression. Hybrid seed of canola tends to be expensive, which can lead to growers often reducing crop seed rate. These questions related to crop sowing time, hybrid vigour and seed rate of canola can only be answered through well designed field trials.

This field trial was undertaken at Roseworthy in SA, a medium rainfall environment, to investigate factorial combinations of sowing time, cultivar (hybrid Vs open-pollinated), seed rate and herbicides on the management of annual ryegrass in triazine tolerant canola.

Methods

This field trial was established in a split-split plot design and investigated combinations of the canola sowing time, variety, 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: 24 May 2021; TOS 2: 10 June 2021
Seeding rate	25 and 50 seeds/m^2
Variety	Bonito (open-pollinated) and HyTTec Trophy (hybrid) – both triazine tolerant
Herbicide treatments	1. Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS 2. Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS Fb Clethodim 500 mL/ha POST 3. Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS 4. Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS Fb Factor 80 g/ha + Clethodim 375 mL/ha
Replicates	4
Seeder	Knife points, press wheels (DBS), 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, canola grain yield.

Roseworthy experienced extremely dry conditions during autumn in 2021. The month of April only received 11.4 mm rain as compared to the long-term average of 30.9 mm. Even the month of May only received 12 mm rainfall until the first time of sowing (TOS 1). Fortunately, 11.8 mm rainfall was received on the day after sowing, which created suitable conditions for crop establishment and activity of pre-emergent herbicides. 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 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

Canola plant density

Even though canola density was very similar in TOS 1 (46.1 plants/m^2) and TOS 2 (43.8 plants/m^2), these differences were statistically significant (P=0.016). As expected canola seed rate had a significant effect (P<0.001) on canola plant density with 33 plants/m^2 in the lower seed rate and 56.9 plants/m^2 in the higher seed rate treatment. It is important to note that crop density achieved in the trial was within the recommended range for canola.

Ryegrass plant and spike density

The paddock selected for this trial is known to have multiple herbicide resistant population with a large seedbank of 22854 ± 4148 seeds/m^2. Therefore, high ryegrass densities were expected at the site. Dry autumn conditions experienced at Roseworthy in 2021 meant there was little ryegrass establishment prior to seeding of the crop. There was no effect of a two-week delay in sowing (P=0.672) on in-crop ryegrass plant density, with 390 plants/m^2 in TOS 1 and 401 plants/m^2 in TOS 2. The combination of a dry autumn and high seed dormancy in this ryegrass population is likely to be the reason for the lack of sowing time effect on weed density. Ryegrass plant density was significantly influenced by the herbicide treatment (P<0.001) (Table 3). Where only pre-emergent herbicides were used, propyzamide treatments were less effective in controlling ryegrass than Atrazine + Treflan. Even where post-emergent clethodim or clethodim + Factor were sprayed, ryegrass plant density was greater than 200 plants/m^2. Such a high level of ryegrass survival is likely to be related to the presence of a high level of group A/1 resistance in this population of ryegrass.

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

Herbicide treatment	**Ryegrass plants/m^2**
Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS	374 b
Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS Fb Clethodim 500 mL/ha POST	249 a
Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS	632 c
Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS Fb Factor 80 g/ha + Clethodim 375 mL/ha	329 b
P	<0.001

Ryegrass spike density was significantly affected by time of sowing of canola (P=0.002). Early sown canola (TOS 1 = 616 spikes/m^2) had 24% less ryegrass spikes than crop sown later (TOS 2) in June (815 spikes/m^2). Greater ryegrass spike density and seed production has been recorded in several other high dormancy populations and it likely to be the result of greater early vigour and weed competitiveness of the early sown crop. Canola variety also had a significant effect (P<0.001) on ryegrass spike density with 20% lower spike density in hybrid Trophy (638 spikes/m^2) than open-pollinated Bonito (793 spikes/m^2). Canola seed rate also had a significant (P<0.001) effect on ryegrass spike density with 31% less spikes produced at 50 seeds/m^2 (584 spikes/m^2) than canola sown at 25 seeds/m^2 (846 spikes/m^2).

Herbicide treatments (P<0.001) had a significant effect on ryegrass spike production with Atrazine + Treflan followed by clethodim having the lowest ryegrass spikes (Table 4). These results also highlight how difficult it can be to prevent ryegrass seed set after its populations have evolved resistance to group A herbicides.

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

Herbicide treatment	**Ryegrass spikes/m^2**
Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS	768 c
Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS Fb Clethodim 500 mL/ha POST	538 a
Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS	890 d
Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS Fb Factor 80 g/ha + Clethodim 375 mL/ha	665 b
P	<0.001

Ryegrass seed production

Ryegrass is a prolific seed producer under situations where high densities are present and control tactics fail due to herbicide resistance. In such situations, it is quite common for ryegrass to often produce more than 20,000 seeds/m^2. As expected, results of ryegrass seed set are a close reflection of its spike density presented above. Ryegrass seed production was significantly affected by canola sowing time (P<0.001) with TOS 1 producing 35,757 seeds/m^2 as compared to 49,368 seeds/m^2 in TOS 2. Greater seed production with delayed crop sowing is likely to be the result of reduced competitive ability of canola with weeds when sown later. Similar effect of delayed crop sowing has been observed in several other trials with ryegrass and brome grass in this project.

Canola variety (P<0.001) and seed rate (P<0.001) had a significant effect of on ryegrass seed set. Hybrid vigour in Trophy was reflected in 21% lower ryegrass seed set than in Bonito (37536 seeds/m^2 Vs 47,589 seed/m^2). Canola sown at the higher seed rate (50 seeds/m^2) resulted in a denser crop canola, which reduced ryegrass seed set by 38% (32,683 Vs 52,442 seeds/m^2). Even though farmers are often reluctant to seed hybrid canola at higher seed rates due to cost issues, these results clearly show the benefit of higher crop densities for weed seed set suppression.

The interaction between canola variety and herbicide treatments appears to be largely associated with similar seed set in both varieties in Atrazine + Treflan whereas in all other treatments, ryegrass produced significantly lower seeds in Trophy than in Bonito (Table 5). Dry start to the growing season appeared to reduce efficacy of propyzamide compared to atrazine. These results again highlight the beneficial effects of crop competition in managing ryegrass.

Table 5. The effect of interaction between canola variety and herbicide treatments on annual ryegrass seed production in canola. Means followed by different letters represent significant differences (P=0.05).

Herbicide treatment	**Ryegrass seeds/m^2**	
	Bonito	**Trophy**
Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS	46324 b	49049 b
Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS Fb Clethodim 500 mL/ha POST	37683 b	26601 a
Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS	61434 c	44306 b
Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS Fb Factor 80 g/ha + Clethodim 375 mL/ha	44914 b	30188 a
P	0.037	

Canola grain yield

Canola grain yield was highly responsive to early sowing (P=0.014) with TOS 1 (2.046 t/ha) producing 25% higher yield than TOS 2 (1.632 t/ha). This is consistent with other research that has shown greater early vigour and yields in canola sown in April-May than in crop sown in cold and wet conditions in June. Hybrid variety HyTTec Trophy produced significantly (P<0.001) greater yield (1.965 t/ha) than open-pollinated Bonito (1.713 t/ha). At 2021 grain prices, 0.25 t/ha of canola was worth >$200, which would far exceed the extra seed cost of hybrid canola varieties. Higher canola seed rate also caused a significant (P<0.001) improvement in canola yield with yield of 1.679 t/ha at 25 seeds/m^2 as compared to 1.999 t/ha at 500 seeds/m^2. When considered in conjunction with ryegrass seed set data, early sowing, higher canola seed rate and hybrid variety are important agronomic elements of ryegrass management in canola.

Canola grain yields was influenced by the significant interaction between canola variety and herbicide treatments (Table 6). This interaction appears to be largely associated with significantly higher yield of Trophy than Bonito in propyzamide treatments. Where propyzamide + atrazine was used without any POST treatment, Trophy produced significantly greater yield than Bonito. This was the weakest herbicide treatment as shown by ryegrass spike density data. Superior vigour of Trophy may have allowed it to suppress ryegrass and achieve higher yield than Bonito. Significantly higher yield of Trophy than Bonito when sprayed with propyzamide + atrazine followed by POST herbicides may be associated with its superior podding capacity.

Combination of early crop sowing, higher seed rate, hybrid variety and herbicide treatments allowed canola to produce more than 2 t/ha yield at this site with a high seedbank of multiple herbicide resistant ryegrass. However, ryegrass population that survived management was able to produce up to 60,000 seeds/m^2. Implementation of harvest weed seed control in paddocks such as this will be ideal. Future management of this trial paddock would require at least 3 years of effective ryegrass management before normal crop management programs can resume.

Table 6. The effect of interaction between canola variety and herbicide treatments on canola yield. Means followed by different letters represent significant differences (P=0.05).

Treatment	**Canola yield t/ha**	
	Bonito	**Trophy**
Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS	1.778 b	1.768 bc
Atrazine 2.2 kg/ha + Treflan 2 L/ha IBS Fb Clethodim 500 mL/ha POST	1.750 bc	2.061 a
Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS	1.573 c	1.896 ab
Propyzamide 1 L/ha + Atrazine 2.2 kg/ha IBS Fb Factor 80 g/ha + Clethodim 375 mL/ha	1.750 bc	2.135 a
P	0.037	