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

Abstract

A field trial was undertaken in 2020 to investigate the effects of sowing time, canola variety, seed rate and herbicides on annual ryegrass management at a high rainfall site in Victoria (Winchelsea). Crop establishment at this trial site was significantly influenced by the time of sowing (P=0.006) and the seed rate (P<0.001) and there was an interaction between time of sowing and seed rate (P=0.014). Crop establishment was close to half of the target density, which may have been due to dry soil conditions in TOS 1 but there may also have been some slug damage. Select and Factor herbicides provided a much higher level of ARG control in TOS 2 than in TOS 1. Evaluation of weather data for the site showed that there were 4 frost events before the application of POST herbicides on 12 June in TOS 1, including the day of herbicide application. Previous research has shown a negative effect of frost on the level of weed control provided by these herbicides. Grain yield of canola was significantly influenced by sowing time (P=0.008), variety (P<0.001), seed rate (P<0.001) and herbicide (P<0.001). There were also significant interactions between time of sowing x variety (P=0.023), sowing time x seed rate (P<0.001) and sowing time x herbicide (P<0.001). Lower grain yield in TOS 1 compared to TOS 2 (2.3 Vs 3.4 t/ha) is most likely related to significantly lower canola plant density. The average grain yield of hybrid Ignite (3.13 t/ha) was significantly greater than that of open pollinated Wahoo (2.54 t/ha). There was a strong correlation between annual ryegrass spike density from herbicide treatments and canola grain yield (R^2=0.96). Sowing time x herbicide treatments that provided weaker control of ARG also produced lower grain yield and vice versa. These results show that ARG can be highly competitive with canola in high rainfall environments and all efforts need to be made to achieve good crop establishment and selection of effective herbicide strategies.

Introduction

Sowing time of canola can have a large impact on crop yield. 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.

This field trial was undertaken Winchelsea in Victoria, a high rainfall environment, to investigate factorial combinations of sowing time, cultivar, 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 following management tactics.

1. **Main plot - sowing time (2)**: late April and early May
2. **Sub-plot – variety x seed rate (4)**:
    a. **Variety**: Ignite (triazine tolerant hybrid) and Wahoo (triazine tolerant open pollinated)

b. **Seed rate**: 25 and 50 seeds/m^2

3. **Herbicides (4)**:

(i) Atrazine 900 @ 1.1 kg/ha POST (at 2 leaf stage of annual ryegrass)
(ii) Edge 900 (propyzamide) @ 560 g + Atrazine 900 @ 2.2 kg/ha IBS
(iii) Atrazine 900 @ 2.2 kg/ha IBS fb Select Xtra 360 @ 330mL/ha POST
(iv) Edge 900 (propyzamide) @ 0.83kg + Atrazine 900 @ 1.1 kg/ha IBS fb Select Xtra 360 @ 250mL/ha POST + Factor 80 g/ha + Atrazine @ 1.1 kg/ha POST

Replicates: 3

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

Trial Management

Table 1. Key management operations undertaken.

Operation	**Details**
Location	Winchelsea, Victoria
Seedbank soil cores	April, 2020
Plot size	1.5 m x 10 m
Seeding date	TOS 1: 22 April, 2020 TOS 2: 8 May, 2020
Fertiliser	At sowing – DAP (18:20:0:2) @ 120 kg/ha
Variety	Ignite and Wahoo triazine tolerant canola
Seeding rate	25 and 50 seeds/m^2
Herbicides	Pre-Emergent herbicides 22 April and 7 May, 2020 (applied immediately before seeding IBS); Post Emergent (POST) herbicides 12 June (TOS 1) and 9 July (TOS 2). POST applied when canola was at 5 leaf stage and annual ryegrass at GS 13-25.

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

Rainfall data for the trial site was obtained from Winchelsea (Table 2). In 2020, the site received above-average rainfall in autumn but the rainfall was well below-average for the winter months. However, the season finished well with above average rainfall in spring. Both annual and growing season rainfall at the site in 2020 were greater than the long-term average (Table 2).

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

	Rainfall (mm)	
Month	**2020**	**Long-term average**
Jan	44.2	31.3
Feb	38.8	33.6
Mar	25.6	34.9
Apr	74.0	38.9
May	54.4	48.9
Jun	31.0	49.3
Jul	19.0	52.9
Aug	45.0	56.8
Sep	88.0	56.5
Oct	80.6	54.9
Nov	56.8	47.7
Dec	49.6	39.4
Annual total	607.0	545.1
GSR total	392.0	358.2

Results and Discussion

Canola plant density

Crop establishment at this trial site was significantly influenced by the time of sowing (P=0.006) and the seed rate (P<0.001) and there was an interaction between time of sowing and seed rate (P=.014). Crop establishment was close to half of the target density, which may have been due to dry soil conditions in TOS 1 (Figure 1) but there may also have been some slug damage. The highest canola density achieved was at the higher seed rate in TOS 2 (30 plants/m^2). Both canola varieties had very similar plant establishment (P=0.693).

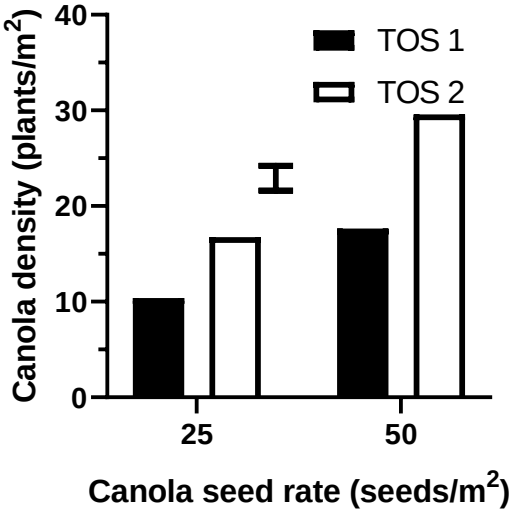

Figure 1. The time of sowing and canola seed rate on canola plant density (P=0.014). Vertical bar represents LSD (P=0.05).

Annual ryegrass plant density and seedbank

The trial site had a moderate but fairly uniform seedbank of ARG (206 ± 5 seeds/m^2). Therefore, ARG plant density expected at site was fairly low. Weed counts undertaken at 90 days after sowing, when all herbicide treatments had exerted their weed control effects, showed a significant interaction between sowing time and herbicide treatments (P<0.001) (Table 3). This interaction was particularly evident for treatments that included POST application of Select and Factor. These herbicides provided a much higher level of ARG control in TOS 2 than in TOS 1. Evaluation of weather data for the site showed that there were 4 frost events before the application of POST herbicides on 12 June in TOS 1, including the day of herbicide application. In contrast, there was only one frost event close to herbicide application for TOS 2. Previous research has shown major negative effects of frost induced plant stress on the efficacy of clethodim. Therefore, it is highly likely that the differences in herbicide efficacy between the two sowing times in this trial are related to the occurrence of frost.

Table 3. Effect of interaction between canola sowing time and herbicides on ARG plant density. Means followed a different letter represent significant differences (P=0.05).

Treatment	**Annual ryegrass (plants/m^2)**	
	TOS 1	**TOS 2**
Atrazine 900 @ 1.1 kg/ha POST	26.3 ***d***	12.2 ***c***
Edge 900 @ 560 g + Atrazine 900 @ 2.2 kg/ha IBS	12.0 ***bc***	9.9 ***bc***
Atrazine 900 @ 2.2 kg/ha IBS fb Select Xtra 360 @ 330mL/ha POST	11.2 ***b***	0.6 ***a***
Edge 900 @ 0.83kg + Atrazine 900 @ 1.1 kg/ha IBS fb Select Xtra 360 @ 250mL/ha POST + Factor 80 g/ha + Atrazine @ 1.1 kg/ha POST	7.0 ***b***	1.0 ***a***

Annual ryegrass spike density and seed production

The interaction between time of sowing and herbicide treatments in ARG plant density (Table 3) was also detected in ARG spike density (P<0.001) (Table 4). The most striking result was the stark differences in ARG spike density in treatments where Select and Factor were used. Consistent with ARG plant density data, these group A herbicides worked very effectively in TOS 2 but not in TOS 1. As explained earlier, this contrasting herbicide performance is most likely associated with severe frost received before and on the day of sowing in TOS 1 but not in TOS 2. Lower spike density in atrazine POST in TOS 2 than in TOS 1 could be associated with good soil moisture when this treatment was applied to these two sowing treatments. Daily rainfall figures (unpublished) at the site showed that in the period of one week before and one week after the application of atrazine post, TOS 1 only received 2 mm rainfall as compared to 10.6 mm in TOS 2. Moist soil moisture conditions in TOS 2 would have been more suitable for atrazine activity than in TOS 1. Furthermore, higher canola density in TOS 2 than in TOS 1 would have also improved weed suppression in the later sown crop. As spike density is the major driver of seed production, these trends are likely to be reflected in weed seed set.

Table 4. Effect of interaction between canola sowing time and herbicides on ARG spike density (P<0.001). Means followed a different letter represent significant differences (P=0.05).

Treatment	**Annual ryegrass (spikes/m^2)**	
	TOS 1	**TOS 2**
Atrazine 900 @ 1.1 kg/ha POST	616 ***c***	190 ***b***
Edge 900 @ 560 g + Atrazine 900 @ 2.2 kg/ha IBS	351 ***b***	198 ***b***
Atrazine 900 @ 2.2 kg/ha IBS fb Select Xtra 360 @ 330mL/ha POST	303 ***b***	5 ***a***
Edge 900 @ 0.83kg + Atrazine 900 @ 1.1 kg/ha IBS fb Select Xtra 360 @ 250mL/ha POST + Factor 80 g/ha + Atrazine @ 1.1 kg/ha POST	236 ***b***	8 ***a***

The trends observed for ARG spike density were also clear for ARG seed production. Again there was a significant interaction (P<0.001) between sowing time and herbicide on ARG seed production (Table 5). Integration of pre- and post-emergent herbicides in TOS 2 was able to maintain or even reduce ARG seedbank. In contrast, all herbicide treatments in TOS 1 resulted in a large build-up in ARG seedbank.

Table 5. Effect of interaction between canola sowing time and herbicides on ARG seed production (P<0.001). Analysis of variance was performed on square root transformed data to normalise the residuals. Means followed a different letter represent significant differences (P=0.05).

Treatment	**Annual ryegrass (seeds/m^2)**	
	TOS 1	**TOS 2**
Atrazine 900 @ 1.1 kg/ha POST	26416 a	6715 b
Edge 900 @ 560 g + Atrazine 900 @ 2.2 kg/ha IBS	12667 b	7544 b
Atrazine 900 @ 2.2 kg/ha IBS fb Select Xtra 360 @ 330mL/ha POST	12786 b	138 c
Edge 900 @ 0.83kg + Atrazine 900 @ 1.1 kg/ha IBS fb Select Xtra 360 @ 250mL/ha POST + Factor 80 g/ha + Atrazine @ 1.1 kg/ha POST	8339 b	213 c

Canola grain yield

Grain yield of canola was significantly influenced by sowing time (P=0.008), variety (P<0.001), seed rate (P<0.001) and herbicide (P<0.001). There were also significant interactions between time of sowing x variety (P=0.023), sowing time x seed rate (P<0.001) and sowing time x herbicide (P<0.001). Lower grain yield in TOS 1 compared to TOS 2 (2.3 Vs 3.4 t/ha) is most likely related to significantly lower canola plant density (Figure 1). The average grain yield of hybrid Ignite (3.13 t/ha) was significantly greater than that of open pollinated Wahoo (2.54 t/ha). The strong interaction between sowing time and herbicide treatments can be seen in Table 6, where yield varied by more than 2.5 t/ha, mainly due to differences in weed control.

Table 6. Effect of interaction between canola sowing time and herbicides on canola grain yield (P<0.001). Means followed a different letter represent significant differences (P=0.05).

Treatment	**Canola grain yield (t/ha)**	
	TOS 1	**TOS 2**
Atrazine 900 @ 1.1 kg/ha POST	1.252 ***d***	3.068 ***b***
Edge 900 @ 560 g + Atrazine 900 @ 2.2 kg/ha IBS	2.568 ***c***	2.990 ***bc***
Atrazine 900 @ 2.2 kg/ha IBS fb Select Xtra 360 @ 330mL/ha POST	2.676 ***c***	3.804 ***a***
Edge 900 @ 0.83kg + Atrazine 900 @ 1.1 kg/ha IBS fb Select Xtra 360 @ 250mL/ha POST + Factor 80 g/ha + Atrazine @ 1.1 kg/ha POST	2.694 ***c***	3.655 ***a***

There was a strong correlation (R^2=0.96) between annual ryegrass spike density and canola grain yield (Figure 2). Sowing time x herbicide treatments that provided weaker control of

ARG also produced lower grain yield and vice versa. These results also show that ARG can be highly competitive with canola in high rainfall environments and all efforts need to be made to achieve good crop establishment and select effective herbicide strategies.

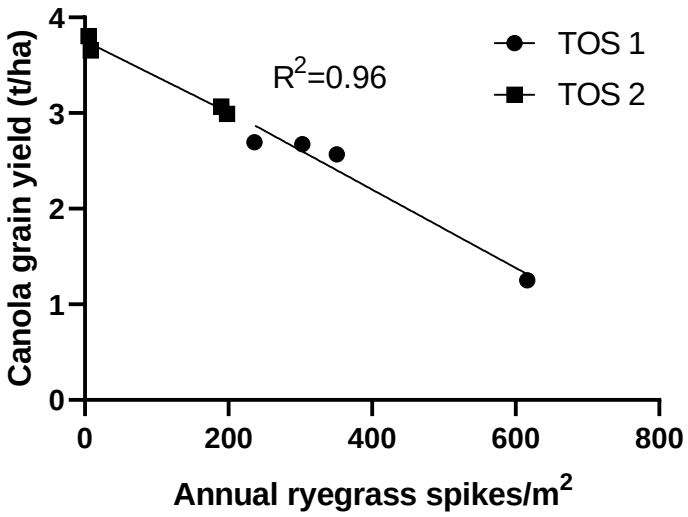

Figure 2. Competitive effects of annual ryegrass on canola yield in TOS 1 and 2 of canola.