Effect of combinations of sowing time, cultivar, seed rate and herbicides on brome grass management in canola (Whirily, VIC)

Abstract

Canola establishment was significantly influenced by the variety (P=0.012) and seed rate (P<0.001). Greater plant density in the hybrid variety T4510 (36 plants/m^2) than the open pollinated Bonito (31 plants/m^2) is likely to be associated with the larger seed size and greater early vigour in the hybrid. Plant density achieved was within 10% of the target density. There was a significant interaction between sowing time of canola and herbicide treatments (P=0.004). This interaction was mainly associated with a significantly lower brome grass density in the control (glyphosate). In contrast, brome grass density was very similar between the two sowing dates where pre-emergent and post-emergent herbicides were used. Consistent with the trend of brome grass panicle density, brome grass seed production in this trial was significantly influenced by the herbicide treatment (P<0.001). The results also show that brome grass panicles set more seeds when only the knockdown or Atrazine IBS was used (49-59 seeds/panicle) as compared to post-emergence Haloxyfop treatments (30 seeds/panicle). Canola grain yield was significantly affected by the time of sowing (P=0.034), with the earlier sown crop (1.58 t/ha) producing higher yield than the later sowing (1.35 t/ha). The hybrid variety Invigor T4510 (1.56 t/ha) produced significantly higher grain yield than the open-pollinated Bonito (1.37 t/ha) (P<0.001). Increase in canola plant density from 25 to 50 plants/m^2 also caused a significant increase in grain yield (P=0.002), even though the yield improvement was only 100 kg/ha. Even though brome grass density at the site was fairly low (~12 plants/m^2), herbicide treatments had a significant positive effect on canola grain yield (P<0.001). Controlling brome increased income by $169/ha or 21% after including the cost of the herbicides and applying the herbicides when averaged across the trial.

Background

Great brome grass (*Bromus diandrus*) is becoming a major problem across the Mallee, costing growers $6.7m in lost revenue each year (Llewellyn et al 2016). Brome grass is one of the most competitive weeds, with an aggressive root system removing nitrogen, phosphorus and moisture from the soil that would otherwise be used by the crop. When considering a rotation to control brome grass, it is important to consider different control options over at least three seasons (Kleemann and Gill 2009), including crop type, variety, herbicides, crop competition, harvest weed seed control and fallow management.

Controlling brome in the Mallee is complex due to variable rainfall patterns at sowing. Due to the shift to dry sowing of a larger proportion of the cropping program, often there isn’t a chance to use a knockdown herbicide prior to sowing. Additionally, dry soil can reduce the efficacy of some pre-emergent herbicides. This variable efficacy of pre-emergent herbicides is further impacted upon by farming systems selecting for brome populations with increased seed dormancy, pushing it to germinate later and later, potentially outside the control window of knockdown and pre-emergent herbicides (Kleemann, Fleet, Preston and Gill 2018). A field trial was undertaken in 2020 to investigate the effects of variety selection, time of sowing, plant density and herbicide strategies on brome seed set in 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**: InVigor® T 4510 Hybrid TT Canola, ATR-Bonito Open Pollinated TT Canola
    b. **Seed rate**: 25 and 50 seeds/m^2
3. **Herbicides (4)**:

(i) **Knockdown only**: Glyphosate 540g/L @ 2L/ha (TOS 1: 17 April, TOS 2: 15 May)

(ii) **Pre-emergent only**: Atrazine @ 1.8kg/ha + Glyphosate 540g/L @ 2L/ha (TOS 1: 17 April, TOS 2: 15 May)

(iii) **Pre- and post-emergent**: Atrazine @ 1.8kg/ha + Glyphosate 540g/L @ 2L/ha (TOS 1: 17 April, TOS 2: 15 May); at4 leaf – Haloxyfop @ 75mL/ha (TOS 1: 12 June, TOS 2: 16 July)

(iv) **Premium pre- and post-emergent**: Atrazine @ 1.8kg/ha + Propyzamide @ 1L/ha IBS + Haloxyfop 75mL/ha + Atrazine @400g/ha at GS 14 brome

Replicates: 3

Trial design: split-split plot design

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, brome panicle density, brome seed production, canola grain yield.

Trial Management

Table 1. Key management operations undertaken.

Operation	Details
Location	Whirily, Victoria
Seedbank soil cores	April, 2020
Plot size	1.5 m x 10 m
Seeding date	TOS 1: 17 April, 2020; TOS 2: 15 May, 2020
Fertiliser	Granulock Supreme Z + Flutriafol (200mL/100kg) @ 60kg/ha at sowing, and 160kg/ha of urea applied as a split application (12/6/2020, 28/7/2020)
Seeder	Knife points, press wheels, 30cm row spacing
Variety	InVigor® T 4510 Hybrid TT Canola ATR-Bonito Open Pollinated TT Canola
Seeding rate	25 and 50 seeds/m^2

Rainfall data for the trial site was obtained from Birchip (Table 2). In 2020, the site received above-average rainfall in summer and autumn but the rainfall was well below-average for May to July. 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 Whirily near Birchip in 2020 and the long-term average for the site.

	Rainfall (mm)	
Month	**2020**	**Long-term average**
Jan	21.4	23.8
Feb	81.8	19.6
Mar	42.2	17.3
Apr	97.6	23.3
May	13.6	35.3
Jun	20.2	31.2
Jul	8.2	33
Aug	32.6	34.4
Sep	24.4	35.2
Oct	41.4	33.2
Nov	13.6	26.3
Dec	3.4	21.9
Annual total	400.4	334.5
GSR total	238.0	225.6

Results and Discussion

Canola plant density

Canola establishment was significantly influenced by the variety (P=0.012) and seed rate (P<0.001). Greater plant density in the hybrid variety T4510 (36 plants/m^2) than the open pollinated Bonito (31 plants/m^2) is likely to be associated with the larger seed size and greater early vigour in the hybrid. Plant density achieved was within 10% of the target density.

Brome grass plant, panicle density and seed production

There was a significant interaction between sowing time of canola and herbicide treatments (P=0.004). This interaction was mainly associated with a significantly lower brome grass density in the control (glyphosate) (Table 2). In contrast, brome grass density was very similar between the two sowing dates where pre-emergent and post-emergent herbicides were used. It should also be mentioned that the overall weed density present at the site was fairly low, so only modest reductions in crop yield were expected.

Table 2. . Effect of interaction between canola sowing time and herbicides on brome grass plant density (P=0.004). Means followed by different letters represent significant differences (P=0.05).

Treatment	**Brome grass (plants/m²)**	
	TOS 1	**TOS 2**
Untreated control (Glyphosate 540g/L @ 2L/ha)	11.9 c	5.5 b
Atrazine @ 1.8kg/ha IBS	2.8 ab	2.7 ab
Atrazine @ 1.8kg/ha IBS Fb Haloxyfop @ 75mL/ha at GS14 brome	0.1 a	0.6 a
Atrazine @ 1.8kg/ha + Propyzamide @ 1L/ha IBS + Haloxyfop 75mL/ha + Atrazine @400g/ha at GS 14 brome	0.3 a	0.7 a

Brome grass panicle density was not affected by crop sowing time (P=0.487), canola variety (P=0.674) or seed rate (P=0.115). However, the herbicide treatments had a significant influence on brome grass panicle density (P<0.001) (Table 3). The results indicate that each brome grass plants produced a single panicle at this site.

Table 3. Effect of herbicide treatments on brome grass panicle density in canola (P<0.001). Means followed by a different letter indicate significant differences (P=0.05).

Treatment	**Brome grass panicles/m²**
Untreated control (Glyphosate 540g/L @ 2L/ha)	8.6 a
Atrazine @ 1.8kg/ha IBS	2.3 b
Atrazine @ 1.8kg/ha IBS Fb Haloxyfop @ 75mL/ha at GS14 brome	0.6 b
Atrazine @ 1.8kg/ha + Propyzamide @ 1L/ha IBS + Haloxyfop 75mL/ha + Atrazine @400g/ha at GS 14 brome	0.6 b

Consistent with the trend of brome grass panicle density, brome grass seed production in this trial was significantly influenced by the herbicide treatment (P<0.001). The results also show that brome grass panicles set more seeds when only the knockdown or Atrazine IBS was used (49-59 seeds/panicle) as compared to post-emergence Haloxyfop treatments (30 seeds/panicle).

Table 4. Effect of herbicide treatments on brome grass seed production (P<0.001). Means followed by a different letter indicate significant differences (P=0.05).

Herbicide treatment	Brome seeds/m^2
Untreated control (Glyphosate 540g/L @ 2L/ha)	508 ***c***
Atrazine @ 1.8kg/ha IBS	112 ***b***
Atrazine @ 1.8kg/ha IBS Fb Haloxyfop @ 75mL/ha at GS14 brome	18 ***a***
Atrazine @ 1.8kg/ha + Propyzamide @ 1L/ha IBS + Haloxyfop 75mL/ha + Atrazine @400g/ha at GS 14 brome	19 ***a***

Canola grain yield

Canola grain yield was significantly affected by the time of sowing (P=0.034), with the earlier sown crop (1.58 t/ha) producing higher yield than the later sowing (1.35 t/ha). The hybrid variety Invigor T4510 (1.56 t/ha) produced significantly higher grain yield than the open-pollinated Bonito (1.37 t/ha) (P<0.001). Increase in canola plant density from 25 to 50 plants/m^2 also caused a significant increase in grain yield (P=0.002), even though the yield improvement was only 100 kg/ha. Even though brome grass density at the site was fairly low (~12 plants/m^2), herbicide treatments had a significant positive effect on canola grain yield (P<0.001) (Table 5). Application of different herbicides resulted in 19 to 26% increase in canola yield, which is impressive considering the low weed density. These results highlight the large competitive effects brome grass can have on canola yield.

Table 4. Effect of herbicide treatments on canola grain yield (P<0.001). Means followed by a different letter indicate significant differences (P=0.05).

Herbicide treatment	Canola grain yield (t/ha)
Untreated control (Glyphosate 540g/L @ 2L/ha)	1.254 a
Atrazine @ 1.8kg/ha IBS	1.491 b
Atrazine @ 1.8kg/ha IBS Fb Haloxyfop @ 75mL/ha at GS14 brome	1.548 b
Atrazine @ 1.8kg/ha + Propyzamide @ 1L/ha IBS + Haloxyfop 75mL/ha + Atrazine @400g/ha at GS 14 brome	1.576 b

Controlling brome increased income by $169/ha or 21% after including the cost of the herbicides and applying the herbicides when averaged across the trial (Table 5). Controlling brome and reducing weed seed set may also reduce herbicide costs in 2021, and will help to deplete the weed seed bank over time. It is interesting to note that even with the use of the best herbicide options, this brome population managed to produce 18 seeds/m^2. These results highlight the practical difficulties growers face in eliminating brome from their cropping paddocks.

While plant density and variety had a significant effect on yield, it did not have a significant effect on income when treatment costs were included. Choosing to grow a hybrid over an OP did not significantly increase or decrease income for the grower in 2020.

It is also important when choosing canola varieties to carefully consider herbicide tolerances. The top triazine-tolerant varieties have yielded similarly to the top Clearfield® varieties in the Birchip NVT. Choosing to grow a triazine tolerant variety provides a break away from the Clearfield® system, which will help to slow the rate of development of imidazolinone (IMI) resistant brome. The option to include multiple herbicide modes of action in a spray program, such as in the premium herbicide strategy, is a useful tool to reduce the rate of resistance development.

Table 5. Effect of herbicide strategy on grower income. ANOVA results across whole trial displayed below table. Herbicide cost calculated using atrazine @ $8/kg, haloxyfop @$44/L, propzyamide @ $21.8/L glyphosate 540 @ $5.4/L. Application costs were $11 per hectare (SARDI Gross Margin Guide).

	Yield (t/ha)	**Oil (%)**	**$/t**	**Herbicide Cost ($/ha)**	**Income after herbicide costs ($/ha)**
Atrazine @ 1.8kg/ha IBS Fb Haloxyfop @ 75mL/ha at GS14 brome	1.54[a]	41.6%	$545	$51	$791[a]
Atrazine @ 1.8kg/ha + Propyzamide @ 1L/ha IBS + Haloxyfop 75mL/ha + Atrazine @400g/ha at GS 14 brome	1.57[a]	41.5%	$544	$76	$784[a]
Atrazine @ 1.8kg/ha IBS	1.48[b]	39.8%	$535	$36	$755[a]
Untreated control (Glyphosate 540g/L @ 2L/ha)	1.25[c]	37.4%	$516	$22	$622[b]