# Integration of crop competition and herbicide strategies for the management of annual ryegrass in canola (Washpool, SA)


## Abstract

In this field trial, combinations of canola sowing time, variety, crop density and herbicides were investigated for annual ryegrass control. Herbicide strategy 1 (HS1), which was based on atrazine pre-sowing followed by clethodim (Select) post-emergence reduced ryegrass plant density relative to the untreated control by 57%. However, use of propyzamide pre-sowing, followed by atrazine and Select + Factor (HS 2) increased ryegrass control to 77%. Canola variety had a significant effect on ryegrass spike density (P=0.002). When averaged across the sowing dates and herbicide strategies, ryegrass growing in HyTTec Trophy produced 52 spikes/m$^2$ as compared to 78 spikes/m$^2$ in Bonito (33% reduction). HyTTec Trophy is a new hybrid triazine tolerant variety from Nuseed, which is known for high early vigour. Herbicide strategies also had a significant effect on ryegrass spike density (P<0.001). Ryegrass grown without any selective herbicide treatment (control – HS3) produced 128 spikes/m$^2$ as compared to 40 spikes/m2 in HS1 and 29 spikes/m$^2$ in HS2. This works out to 69% reduction in HS1 relative to the control and 78% reduction in HS2. Herbicide strategies had the largest effect on canola yield (P<0.001). HS1 and 2 produced canola yield of around 0.8 t/ha, which was almost 50% greater than the yield obtained in the control (Table 1). These results highlight the competitive ability of ryegrass against canola, especially in a dry season such as 2018.


## Introduction

Farmers in the southern region have been gradually moving towards earlier sowing time of canola. In fact many growers have been seeding canola into dry soil in mid-late April. Canola crops sown early tend to respond positively to the warm growing conditions and crop canopy closure can be very rapid in such situations. Therefore, early sowing could be highly beneficial in achieving greater suppression of weeds such as ryegrass. Previous research has shown that there are large differences in early vigour between hybrids and open pollinated TT cultivars, which could play an important role in weed suppression. Therefore, it is important to investigate the combinations of sowing time x cultivar to identify best-bet cultural weed management tactics for canola.

Cost of hybrid canola seed tends to be as high (> $30/kg). Therefore, growers are tempted to reduce the seed rate to reduce their production costs. Under weedy conditions, there may be a significant penalty for reducing plant density of hybrid varieties but this has not been tested experimentally. In Western Australia, French et al. (2016) showed that canola plant densities <20 plants/m$^2$ were more vulnerable to ryegrass competition especially open-pollinated triazine tolerant varieties.

The aim of this trial is to investigate factorial combinations of sowing time, varieties and seed rate with herbicide strategies for ryegrass management.

## Methods

Trial site: Washpool (between Spalding and Jamestown)

Collaborator: Hart Field Site Group (Dr Sarah Noack)

In this field trial at Washpool, the following weed management factors were investigated.

1. **Sowing time (2)**: late April and mid-late May [Main plot]
2. **Cultivar (2) x crop density (3)** [Sub-plot]
   Cultivars: Bonito and HyTTec Trophy
   Seed rate: 0.5x, 0.75x and 1x (where x = target plant density of 50 plants/m$^2$)

3. **Herbicides (3) [Sub-sub plot]**

(i) Atrazine (e.g. Gesaprim 900 WG) 2.2 kg/ha IBS fb Select 500 mL/ha at GS14 of ARG [HS1]
(ii) Propyzamide (e.g. Rustler) 1 L/ha IBS fb atrazine 1.1 kg/ha at GS12 of ARG fb Select 0.5 L/ha + Factor 80 g/ha at GS14 of ARG [HS2]
(iii) Control (pre-sowing glyphosate treatment only) [HS3]

Trial design: split-split plot design

Replicates = 3

**Trial Management**

Table 1. Key management operations undertaken.

| **Operation** | **Details** |
|---|---|
| Seedbank soil cores | 24 April, 2018 |
| Sowing date | TOS 1: 16 May, 2018<br>TOS 2: 31 May, 2018 |
| Fertiliser at sowing | Diammonium phosphate + zinc + Imapct @ 100 kg/ha |
| In-crop fertiliser application | Urea @ 100 kg/ha at GS30 |
| IBS herbicides: Atrazine (HS1) and propyzamide (HS2) were applied pre-seeding | TOS 1: 16 May, 2018<br>TOS 2: 31 May, 2018 |
| Post-emergent herbicides:<br>post atrazine (HS2) | TOS 1: 25 June<br>TOS 2: 13 July |
| Post-emergence herbicides: post select (HS1) and select + factor (HS2) | TOS 1: 13 July, 2018<br>TOS 2: 16 August, 2018 |

All data collected during the growing season was analysed using the Analysis of Variance function in GenStat version 15.0.

**Results and Discussion**

*Canola plant density*

Canola plant density was significantly influenced by the seed rate (P<0.001). Averaged across the two sowing dates, weed control treatments and the two varieties, canola plant density increased from 32 plants/m$^2$ in low seed rate to 44 plants/m$^2$ in the medium seed rate to 63 plants/m$^2$ in the high seed rate (Figure 1). Even though canola plant density in the Trophy was greater than Bonito by 10-20%, the differences between the two varieties were non-significant (P<0.064).

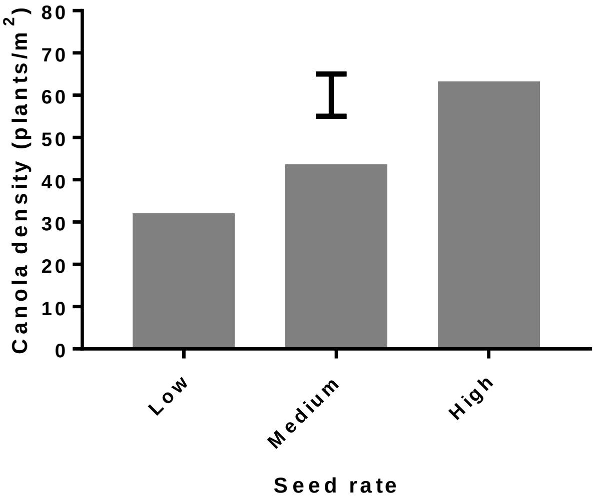


Figure 1. The effect of canola seed rate on its plant density. The vertical bar represents LSD (P=0.05).

*Ryegrass seedbank plant and spike density*

Ryegrass seedbank at the site was 1655 ± 211 seeds/m$^2$. Seedbank of ARG increased across the trial site with an average of 1263 ± 185 seeds/m$^2$ in replicate 1 to 1433 ± 164 seeds/m$^2$ in replicate 2 and 2269 ± 284 seeds/m$^2$ in replicate 3. The experimental site had a moderate infestation of annual ryegrass. In the control (nil herbicide) plots, ryegrass plant density was 88 plants/m$^2$ in sowing time 1 and 100 plants/m$^2$ in sowing time 2. This result clearly indicates that the two week delay in sowing had no impact on annual ryegrass plant density. The herbicide strategy was the only factor to have a significant effect on ryegrass density ($P<0.001$). HS1 reduced ryegrass plant density relative to the control (nil herbicide – HS3) by 57% as compared to 77% reduction in HS2 (Figure 2). However, the differences between these two herbicide strategies were non-significant. The recruitment index (RI) for ARG (% establishment of ARG plants from the seedbank) was significantly affected only by the herbicide treatment. The average RI for the untreated control at this site was 8.8% as compared to 3.7% in HS1 and 1.7% in HS2. These results clearly highlight even though ARG is a prolific seed producer, a large proportion of its seedbank undergoes decay due to biotic and abiotic factors in the environment.

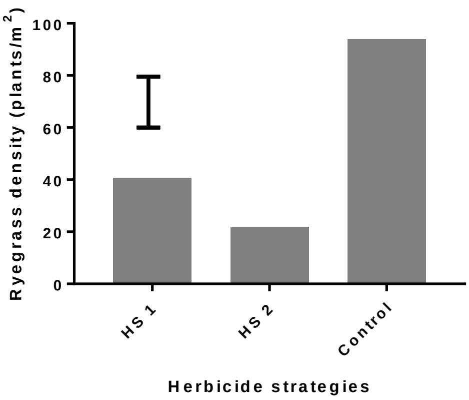


Figure 2. The effect of herbicide strategies on ryegrass plant density. The vertical bar represents LSD (P=0.05).

Data on ryegrass spike density revealed greater differences between the management factors investigated. Canola variety had a significant effect on ryegrass spike density ($P=0.002$). When averaged across the sowing dates and herbicide strategies, ryegrass growing in Trophy produced 52 spikes/m$^2$ as compared to 78 spikes/m$^2$ in Bonito (33% reduction). HyTTec Trophy is a new hybrid triazine tolerant variety from Nuseed, which is known for high early vigour. In contrast, Bonito is an open pollinated canola cultivar from Nuseed. It is possible these differences in early vigour may have contributed to the significant differences in ryegrass spike density between Trophy and Bonito.

Herbicide strategies also had a significant effect on ryegrass spike density (P<0.001). Ryegrass grown without any selective herbicide treatment (control – HS3) produced 128 spikes/m$^2$ as compared to 40 spikes/m$^2$ in HS1 and 29 spikes/m$^2$ in HS2. This works out to 69% reduction in HS1 relative to the control and 78% reduction in HS2.

There was a significant interaction between the time of sowing and the herbicide strategies (P<0.001). This interaction appears to be associated with greater ARG spike density in TOS2, which may be an indication of reduced competitive ability of canola when sown later under colder conditions. However, herbicide activity against ryegrass was greater in TOS2 which may be associated with wetter soil conditions leading to better herbicide uptake and activity (Figure 3). For example, HS2 only had 8 ARG spikes/m$^2$ in TOS2 as compared to 50 spikes/m$^2$ in TOS1. There was also a significant interaction between TOS x Variety x Herbicide (P=0.013), which was associated with superior weed competitive ability of Trophy in TOS2. ARG spike density in Bonito increased from 100 spikes/m$^2$ in TOS1 to 193 spikes/m$^2$ in TOS2, which indicated poorer competitive ability in later sown conditions. In contrast, ARG spike density in Trophy was similar in TOS1 (103 spikes/m$^2$) and TOS2 (114 spikes/m$^2$).

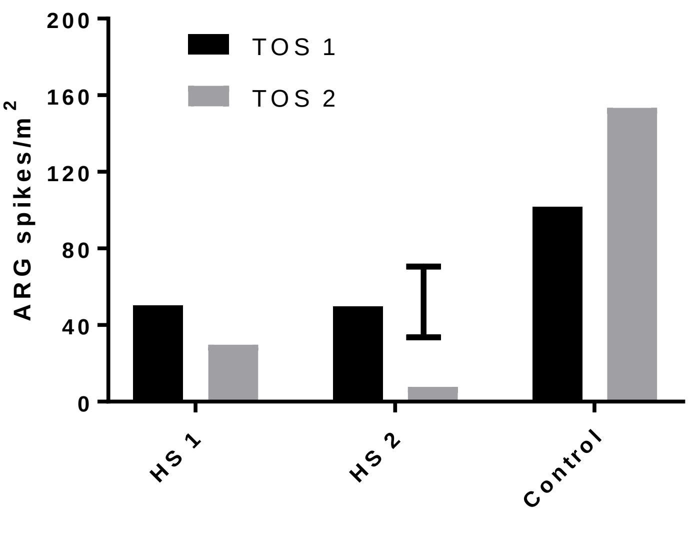


Figure 3. The interaction between sowing time and herbicide strategies (P<0.001) for ARG spike density. The vertical bar represents LSD (P=0.05).

*Annual ryegrass seed production*

As was the case for ryegrass plant density, delayed sowing had no effect on ryegrass seed production (P=0.305). However, there were significant differences between the two canola varieties in ARG seed production (P=0.003). Averaged across the two sowing dates and herbicide treatments, ARG produced 3775 seeds/m$^2$ in Bonito compared to 2564 seeds/m$^2$ in HyTTec Trophy, a reduction of 32%. These results clearly highlight the potential for integrating vigorous hybrid cultivars of canola for improving weed management.

Ryegrass seed production reflected the trends observed in spike density data. There was a significant interaction between the time of sowing and herbicide strategies (P<0.001). Even though ARG seed set in the control was lower in TOS 1 than TOS 2, when herbicide treatments were applied, ARG seed set was significantly lower in TOS 2 (Figure 4). Greater herbicide activity in TOS 2 is likely to be due to better soil moisture content at sowing in TOS 2.

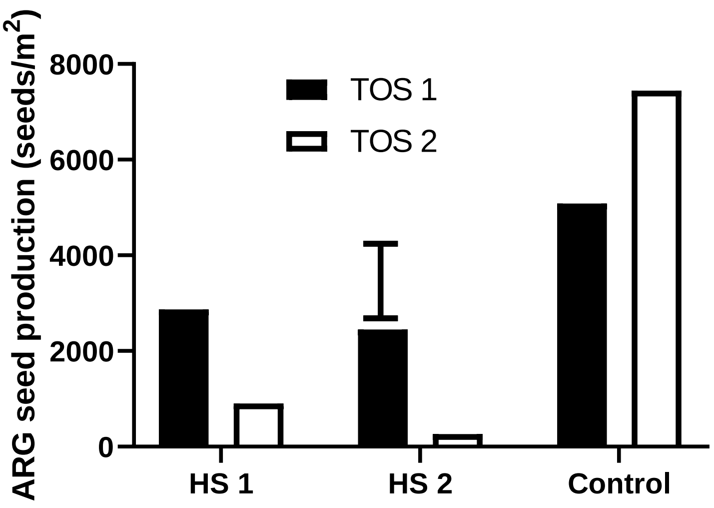


Figure 4. The effect of interaction between the time of sowing and herbicide treatments for ARG seed production. The vertical bar represents the LSD (P=0.05).

*Canola grain yield*

As expected canola grain yield was significantly reduced by the 2 week delay between TOS1 and TOS2 (Figure 4). Averaged across the sowing dates, seed rates and herbicide treatments, Trophy produced 40% greater grain yield than Bonito (0.50 t/ha Vs 0.83 t/ha; P<0.001). Canola seed rate also increased the grain yield; yield increased by 14% as plant density increased from 32 to 44 plants/m $^2$ and to 19% as density increased to 63 plants/m $^2$.

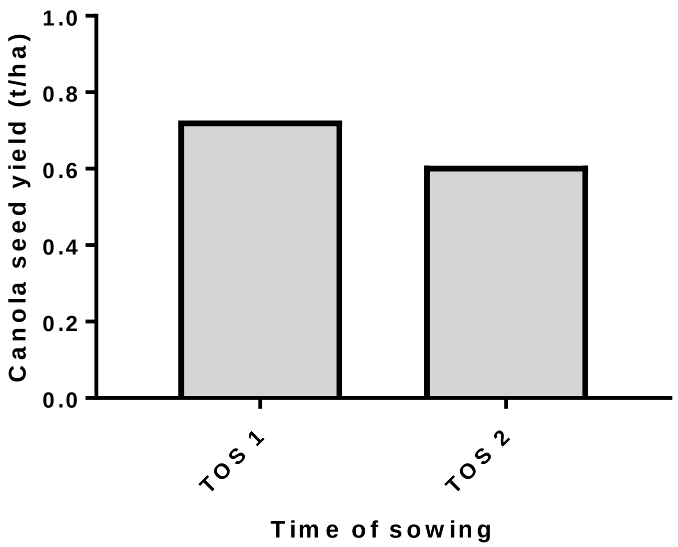


Figure 4. The effect of time of sowing (TOS) on canola seed yield; LSD (P=0.05) = 0.07.

Herbicide strategies had the largest effect on canola yield (P<0.001). HS1 and 2 produced canola yield of around 0.8 t/ha, which was almost 50% greater than the yield obtained in the control (Table 1). These results highlight the competitive ability of ryegrass against canola, especially in a dry season such as 2018.

Table 1. The effect of 3 herbicide strategies on canola grain yield.

| Herbicide strategy | Canola grain yield (t/ha) |
|---|---|
| 1. Atrazine (e.g. Gesaprim 900 WG) 2.2 kg/ha IBS fb Select 500 mL/ha at GS14 of ARG | 0.853 |
| 2. Propyzamide (e.g. Rustler) 1 L/ha IBS fb atrazine 1.1 kg/ha at GS12 of ARG fb Select 0.5 L/ha + Factor 80 g/ha at GS14 of ARG | 0.756 |
| 3. Untreated control | 0.392 |
| LSD (P=0.05) | 0.082 |

Even though there was no interaction between the variety and other management factors investigated, it is instructive to look at the yield response of Trophy and Bonito the herbicide strategies (Figure 5). Trophy had a yield advantage of 0.36 t/ha over Bonito in HS2 and HS3. Gross margin analysis for two varieties was undertaken based on grain yields averaged across the sowing dates, seed rates and herbicide treatments (Table 2). Based on the yield advantage of Trophy over Bonito and taking into extra costs related to seed purchase and end point royalty, the gross margin for Trophy ($381.29) was $114.60/ha greater than for Bonito ($266.70). As oil content of canola grain was not determined, it is assumed that both varieties had a similar oil content.

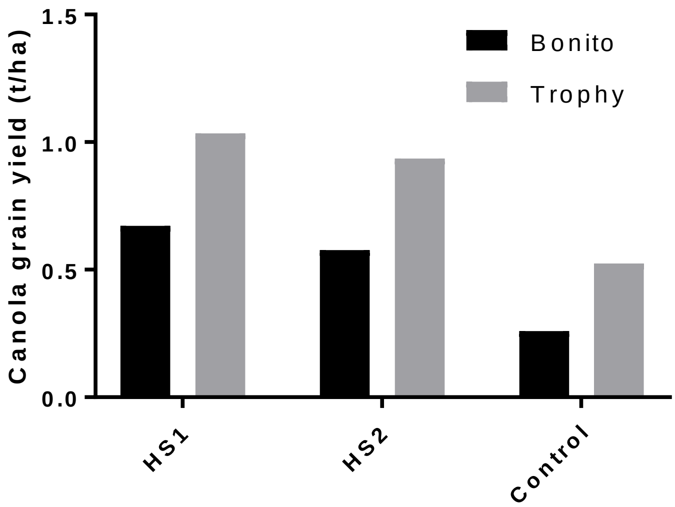


Figure 5. The response of grain yield of Bonito and Trophy to ryegrass control strategies.

Table 2. Estimation of gross margin for Bonito farmer retained seed and HyTTec Trophy in Washpool trial. Canola yields for the two varieties are averages for the two sowing times, seed rates and herbicide treatments. Fertiliser and other management costs have been assumed to be identical for the two varieties.

| | **Bonito retained** | **HyTTec Trophy** |
|---|---|---|
| **Income** | | |
| Grain yield t/ha | 0.503 | 0.831 |
| Cash price $/t | 550 | 550 |
| Gross $/ha | 276.65 | 457.05 |
| **Costs** | | |
| Seed cost per kg | 2 | 19 |
| Sowing rate kg/ha | 3.72 | 3.55 |
| Seed cost $ | 7.44 | 67.45 |
| End point royalty $/t | 5 | 10 |
| EPR $/ha | 2.515 | 8.31 |
| Costs per ha | 9.95 | 75.76 |
| | | |
| Gross margin $/ha | **266.70** | **381.29** |