

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

Abstract

A field trial was undertaken in 2019 to investigate combinations of faba bean sowing time, seed rate and herbicide treatments to control annual ryegrass. ARG plant density was significantly influenced by the time of sowing ($P < 0.001$), herbicide treatment ($P < 0.001$) and the interaction between the time of sowing and herbicide ($P = 0.012$). The 3 week delay in seeding faba beans had no impact on ARG plant density, as shown by the similar ARG density in the simazine + trifluralin treatment. However, POST clethodim and butoxydim had much greater efficacy in the 2nd time of sowing (TOS 2) than in the TOS 1. The same trend was evident in ARG seed set when crop seeding was delayed. In the Simazine + Trifluralin (IBS) treatment there was only an 8% reduction in ARG seed production when seeding was delayed. However, Simazine + Trifluralin (IBS) fb Clethodim had a 62% reduction in ARG seed production in TOS 2 than in TOS 1. ARG seed production was also strongly influenced by faba bean seed rate ($P < 0.001$). The high faba bean seed rate had 43% less ARG seed set compared to the low faba bean seed rate. This result indicates that faba beans can be highly competitive with ARG at the high seed rate. Faba bean grain yield was significantly influenced by crop seed rate ($P < 0.001$), with the high seed rate yielding 14% and 30% higher than the medium and low seed rates, respectively. Herbicide treatment had a significant effect on faba bean grain yield. When POST clethodim was applied after the Simazine + Trifluralin IBS (1.55 t/ha), faba bean grain yield improved by 43% to 2.211 t/ha. Crop yield responses to herbicides treatments were consistent with their efficacy on ARG, which highlights the sensitivity of faba bean grain yield to weed competition. This study has shown that at high plant density, faba beans can provide a significant suppression of ARG. However, faba beans were very intolerant to weeds as shown by the large yield losses. Higher seed rates, are important to both increase competitiveness of faba beans in suppressing ARG, and to also maintain grain yield. However, fungal disease management would need to be monitored and managed effectively.

Introduction

Change in sowing time can have multiple effects on crop-weed competition. Delayed sowing can provide opportunities to kill greater proportion of weed seedbank before seeding the crop but weeds that establish in late sown crops can be more competitive on per plant basis. This is one of reasons why farmers who have adopted early seeding have reported excellent results in crop yield and weed suppression. Therefore, it is important to investigate sowing time in combination with other practices across different rainfall zones. The review of Widderick et al. (2015) also recommended research on sowing time in many crops. Delayed sowing can also reduce crop yield so the gains made in weed control may be completely nullified by the yield penalty.

There has been some research already on crop seed rate on weed suppression but none of these studies have investigated the benefits of higher crop density in factorial combinations with sowing time and herbicide treatments. Crop seed rate is an easy tactic for the growers to adopt provided they are convinced of its benefits to weed management and profitability. Furthermore, growers tend to be reluctant to increase their faba bean seed rate due to concerns about the negative impact of high seed rate on foliar fungal disease pressure.

This field trial at Roseworthy was undertaken to investigate factorial combinations of sowing time, seed rate and herbicides on the management of annual ryegrass in faba beans.

Methods

This field trial investigated combinations of the following management tactics.

1. **Sowing time (2):** early May and late May
2. **Seed rate (3):** 1x (40 seeds/m²), 0.75x (30 seeds/m²), 0.5x (20 seeds/m²)
3. **Herbicides (4):**
 - (i) Simazine (900DF) 1.1 kg/ha + Trifluralin 0.8 L/ha IBS
 - (ii) Simazine (900DF) 1.1 kg/ha + Trifluralin 0.8 L/ha IBS fb Clethodim 500 mL/ha PE
 - (iii) Boxer Gold 2.5 L/ha IBS fb Clethodim 500 mL/ha PE
 - (iv) Propyzamide 1 L/ha IBS fb Clethodim 500 mL/ha + Butroxydim 25 g/ha PE

Variety: Bendoc

Trial design: split plot design

Replicates: 4

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

Trial Management

Table 1. Key management operations undertaken.

Operation	Details
Location	Roseworthy Campus, SA
Seedbank soil cores	14-15 April, 2019
Plot size	1.5 m x 10 m
Seeding date	TOS 1: 7 May, 2019 TOS 2: 31 May, 2019
Fertiliser	At sowing – DAP (18:20:0:2) @ 120 kg/ha
Variety	Bendoc faba beans
Seeding rate	20 seeds/m ² 30 seeds/m ² 40 seeds/m ²
Herbicides	Pre-Emergent herbicides 6 May and 31 May, 2019 (applied immediately before seeding IBS), Post Emergent PE herbicides 19 June (TOS 1) and 24 July (TOS 2). PE applied when faba beans 3-4 node and annual ryegrass ARG Z11-13 to Z21-25. 1. Simazine 900DF (900 g/kg simazine) 1.1 kg/ha + Trifluralin (480 g/L trifluralin) 0.8 L/ha IBS 2. Simazine 900DF (900 g/kg simazine) 1.1 kg/ha + Trifluralin (480 g/L trifluralin) 0.8 L/ha IBS fb Clethodim (240 g/L clethodim) 500 mL/ha POST 3. Boxer Gold (800 g/L prosulfocarb + 120 g/L s-metolachlor) 2.5 L/ha IBS fb Clethodim (240 g/L clethodim) 500 mL/ha POST 4. Rustler (500 g/L propyzamide) 1 L/ha IBS fb Clethodim (240 g/L clethodim) 500 mL/ha + Factor (250 g/kg butroxydim) 125 g/ha POST

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

In 2019, annual rainfall received at Roseworthy was 36% below the long-term average (1997-2020) and growing season rainfall was 25% below the long-term average. Interestingly the total rainfall in 2019 was 44% below the 1883-1997 average rainfall. The rainfall received in May and June was greater than the long-term average with all other months being well below the long-term average (Table 2).

Table 2. Rainfall received at Roseworthy in 2019 and the long-term average for the site.

Month	Rainfall (mm)	
	2019	Long-term rainfall
Jan	0.4	17.0
Feb	4.4	19.7
Mar	6.6	17.9
Apr	1.2	30.4
May	52.4	38.7
Jun	48.6	45.2
Jul	29.8	43.8
Aug	34.2	45.9
Sep	29.0	46.1
Oct	14.2	30.1
Nov	14.8	25.7
Dec	10	25.7
Annual total	245.6	386.3
GSR total	209.4	280.2

Results and Discussion

Faba bean plant density

Seed rate had a significant effect on faba bean density ($P < 0.001$) and target faba bean densities were achieved (Figure 1). Sowing time did not have a significant effect ($P = 0.068$) on faba bean establishment was slightly higher in TOS 2 that experienced more favourable seedbed conditions. Herbicide treatments did not influence faba bean density ($P = 0.526$).

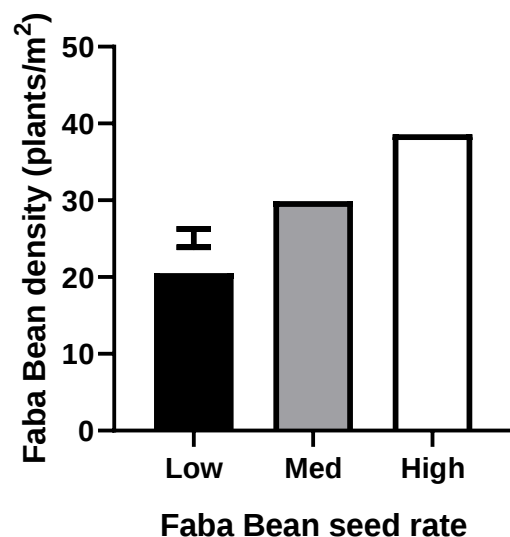


Figure 1. The effect of seed rate on faba bean plant density. The vertical bar represents the LSD ($P = 0.05$).

Annual ryegrass plant density and seedbank

The average seedbank of annual ryegrass (ARG) at the site was 5317 ± 563 seeds/m². The recruitment index (RI) of the ryegrass (the ratio between ARG seedbank and plant density) ranged between 0.5% and 9% in this trial. ARG plant density was significantly influenced by the time of sowing ($P < 0.001$), herbicide treatment ($P < 0.001$) and the interaction between the time of sowing and herbicide ($P = 0.012$).

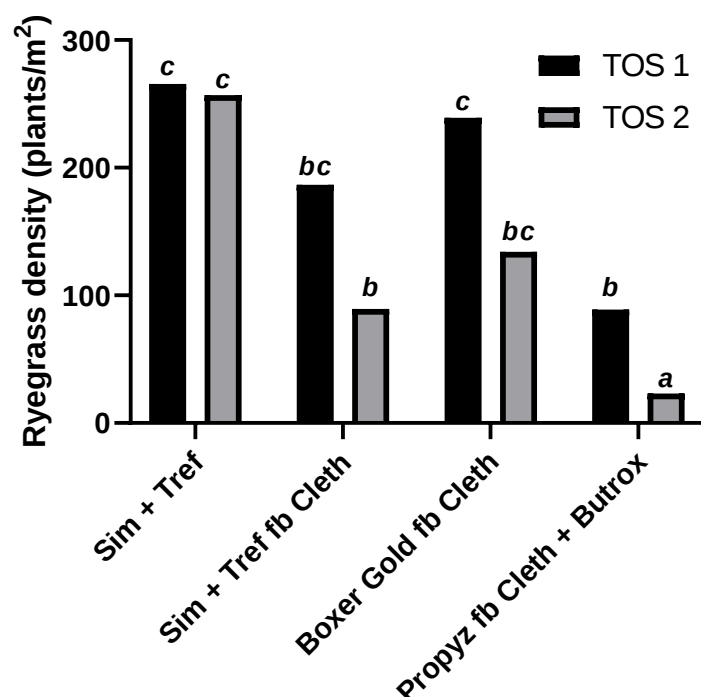


Figure 2. The interaction between the time of sowing and herbicide treatments ($P = 0.006$) where data was square root transformed. The letters above columns represent significant difference ($P = 0.05$).

There was no effect of the 3 week delay in seeding faba bean on ARG plant density (Figure 2), as shown in the simazine + trifluralin treatment. However, POST treatment with clethodim or clethodim + butoxydim had a much greater efficacy in TOS 2 than TOS 1. This difference is most likely due to more favourable environmental conditions at the time of application of the POST herbicides in TOS 2 crop. The POST treatments in TOS 1 experienced two frost events at 4 and 5 days after application that may have influenced the efficacy of group A herbicides.

Annual ryegrass spike density and seed production

ARG spike density was significantly influenced by the time of sowing ($P = 0.035$), crop seed rate ($P < 0.001$), and herbicide treatment ($P < 0.001$). When averaged across the seed rates and herbicide treatments, the three week delay in seeding reduced ARG spike density from 399 spikes/m² to 254 spikes/m² (36% reduction). ARG spike density decreased as faba bean seed rate was increased (Figure 3). When averaged across sowing time and seed rate treatments, herbicide treatments differed considerably in their efficacy on ARG (Figure 4). The Simazine + Trifluralin treatment had the highest ARG spike density (474 ARG spikes/m²). In contrast, Propyzamide fb Clethodim + Butoxydim (166 ARG spikes/m²) provided the largest reduction in ARG spike density.

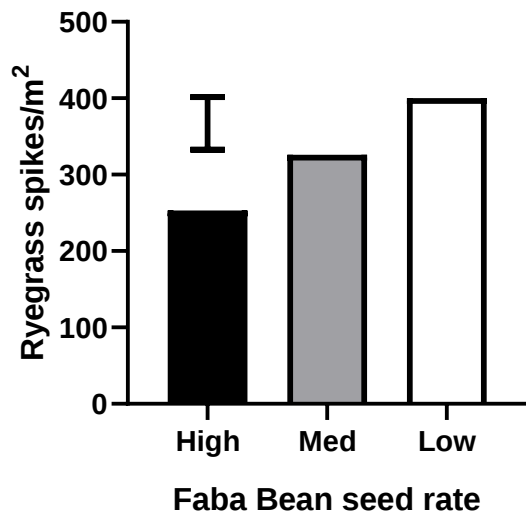


Figure 3. The effect of faba bean seed rate on ($P<0.001$) on ARG spike density. The vertical bar represents the LSD ($P=0.05$).

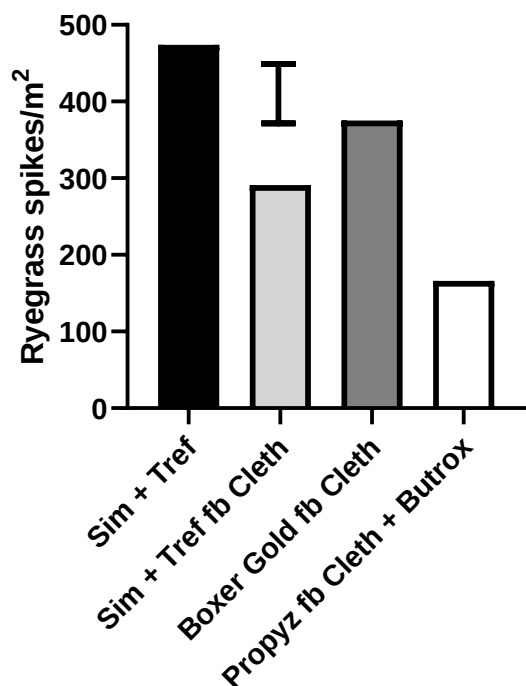


Figure 4. The effect of herbicide ($P<0.001$) on ARG spike density. The vertical bar represents the LSD ($P=0.05$).

Consistent with the trends observed for ARG spike density, ARG seed production was also significantly affected by faba bean seed rate ($P<0.001$), herbicide treatments ($P<0.001$) and the interaction between the TOS and the herbicide treatments ($P=0.022$). This significant reduction in ARG seed production as faba bean seed rate was increased shows the competitive suppression of ARG by faba beans (Figure 5). The high crop seed rate had 43% less ARG seed set compared to the low seed rate. If fungal diseases are managed carefully, increased faba bean seed rate could be quite effective in reducing ryegrass seed set.

There was a trend towards lower ARG seed set when seeding is delayed, which was associated with greater efficacy of group A herbicides in TOS 2 (Figure 6). In the Simazine + Trifluralin (IBS) treatment, there was only an 8% reduction in ARG seed production when crop seeding was delayed. In contrast, Simazine + Trifluralin (IBS) fb Clethodim had a 62% reduction in ARG seed production when seeding was delayed. As mentioned earlier, frost events at 4 and 5 days after the application of clethodim in TOS1 could have reduced herbicide efficacy. The most effective herbicide treatment of TOS 2 with Propyzamide fb Clethodim + Butroxydim (4575 ARG seeds/m²) produced 86% less ryegrass seed than the worst performing treatment (Figure 6). While this is an impressive result in ARG control, it would still allow ARG to replenish the seedbank and infest the next crop.

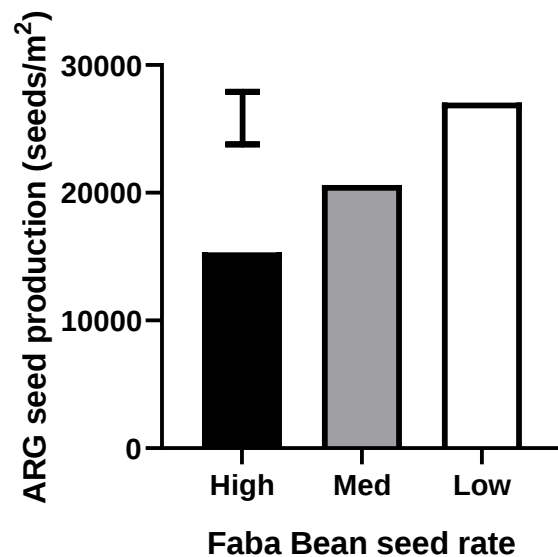


Figure 5. The effect of faba bean seed rate on ($P < 0.001$) on ARG seed production. The vertical bar represents the LSD ($P = 0.05$).

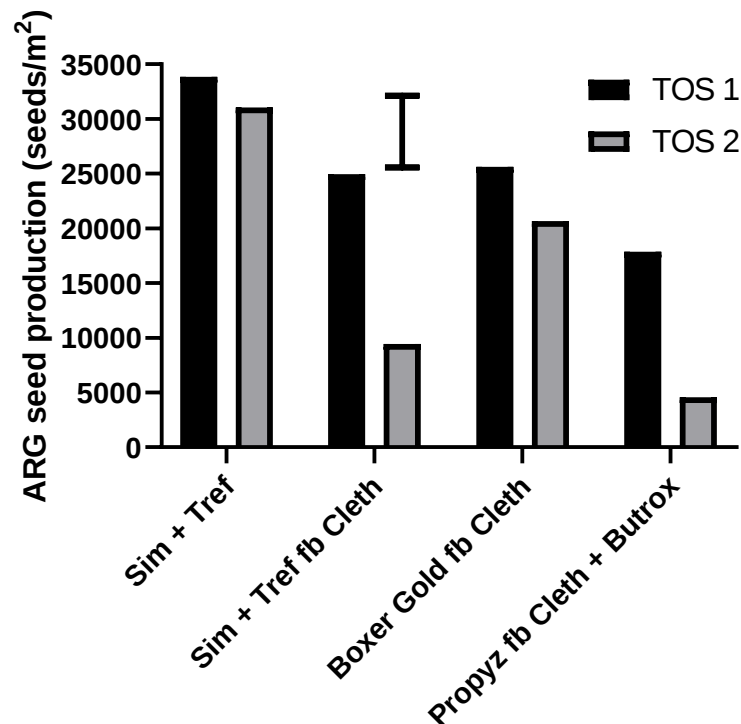


Figure 6. The effect of interaction between the time of sowing and herbicide treatments ($P = 0.023$) on ARG seed production. The vertical bar represents the LSD ($P = 0.05$).

Faba bean grain yield

Faba bean grain yield at Roseworthy ranged from 0.933 t/ha to 3.172 t/ha and with a site mean across all treatments of 2.090 t/ha. Faba bean grain yield was significantly influenced by faba bean seed rate ($P<0.001$), with the high seed rate yielding 14% and 30% higher than the medium and low seed rates respectively. Higher crop seed rate was also shown to reduce ARG seed production in figure 5. This can also be seen in the interaction ($P=0.03$) of time of sowing and seed rate on faba bean grain yield (Figure 7.) Here the higher faba bean seed rates resulted in higher grain yield. However this relationship was stronger in TOS 1, which had higher ARG pressure than TOS 2 particularly in treatments with POST herbicides (Figure 6). This higher weed pressure would result in a larger grain yield penalty as beans become less competitive against ARG when seed rate was reduced.

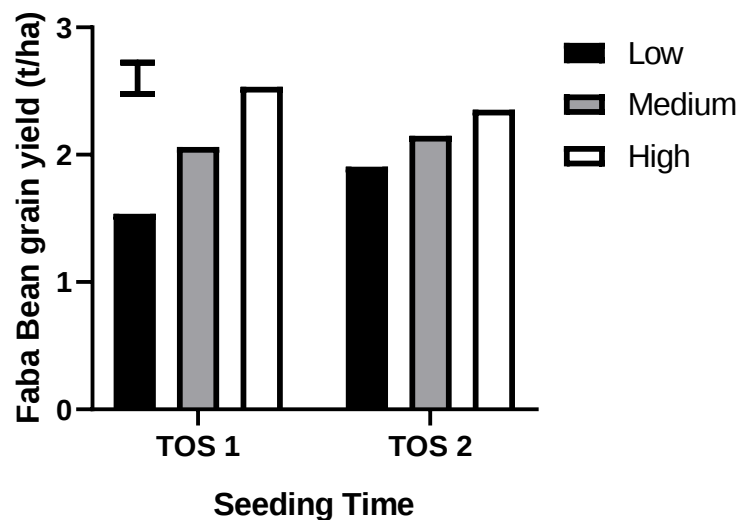


Figure 7. The effect of the interaction between sowing time and faba bean seed rate treatments ($P<0.001$) on faba bean grain yield. The vertical bar represents the LSD ($P=0.03$).

Herbicide treatment had a significant effect on faba bean grain yield. When clethodim treatment (POST) was applied after Simazine + Trifluralin IBS (1.55 t/ha), faba bean grain yield improved by 43% to 2.211 t/ha (Figure 8.) The highest yielding herbicide treatment propyzamide fb clethodim + butroxydim (2.613 t/ha) also provided the highest ARG control (Figures 6 and 8). Crop yield responses to herbicides treatments were consistent with their efficacy on ARG, which highlights the sensitivity of faba bean grain yield to weed competition. Faba bean grain size at the site ranged from 44.5 – 52.2 g/100 grains and was also significantly influenced by herbicide treatments ($P<0.001$). Herbicide treatments that provided higher levels of ARG control were also associated with higher grain yields and larger grain size.

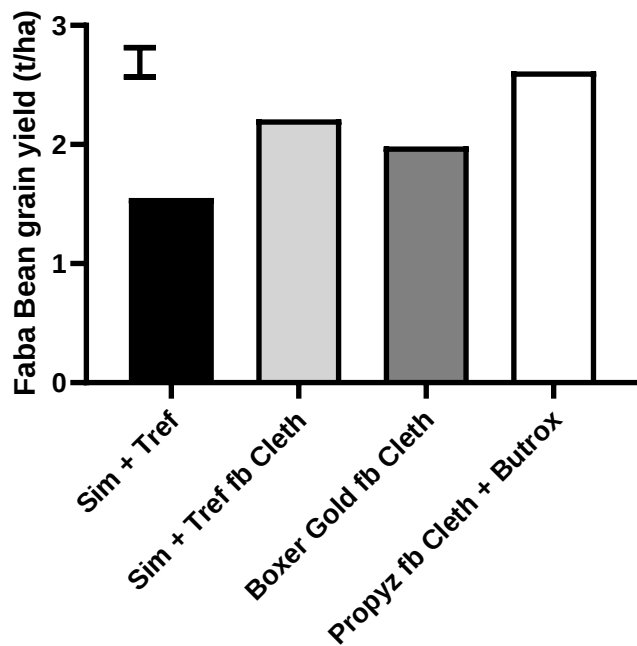


Figure 8. The effect of herbicide treatments ($P < 0.001$) on faba bean grain yield. The vertical bar represents the LSD ($P = 0.05$).

Faba bean grain yield was greatly reduced when by the treatments that were ineffective in controlling ARG. This significant reduction in grain yield from weeds indicates that faba beans have a low tolerance of weeds. However, when faba beans were growing at higher densities, they were able to suppress ARG seed set. These results suggest that management practices aimed at increasing faba bean weed competitiveness, particularly through higher seed rates, are likely to be helpful in improving ARG control and maintaining crop grain yield.

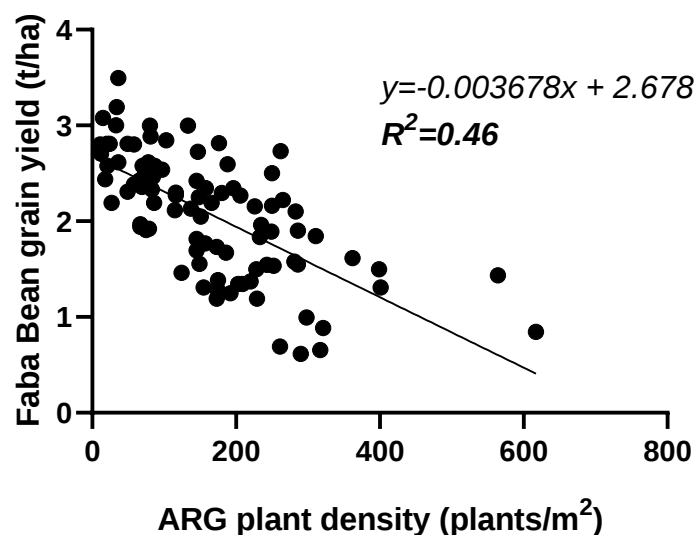


Figure 9. The relationship between ARG plant density (weed pressure) on faba bean grain yield ($P < 0.0001$).