Effect of sowing time x seed rate x herbicides on ryegrass management in faba beans (Frances, SA)

Abstract

A field trial was undertaken at Frances to investigate combinations of faba bean sowing time, seed rate and herbicide treatments to control annual ryegrass (ARG). The average seedbank of ARG at the site was 3932 ± 270 seeds/m^2. 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 ($P<0.001$). The delay in seeding from TOS 1 to TOS 2 (16 weeks) caused a large reduction in ARG plant density. This was particularly evident in the untreated control in which ARG density decreased from 825 plants/m^2 in TOS 1 to 31 plants/m^2 in TOS 2 (96% reduction). This large reduction in ARG density due to delayed sowing is most likely related to an effective knockdown herbicide treatment after most ARG had emerged before TOS 2. Herbicide treatments reduced ARG plant density significantly in TOS 1, however herbicide effect on ARG plant density in TOS 2 was non-significant, possibly due to a much lower ARG density. While the delay in sowing significantly reduced ARG plant density ($P<0.001$), it did not significantly reduce ARG seed spikes ($P=0.495$). This result indicates that despite low ARG plant numbers in TOS 2, faba beans failed to compete effectively with ARG and suppress its growth. As a result, even at a relatively low density ARG was able to produce a large amount of seed for future infestations. Faba bean grain yield at Frances was significantly influenced by the time of sowing ($P=0.033$), seed rate ($P<0.003$), and herbicide treatment ($P<0.001$). Averaged across the seed rates and herbicide treatments, faba beans produced grain yield of 1.34 t/ha in TOS 1 as compared to 1.81 t/ha in TOS 2. Superior faba bean grain yield in TOS 2 In 2018 at Frances is most likely due to the reduction in ARG plant density.

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) has 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.

This field trial at Frances 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 (refer to Table 1 for details).

Sowing time (2): early May and early June (due to complete bird damage re-sown early Sept)

Seed rate (4): 1x (40 seeds/m^2), 0.8x (32 seeds/m^2), 0.6x (24 seeds/m^2), 0.4x (16 seeds/m^2).

Herbicides (3):

(i) Control (pre-sowing glyphosate treatment only)
(ii) Simazine (900g/kg) 1.1 kg/ha + Trifluralin (480g/L) IBS, followed by Select 500 ml/ha (when ARG at GS14)
(iii) Boxer Gold 2.5 L/ha IBS, followed by Select 500 ml/ha (when ARG at GS14)

Variety: PBA Samira

Trial design: split plot design

Replicates: 3

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	Frances, SA
Seedbank soil cores	4 May, 2018
Plot size	1.25m x 8m
Seeding date	TOS 1: 18 May, 2018 TOS 2: 5 September, 2018
Fertiliser	At sowing – Pasture King (15:16:0:5:2%Zn) @ 150 kg/ha
Variety	PBA Samira faba bean
Seeding rate	16 seeds/m^2 24 seeds/m^2 32 seeds/m^2 40 seeds/m^2
Herbicides	18 May and 5 September, 2018 (applied just before seeding) Boxer Gold 2.5 L/ha IBS, followed by Select 500 ml/ha (when ARG at GS14) Simazine (900g/kg) 1.1 kg/ha + Trifluralin (480g/L) IBS, followed by Select 500 ml/ha (when ARG at GS14) Control (pre-sowing glyphosate treatment only)
Harvest	18 December TOS 1, 21 December TOS-2

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

In 2018, annual rainfall received at Frances (Naracoorte BOM) was 1% above the long-term average and the growing season rainfall was 12% above from the long-term average (Table 2). The rainfall received in July and August was above the long-term average (Table 2) but rainfall in September was below the long-term average.

Table 2. Rainfall received at Frances (Naracoorte) in 2018 and the long-term average for the site.

	Rainfall (mm)	
Month	**2018**	**Long-term rainfall**
Jan	8.8	23.0
Feb	12.0	18.6
Mar	10.6	25.1
Apr	19.0	27.8
May	48.2	41.1
Jun	67.6	56.3
Jul	93.6	61.3
Aug	94.8	72.0
Sep	18.4	52.6
Oct	47.6	37.4
Nov	26.0	33.9
Dec	50.2	37.7
Annual total	496.8	490.8
GSR total	388.8	348.5

Results and Discussion

Faba Bean plant density

Despite the 16-week delay between TOS 1 and 2 and dryer conditions after TOS 2 (Table 2), there was no effect of time of sowing on faba bean density (P=0.290). The herbicide treatments had no effect on faba bean density (P=0.769), indicating crop safety of pre-emergent herbicides. Unsurprisingly faba bean seed rate significantly influenced faba bean density (P<0.001).

Annual ryegrass plant density and seedbank

The average seedbank of annual ryegrass (ARG) at the site was 3932 ± 270 seeds/m^2. 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<0.001).

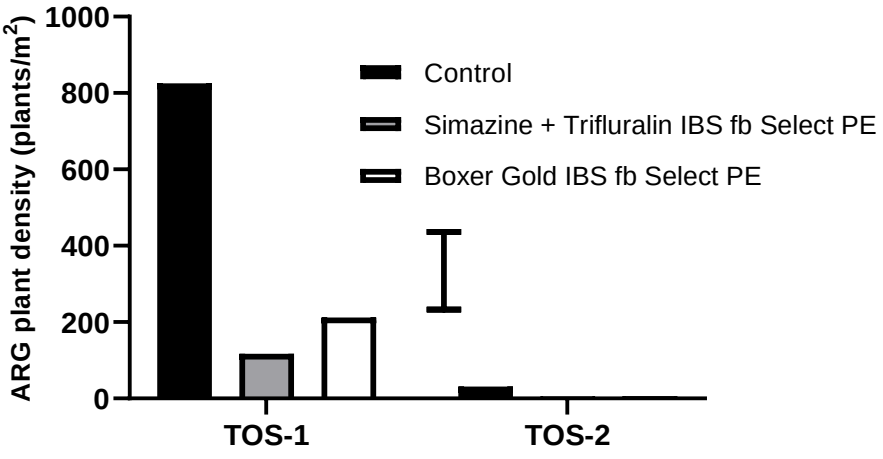

Figure 1. The interaction between the time of sowing and herbicide treatments (P<0.001). The vertical bar represents the LSD (P=0.05).

There was a large impact of the 15 week delay in seeding wheat on ARG plant density (Figure 1). This was particularly evident in the untreated control in which ARG density decreased from 825 plants/m^2 in TOS 1 to 31 plants/m^2 in TOS 2 (96% reduction). This large response of ARG density to delayed sowing is most likely related to the application of an effective knockdown herbicide prior to TOS 2, after most ARG cohorts had emerged. The herbicide treatments in TOS 1 caused a significant reduction ($P<0.001$) in ARG plant density. However with the strong influence of delayed sowing on ARG density, herbicide treatments were similar to the untreated control within TOS 2 (Figure 1).

The recruitment index (RI) of ryegrass (the ratio between ARG seedbank and plant density) was also significantly affected by the interaction between the time of sowing and herbicide treatments ($P<0.001$). In the untreated control, RI for ARG was 0.41 (i.e. 41% recruitment) which declined to 0.01 (1% recruitment) in TOS 2. This large difference in ARG establishment in two sowing dates again points to high pre-sowing weed establishment, which was effectively controlled by the knockdown treatment of glyphosate.

Annual ryegrass spike density

ARG spike density was not significantly influenced by the time of sowing ($P=0.495$), despite time of sowing having a strong effect on ARG plant numbers. This result highlights the poor competitive ability of faba beans against ARG, which allowed even a low density of ARG to produce many tillers and spikes in TOS 2. In contrast, the presence of very high ARG plant densities in TOS-1 would have resulted in an extremely high intraspecific competition, which would have reduced ARG spikes per plant. Consequently, delayed seeding had no impact on the potential amount of ARG seed produced.

Faba bean seed rate had a significant effect ($P=0.045$) on ARG seed spikes. An increase in faba bean seed rate from 16 seed/m^2 to 40 seeds/m^2 reduced ARG spikes density from 1473 and 964 ARG spikes/m^2, respectively.

Herbicide treatment also had a significant effect on ARG spike density across all times of sowing and seed rates ($P<0.001$). There was also a strong interaction ($P<0.001$) between time of sowing and herbicide treatment (figure 2). Where herbicide treatments were applied, ARG spike density was lower in TOS 2 than in TOS 1. However in the absence of effective herbicide (untreated control), ARG spike density was significantly greater in TOS 2 than TOS 1 (Figure 2).

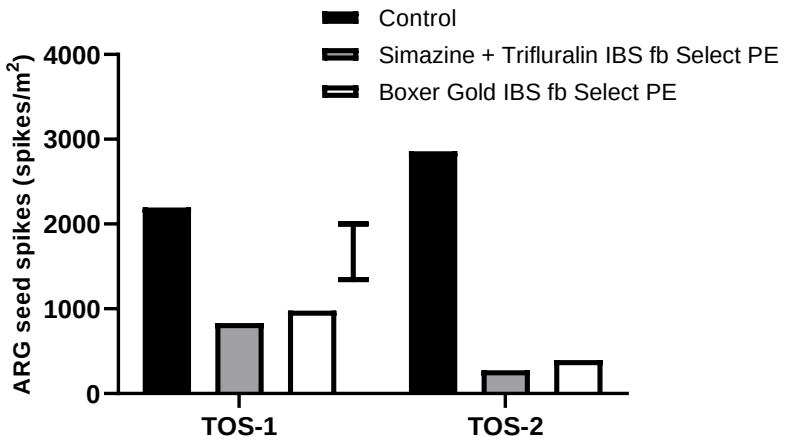

Figure 2. The effect of interaction between the time of sowing and herbicide treatments ($P<0.001$) on ARG spike density. The vertical bar represents the LSD ($P=0.05$).

Faba bean grain yield

Faba bean grain yield at Frances was significantly influenced by the time of sowing (P=0.033), seed rate (P=0.003), herbicide treatment (P<0.001). Averaged across the seed rates and herbicide treatments, faba beans produced grain yield of 1.34 t/ha in TOS 1 as compared to 1.81 t/ha in TOS 2. This flexibility of faba bean for late sowing is somewhat surprising. As faba beans matured at a similar time in both sowing times (Table 1), TOS 2 had a 15-week shorter growing season than TOS 1. Despite a dry start to TOS 2, faba beans were able to successfully utilise stored soil moisture in the absence of heavy ARG infestation. It is possible wet conditions and transient water-logging at this site may have restricted faba bean grain yield in TOS 1 at this site.

While faba bean grain yield was improved by delaying sowing, it came at a cost for faba bean grain size. Grain size reduced from 71.8 g/100 seeds to 48.5 g/100 seeds when sowing was delayed by 15 weeks, a reduction in grain size of 32%. This reduced grain size could limit market access possibly limiting grain of this size to animal feed, despite advantages of potentially higher yields.

Faba bean yield increased as seed rate increased consistently from 16 seeds/m^2 (1.13 t/ha) to 32 seeds/m^2 (1.84 t/ha). There was a strong logarithmic or hyperbolic relationship between faba bean seed rate and grain yield which accounted for 96% of yield variation (Figure 3).

Both pre-emergent herbicides followed by post-emergence clethodim (Select) caused a significant increase in faba bean grain yield (Figure 4). These results also highlight poor tolerance of faba bean to competition from ARG. As both herbicide treatments had a very similar level of efficacy on ARG, they also provided a similar increase in grain yield (63-64%) relative to the untreated control. Both herbicide treatments were effective in controlling annual ryegrass (figure 1) and this is reflected in improved faba bean grain yields (figure 3). This indicates that ARG is quite competitive over faba beans in this environment.

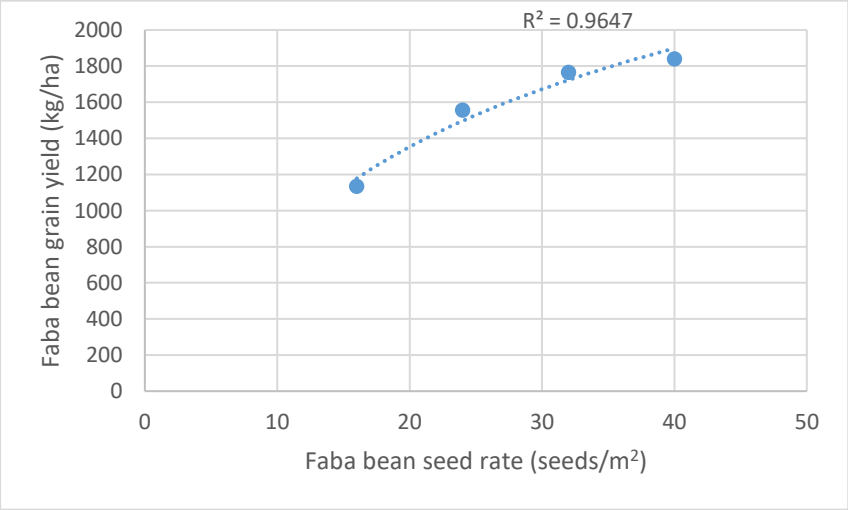

Figure 3. The logarithmic relationship between faba bean seed rate and its grain yield at Frances.

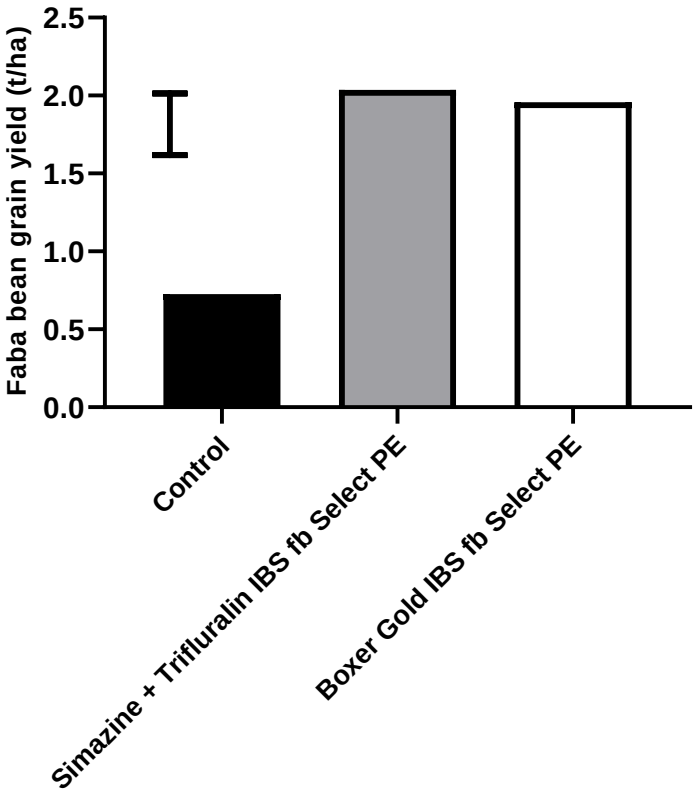

Figure 4. The effect of herbicide treatments (P<0.001) on faba bean grain yield. The vertical bar represents the LSD (P=0.05).