Effect of seed rate x herbicides on annual ryegrass management in field peas (Roseworthy, SA)

Key messages

- Increase in field pea plant density from 40 to 60 plants/m^2 by higher seed rate treatments significantly reduced ARG plant and spike density, and increased field pea grain yield. However, the major driver of ARG density and crop yield in this trial was herbicide treatments ($P<0.001$).
- Large ARG seedbank present at the trial site resulted in continued weed establishment for at least 2 months after sowing, which was reflected in inadequate ARG control by pre-emergent propyzamide alone.
- This trial site has group 1 resistant ARG population, which was reflected in inadequate weed control by the post-emergent clethodim + butroxydim treatment (64% ARG control). The sequential application of pre-emergent herbicide treatments followed by post-emergent herbicides substantially increased ARG control to 86-93%.
- Field pea grain yield increased from 2.19 t/ha at the lowest crop density to 2.65 t/ha at the highest density, a gain of nearly 0.5 t/ha. This improvement in grain yield is likely to be associated with improved weed suppression at the higher seed rates.
- Effective herbicide treatments more than doubled field pea grain yield by reducing competition from ARG. Pre-emergent application of propyzamide followed by post-emergent clethodim + butroxydim was the best treatment with grain yield of 3.1 t/ha as compared to 1.2 t/ha in the untreated control.

Introduction

Pulse crops such as lentils and field peas are well known for their inability to effectively compete with weeds such as ARG. However, pulse crops provide important benefits to the production system from cereal disease break as well biological nitrogen fixation. Due to weak competitive ability with weeds, pulse crops require integration of pre-emergent herbicides with post-emergent herbicides. However, widespread presence of resistance to group 1 herbicides is making effective ryegrass management in pulse crops increasingly difficult.

Previous research has shown benefits of increased plant density of various crops on weed suppression. Generally, improvement in weed suppression with higher crop density tend to be greater in cereals than pulse crops. There are also concerns about increased foliar diseases if plant density is increased in pulse crops. However, it's important to investigate the trade-offs between improved weed suppression and disease risks from increased crop density.

This field trial at Roseworthy was undertaken to investigate factorial combinations of field pea seed rate and herbicides on the management of ARG.

Methods

Trial design: Factorial randomised block design
Replicates: 3
Measurements: crop density, ARG plant density, ARG spike density, ARG seed production, and field pea grain yield.

Table 1. Key management operations undertaken.

Operation	**Details**
Location	Roseworthy, SA
Plot size	1.5 m x 10 m
Fertiliser	At sowing – DAP (18:20:0) @ 120 kg/ha
Variety	Wharton
Seeding rate	40 seeds/m^2 50 seeds/m^2 60 seeds/m^2
Crop sowing date	June 19
Herbicides	Pre-emergent treatment spray: June 19 (applied just before seeding) Post-emergent treatment spray: August 8 (V 6-7 stage) Refer to Table 5 for information on herbicide treatments.

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

Rainfall at Roseworthy during the growing season was 30% above the long-term average. Total annual rainfall was 46% above the long-term average for the site. The year (2022) was characterised by a very dry autumn, only breaking with reasonable rains at the end of May, July had below average rainfall, while October and November had well above average rainfall. The November rainfall, though classed as outside of growing season (April-October), could have been used by the crop due to exceptionally mild weather in 2022 (Table 2).

Table 2. Rainfall received at Roseworthy in 2022 and the long-term (1997-2022) average for the site.

	Rainfall (mm)	
Month	**2022**	**Long-term rainfall**
Jan	64.6	18.3
Feb	5.8	19.0
Mar	11.4	16.7
Apr	6.8	29.9
May	78.8	39.5
Jun	52.8	45.5
Jul	26.0	43.7
Aug	49.2	45.9
Sep	56.8	45.5
Oct	99.8	34.7
Nov	107.0	29.6
Dec	14.0	23.8
Annual total	573.0	392.3
GSR total	370.2	284.7

Results and Discussion

Field pea plant density

As expected, field pea seed rate had a significant effect on crop density ($P<0.001$, Table 3), which was within 1-3 plants/m^2 of the target density. Successful crop establishment provided

an opportunity to investigate the benefits of increased crop competition for ARG management.

Table 3. Effect of field pea seed rate on crop plant density (P<0.001) trial at Roseworthy.

Field pea seed rate (seeds/m^2)	Crop density (plants/m^2)
40	41.1
50	53.4
60	60.8
P	<0.001
LSD (P=0.05)	4.83

Annual ryegrass plant density

ARG plant density in this trial was significantly affected by crop density (P=0.049) and herbicide treatments (P<0.001). ARG plant density was almost identical at the low (40) and medium (50) seed rates but there was around 18% reduction in ryegrass plant density at the highest crop density (60 plants/m^2) (table 4). It is possible that competition provided by the larger crop canopy at the highest density may have reduced ARG recruitment from its seedbank or some weed seedlings may have died due to more intense interspecific competition.

Table 4. Effect of field pea seed rate on annual ryegrass plant and spike density.

Field pea seed rate (seeds/m^2)	Annual ryegrass plant density (plants/m^2)	Annual ryegrass spike density (spikes/m^2)
40	324	657
50	326	576
60	264	508
P	0.049	0.029
LSD (P=0.05)	56.3	108.1

Excellent soil moisture conditions at crop sowing in 2022 were ideal for the activity of pre-emergent herbicides. However, massive seedbank present at the site resulted in continuous weed establishment for at least 2 months after sowing, which meant that pre-emergent propyzamide alone was inadequate for ARG control (Table 5). The trial site has group 1 resistant ARG population, which was reflected in inadequate weed control by the post-emergent clethodim + butroxydim herbicide treatment (64% ARG control). However, the sequential application of pre-emergent herbicide treatments followed by post-emergent herbicides substantially increased ARG control to 86-93% (Table 5).

Annual ryegrass spike density

Spike density of ARG was significantly influenced by field pea seed rate (P=0.029) and herbicide treatments (P<0.001) but there was no interaction between these two factors (P=0.136). The highest density of field peas reduced ARG spike density by 23% which was statistically significant (Table 4).

Consistent with the results for ARG plant density, herbicide treatments caused a significant (P<0.001) reduction in its spike density (Table 5). The combination of pre-emergent herbicides followed by the post-emergent treatments reduced ARG spike density by 58 to 71% (Table 5). These results highlight the difficulty that group 1 herbicide resistance can make in effectively managing ARG populations. In such situations, growers need to use crop-topping and harvest weed seed control to reduce future infestations of ARG.

Table 5. The effect of herbicide treatments (P<0.001) on annual ryegrass plant and spike density in field peas at Roseworthy. Figures in brackets are percentage reduction compared to the untreated control.

Herbicide treatment	**Annual ryegrass plants/m^2**	**Annual ryegrass spikes/m^2**
Untreated **control**	919	1029
Propyzamide IBS (Edge 900WG 1.1 kg/ha)	284 (69%)	594 (42%)
Clethodim (Grasidim® 500mL/ha) + Butroxydim (Factor® 180 g/ha) POST	328 (64%)	766 (26%)
Propyzamide IBS fb Clethodim + Butroxydim POST	131 (86%)	300 (71%)
Experimental 1 (Clethodim + Butroxydim + Propyzamide POST)	102 (89%)	427 (58%)
Experimental 2 (Trifluralin 1.5 L/ha IBS fb Clethodim + Butroxydim + Propyzamide POST)	63 (93%)	369 (64%)
P	<0.001	<0.001
LSD (P=0.05)	79.6	152.8

Field pea grain yield

Grain yield of field peas was significantly influenced by crop seed rate (P<0.001) and herbicide treatments (P<0.001), but there was no interaction between these factors (P=0.639). Absence of interaction between the treatment factors shows that field pea grain yield responded positively to the higher crop seed rates irrespective of the herbicide treatments. Field pea grain yield increased from 2.19 t/ha at the lowest crop density to 2.65 t/ha at the highest density, a gain of close to 0.5 t/ha (Figure 1). This improvement in grain yield is likely to be associated with increased weed suppression at the higher seed rates.

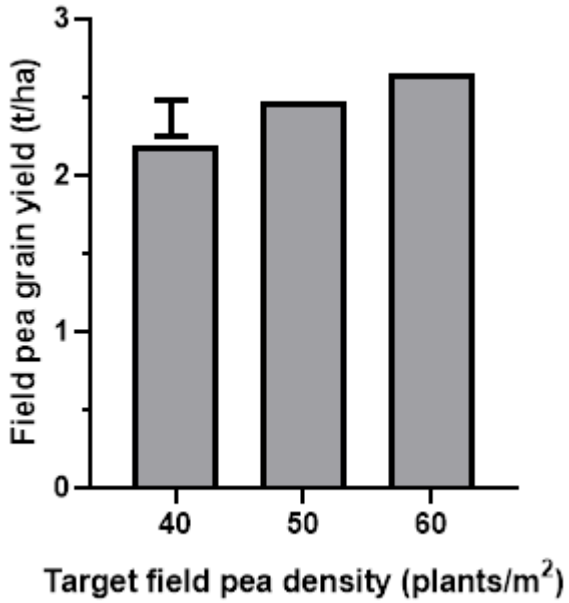

Figure 1. The effect of field pea density on grain yield at Roseworthy in 2022. The vertical line represents LSD (P=0.05).

As field peas are a weak competitor against weeds, herbicide treatments had a highly significant impact on crop yield (P<0.001). Effective herbicide treatments more than doubled field pea grain yield by reducing competition from ARG (Table 6). Pre-emergent application of propyzamide followed by post-emergent clethodim + butroxydim was the best treatment with grain yield of 3.1 t/ha as compared to 1.2 t/ha in the untreated control. These results also highlight that there is likely to be some yield penalty in situations where growers rely exclusively on post-emergent herbicides especially when dealing with dense ARG populations. In such situations, early competition from weeds is likely to cause a major setback to the crops that will be reflected in a yield penalty even when weeds are controlled effectively later in the season with post-emergent herbicides.

Table 6. The effect of herbicide treatments (P<0.001) on field pea grain yield at Roseworthy. Figures in brackets are percentage increase in yield compared to the untreated control.

Herbicide treatment	**Field pea grain yield (t/ha)**
Untreated control	1.179
Propyzamide IBS (Edge 900WG 1.1 kg/ha)	2.519 (113.7%)
Clethodim (Grasidim® 500mL/ha) + Butroxydim (Factor® 180 g/ha) POST	2.187 (85.5%)
Propyzamide IBS fb Clethodim + Butroxydim POST	3.104 (163.3%)
Experimental 1 (Clethodim + Butroxydim + Propyzamide POST)	2.741 (132.5%)
Experimental 2 (Trifluralin 1.5 L/ha IBS fb Clethodim + Butroxydim + Propyzamide POST)	2.888 (145.0%)
P	<0.001
LSD (P=0.05)	0.250

Consistent with the large effects of herbicide treatments on crop yield (Table 6), there was a strong correlation (R^2=0.74) between ARG plant density and field pea grain yield (Figure 2). These results clearly highlight the competitive effect of ARG on field peas even in an above-average rainfall growing season. Any ARG plants that survive the knockdown or pre-emergent herbicides are likely to have a significant effect on crop yield. Even though field pea grain yield may have been largely protected by the effective herbicide treatments, none of the treatments appear to have prevented ARG from setting seeds for future infestations. These results clearly highlight the need for using tactics such as crop-topping and harvest weed seed control when dealing with large herbicide resistant populations of ARG.

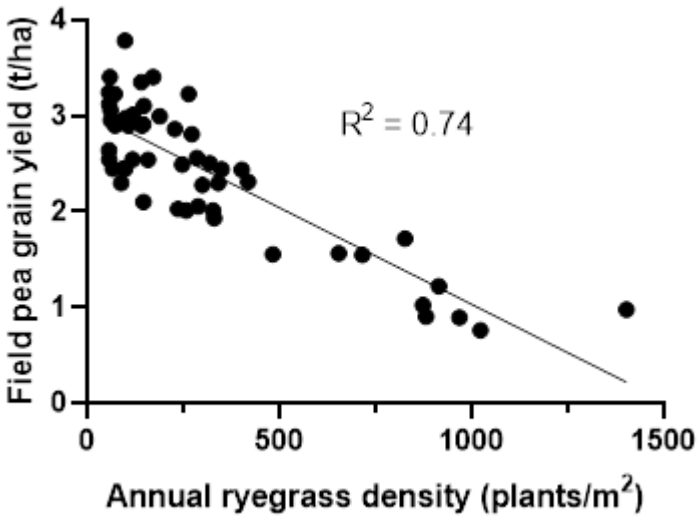

Figure 2. The linear relationship between annual ryegrass plant density and field pea grain yield. This relationship illustrates high sensitivity of field peas to competition with annual ryegrass.