Faba bean agronomy and canopy management

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Key findings

- Grain yields were increased by sowing early (mid-April to early-May) over later sowing (end of May) under the favourable growing seasons experienced at Hart in 2016, in contrast to similar climatic seasons in higher rainfall areas of SA such as Tarlee.
- Varieties with agronomic characteristics of early flowering and high biomass production optimised yields.
- There was no change in grain yields from application of plant growth regulators (PGRs) on early sown faba beans.
- Agronomic traits related to improved harvestability were observed from some PGRs, however further field testing will be required to better understand the best application timings and quantify benefits.

Why do the trial?

Choosing the optimum sowing time is key to managing and reducing abiotic stress and increasing yields of pulses. Pulses are particularly sensitive to abiotic stresses associated with cold/frosts and heat during the reproductive stages of podding and grain filling. Due to an expansion of faba bean production outside of traditional areas and the development of new varieties with improved agronomic traits, an understanding of optimum sowing time by variety will help to maximise yields in different environments.

Early sowing of faba beans, particularly in favourable environments and seasons, results in large bulky canopies potentially leading to issues with light and pollinator penetration, flower retention, pod-setting and disease management. Agronomic evaluation of canopy management strategies using plant growth regulator (PGR) hormones is needed to better understand the impact of modifying plant architectural traits such as height and stand ability on yields. Faba bean sowing date by variety and canopy management trials were sown at Hart in 2016 to improve the understanding of production in non-traditional areas along with providing a contrasting information source to similar experiments sown at Tarlee in a more traditional and favourable faba bean producing region.

How was it done?

The sowing date by variety trial was designed as a split plot randomised complete block design with sowing date as the main plot and faba bean varieties as the sub-plots replicated three times. Nine faba bean varieties, including, five commercial varieties (Farah, PBA Zahra, PBA Rana, Nura and PBA Samira), three advanced breeding lines (AF09167, AF09169 and AF1212) and one experimental determinant line (AF13250) were sown at three sowing dates, 14 April, 7 May and 26 May. The advanced breeding lines were chosen to evaluate their adaptation in high biomass producing environments and to explore their potential in low rainfall faba bean growing areas.

The determinate line has a growth type similar to lupins with characteristics of a terminal inflorescence that develops after the plants have developed flowers at about 4 or 5 nodes at which growth in plant height is restricted. This experimental line was included in our trials to help understand the potential of this trait in managing canopy growth where conventional plant types may produce too much vegetative growth at the expense of grain yield. Plots measured 10 m x 1.35 m. Sowing was direct drilled with a narrow point plot cone seeder at a depth of 5-7 cm with 22.5 cm (9 inches) row spacing.

Sowing occurred in relatively dry seed bed conditions, requiring an irrigation event of 20 mm of water immediately post sowing to enhance seed germination. MAP was applied at sowing at a rate of 100 kg/ha. Strategic fungicide and insecticide sprays were applied during the growing season to prevent disease and pests in line with the standard district practice for beans. Agronomic measurements and observations were taken including phenology, dry matter weight and grain yield.

The canopy management trial was sown on 14 April and standard trial design, layout and management, including an irrigation event to aid emergence, was done as for the sowing date trial. Treatments were a) nil; b) ethephon & trinexapac-ethyl - ethephon was applied at 8 node followed by trinexapac-ethyl at plant budding; c) paraquat & diquat herbicide – applied at a rate of 250 ml/ha at 8 node; d) Physical terminal bud removal (by hand pinching to simulate slashing/grazing) at 8 node. Faba bean variety PBA Samira, was used in the trial due to its suitability in medium and high rainfall faba bean districts. Agronomic measurements assessed included plant height, lodging, and grain yield. Plant heights were only taken at commencement of flowering as plants were lodged heavily at the time of harvest.

Results and discussion

Review of seasonal conditions, 2016

The Hart field site received a growing season rainfall of 356 mm in 2016, which was above the long term average of 305 mm. The last month of Autumn recorded a total of 36 mm marking the break to the season, which was followed by wet conditions in Winter and heavy rains in early to mid-Spring. Wet conditions favoured early crop vigour and provided conditions for beans to develop large canopies. Wet conditions also favoured development of disease and small outbreaks of ascochyta blight (AB) were observed in varieties such as Farah, PBA Rana and PBA Zahra. Strategic sprays during vegetative growth, at canopy closure and during podding were applied to control AB in the trials. Cool, wet conditions during Spring favoured pod filling and prolonged maturation of crops. As a result, significantly high yields above long term averages were recorded.

Sowing date by variety trial

Flowering and biomass production

The advanced breeding line AF09169, sown mid-April, flowered 25 days earlier than Farah, AF09167, AF11212 and AF13250 which all flowered at similar dates (Table 1). Commercial varieties Nura, PBA Rana and PBA Samira sown mid-April flowered less than 10 days from each other but one month after the advanced breeding line, AF09169. Differences in variety time to flower when sown in early and late May decreased considerably compared with the earlier sowing date. The early flowering varieties flowered between 10 and 17 days earlier than the later maturing varieties (Nura, PBA Rana and PBA Samira) at the May 7 sowing and the difference was even less at the last sowing date (27 May).

Table 1. Calendar date and number of days from sowing to commencement of flowering of nine faba bean varieties sown at three different dates at Hart field site, 2016.

Variety	Date of commencement of flowering			No. of days to commencement of flowering from sowing date		
	Time of sowing			Time of sowing		
	14-Apr	7-May	26-May	14-Apr	7-May	26-May
AF09167	26-Jul	5-Aug	22-Aug	103	90	88
AF09169	1-Jul	5-Aug	23-Aug	78	90	89
AF11212	26-Jul	8-Aug	22-Aug	103	93	88
AF13250	29-Jul	11-Aug	24-Aug	106	96	90
Farah	26-Jul	5-Aug	22-Aug	103	90	88
Nura	6-Aug	22-Aug	25-Aug	114	107	91
PBA Rana	5-Aug	15-Aug	25-Aug	113	100	91
PBA Samira	8-Aug	22-Aug	26-Aug	116	107	92
PBA Zahra	29-Jul	15-Aug	25-Aug	106	100	91

*Commencement of flowering was taken as 50% flowering and determined by 50% of plants within plot having one opened flower

Varieties differed in the amounts of biomass produced at commencement of flowering however, this was dependent on sowing date (Table 2). Most varieties recorded higher amounts of biomass from the earliest sowing date while the two later sowings recorded lower and more variable biomass between varieties. Early flowering varieties Farah, AF09167, AF11212 and AF13250 recorded lower amounts biomass at the mid and later sowing dates compared to the early sowing date. Similarly, later flowering varieties PBA Zahra and PBA Rana, had reduced dry matter weight with delayed sowing. In contrast, the biomass of Nura and PBA Samira was unaffected by sowing date. It is worth noting that beans produced higher amounts of biomass at flowering in 2016 compared with the previous year at this site.

Table 2. Dry matter production (t/ha) at commencement of flowering of nine faba bean varieties sown at three different dates at Hart, 2016.

Variety	Dry biomass weight (t/ha)		
	Time of sowing		
	14-Apr	7-May	26-May
AF09167	4.28	3.29	2.51
AF09169	3.58	3.11	3.07
AF11212	3.38	2.38	2.53
AF13250	4.72	2.89	3.19
Farah	5.31	2.48	2.75
Nura	3.91	3.69	3.04
PBA Rana	4.97	3.64	2.65
PBA Samira	4.03	4.93	3.69
PBA Zahra	5.14	4.63	3.05
LSD (P≤0.05)		**1.09**	

Grain yield

There was no sowing date by variety interaction for grain yields at this site. Sowing early in mid-April and early-May resulted in higher yields than late sowing at the end of May (Figure 1). Bean varieties yielded exceptionally well ranging from 5.5 to 6.3 t/ha (Figure 2), which was well above long term averages for this site. Two early flowering varieties, AF09169 and AF11212 had the highest yields, equal to the commercial variety PBA Zahra. All other varieties had lower yields with little to no differences between them.

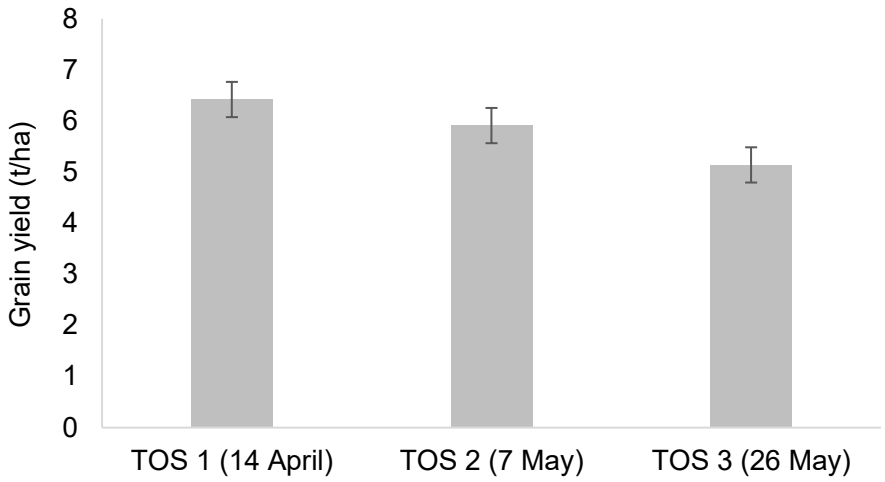

Figure 1. Grain yield (t/ha) across three sowing dates averaged across nine faba bean varieties at Hart, 2016.

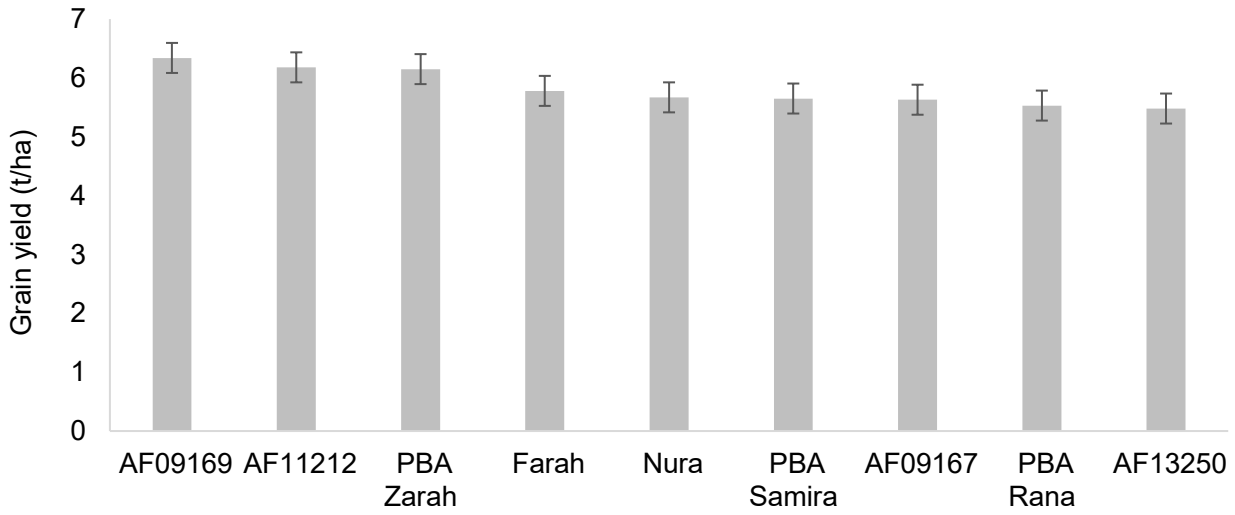

Figure 2. Grain yield (t/ha) of nine faba bean varieties averaged across three sowing dates at Hart, 2016.

Canopy management trial

A treatment response was found for plant height (cm) and lodging (1-9 scale). The treatments ethephon & trinexapac-ethyl and paraquat & diquat significantly reduced plant height compared to the nil and physical terminal bud removal. Lodging was reduced only by the application of ethephon & Terinexapac-Ethyl (Table 3). There was no grain yield response for any PGR treatments trialled, averaging 5.6 t/ha.

Table 3. Plant height (cm) and lodging (1-9 scale) in faba bean variety, PBA Samira as affected by application of four canopy management treatments, Hart, SA, 2016.

Treatment	Plant height (cm) at flowering	Lodging (1-9 scale)*
Nil	53	2
Physical terminal bud removal	48	2
Ethephon & trinexapac-ethyl	36	5
Paraquat & diquat	34	3
LSD (P = 0.05)	**11.60**	**1.13**

*Lodging scores 1-9 scale where 1 = flat and 9 = erect; numbers represent angle from ground as follows: 0-10^{o} = 1, 11-20^{o} = 2, 21-30^{o} = 3, 31-40^{o} = 4, 41-50^{o} = 5, 51-60^{o} = 6, 61-70^{o} =7, 71-80^{o} = 8, 81-90^{o}=9

Summary / implications

Above average rainfall during the faba bean growing months favoured early crop vigour and provided ideal conditions for development of high biomass canopies. Further, cool and wet Spring conditions during pod-filling led to prolonged maturation contributing to significantly higher yields at this site. Pulse crop yields are strongly driven by environmental conditions in Spring, particularly the length of grain filling period which is largely influenced by availability of soil water and optimum temperature. The current results should therefore be interpreted in the context of the favourable season. It is also interesting to note that despite the extremely high yields and favourable growing season, early sowing was still beneficial in faba beans at Hart in 2016 in contrast to similar climatic seasons in higher rainfall areas of SA such as Tarlee.

The advanced breeding line AF09169 sown in mid-April, flowered 25 days earlier than varieties with similar flowering profile suggesting the existence of genotypic variation in sensitivity to environmental factors such as photoperiod and temperature. This variety was also equal to AF11212 and PBA Zahra, which indicates that the three varieties were responsive under favourable Spring conditions. The two highest yielding advanced breeding lines, AF09169 and AF11212 produced the least amount of biomass compared with other varieties at this site. Results from sowing date by variety trials over a number of seasons are now starting to show differences between varieties in biomass production at the early sowing date and these associations will be explored in our future trials. Compared to other commercial varieties, the newly released PBA Zahra is characterised by high biomass production and early canopy growth and it is more suited to favourable environments and seasons. The experimental determinate faba bean line AF13250 had low yields similar to Farah, which may be explained by susceptibility to disease (rust) and weather damage due to its determinate growth habit, where the inflorescence and pods are exposed at the top of the plants.

Trial results from various sites in SA over the last three years have shown that some PGRs, ethephon and trinexapac-ethyl, were consistently associated with a reduction in plant height together with resistance to lodging and necking without compromising grain yields in faba bean. Ethephon, which, breaks down in plants and releases ethylene which in turn inhibits the growth of the terminal shoot thereby enhancing lateral growth with a corresponding reduction in height. Application timing has been shown to be important for effectiveness of PGR with an early application timing at 8 node growth stage more responsive than later applications pre-flowering.

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Lucy (10 years old) standing in the first bean ToS treatment at Hart on Sept 3, 2016.