SOUTHERN

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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FABA BEAN

SECTION 4

PLANTING

KEY POINTS | TIME OF SOWING | SOWING RATES AND PLANT DENSITY | ROW SPACING | INOCULATION | INOCULANT COMPATIBILITY WITH PESTICIDES | CHECK FOR NODULATION | SEED TREATMENTS | SOWING DEPTH | SOWING EQUIPMENT | ROLLING | DRY SOWING | IRRIGATION

Planting

Key points

- **Ensure faba bean is sown within the recommended window. Early sowing of faba bean within the sowing window is important in the medium and low-rainfall zones but responses are inconsistent in the high-rainfall zone.**
- **Sowing rate can have a major effect on yield and disease resistance. It should be based on target plant density and will vary with seed size.**
- **Faba bean is adaptable to a range of row spacings. Wide rows with stubble retention are becoming more popular as a farming system, but faba bean yield responses are inconsistent.**
- **Faba bean seed should be inoculated with Group F inoculant.**
- **Sowing equipment may need to be modified to accommodate large seed. Sow 5–8 cm deep. Dry sowing is an option.**
- **Paddocks may require rolling to make harvest manageable.**

MORE INFORMATION

GRDC Nitrogen fixation of crop legume Fact Sheet.
https://grdc.com.au/Resources/Factsheets/2014/07/Nitrogen-fixation-of-crop-legumes-basic-principles-and-practical-management

GRDC Rhizobial Inoculants Fact Sheet.
https://grdc.com.au/Resources/Factsheets/2013/01/Rhizobial-Inoculants

4.1 Time of sowing

Faba bean and broad bean respond markedly to time of sowing, with crops sown at the optimal time having the best chance of producing high yields. Crops sown earlier or later than recommended will often suffer from reduced yields.

4.1.1 Optimal time of sowing in southern Australia

The ideal sowing time for pulses varies with location. Rainfall and the timing of risk periods, such as disease, frost and critical heat stress, are key factors but soil type and fertility can also be important. It is essential to have adequate soil moisture at sowing time, unless dry sowing.

Most faba bean and broad bean varieties are either susceptible (S) or moderately susceptible (MS) to chocolate spot (*Botrytis fabae*), meaning that sowing times in southern Australia may need to be delayed in some circumstances to reduce the risk of chocolate spot infection. However, most new varieties are either resistant (R) or moderately resistant (MR) to Ascochyta blight. Sowing times in southern Australia therefore no longer need to be delayed to specifically reduce the risk of Ascochyta blight infection with these varieties.

Avoiding frost or cold conditions during flowering can be important, particularly in areas with long growing seasons where sowing time may also need to be delayed to avoid chocolate spot.

Faba bean and broad bean show a marked response to time of sowing, with crops sown 'on time' having an excellent chance of producing very high yields. However, crops sown earlier or later than recommended will often suffer from reduced yields.

Water use efficiency is commonly in the range of 8–12 kg grain/ha/mm for sowings made during the preferred sowing window. This drops away to 4–6 kg/mm for very late or very early sowings.[1]

Growers are increasingly sowing pulse crops early (within the sowing window), to minimise the effects of heat and moisture stress during spring. Heat stress during flowering and pod-fill can have a significant impact on grain yield. For each week's delay in sowing, an average of 250 kg/ha yield may be lost. Early sowing requires greater attention to disease control, particularly for chocolate spot.

While early sowing is often beneficial in the low and medium-rainfall zones, the benefits are less definitive in the high-rainfall zone (HRZ), as it can result in excessive vegetative growth, increasing the likelihood of crop lodging and foliar diseases.

Delayed sowing may be necessary in some situations until risk factors, such as disease, reach an acceptable level.

Faba bean begin producing pods and filling seeds early in the season, usually before severe drought stress begins in spring (see Section 5 Plant growth and physiology for more information).

Some varieties such as Fiesta VF and Farah$^{\text{\textcircled{h}}}$ faba bean and Aquadulce broad bean respond less to early sowing because they do not set early pods under cold and shaded conditions.

Optimum times of sowing for faba bean in South Australia and Victoria are shown in Table 1 and Table 2. However, a recent recommendation for Victoria is to sow faba bean between mid-April and the first week of May. For such early sowing to be successful, growers need to choose well-adapted varieties, and have excellent disease management and weed control.

On acidic soils in southern New South Wales, sow faba bean from 20 April to 15 May. Crops sown later than mid-May, flower and fill pods in rising spring temperatures and moisture stress, restricting plant height, dry matter production and grain yield.

1 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

Trials have found that sowing time is more important than variety choice in the Riverina.[2,3,4,5,6,7]

Table 1: Times of sowing for faba bean in South Australia.

Month			**April**				**May**				**June**	
Week	1	2	3	4	1	2	3	4	1	2	3	4
SA: less than 350 mm												
SA: 350–450 mm												
SA: 450–550 mm												
SA: 550–650 mm												
SA: less than 350 mm												

Note: Sowing time needs vary with the variety flowering date and maturity rating.

Source: Southern faba and broad bean best management practices training course – 2016

Yellow Earlier than ideal sowing time.
Green Optimum sowing time.
Red Later than ideal but acceptable.

Recent recommendations encourage Victorian growers to sow between mid-April and the first week of May.[8] Recommendations for Tasmania may be based on those for Victoria and SA as information about sowing times was unavailable for Tasmania at the time of writing.

Table 2: Times of sowing for faba bean in regions of Victoria.

Region			**April**				**May**				**June**	
Week	1	2	3	4	1	2	3	4	1	2	3	4
Mallee												
Wimmera												
North Central (one week earlier for irrigation)												
North East												
South West												

Note: Recommendations for Tasmania may be based on those for Victoria as information about sowing times is unavailable for Tasmania at the time of writing.

Source: 2017 Victorian Winter Crop Summary

Yellow Earlier than ideal sowing time.
Green Optimum sowing time.
Red Later than ideal but acceptable.

2 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

3 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

4 C Walela, L McMurray, J Paull (2015) Variety and agronomic performance of faba beans in medium and high rainfall zones in SA. Hart Trial Results 2015. Hart Field Site, http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results_Variety_and_agronomic_performance_of_faba_beans_in_medium_and_high_rainfall_zones_in_SA.pdf

5 S Loss, K Siddique, L Martin (1997) Adaptation of faba bean (Vicia faba L.) to dryland Mediterranean-type environments II. Phenology, canopy development, radiation absorption and biomass partitioning. Field Crops Research 52(1–2). pp 29–41, www.sciencedirect.com/science/article/pii/S0378429096034545

6 J Brand, L McMurray, C Walele, M Beveridge, M Rodda, J Paull (2016) Agronomy best practices with pulses – Victoria. GRDC Update Paper 23 February 2016.

7 E Armstrong, L Gaynor, G O'Connor, S Ellis, N Coombes (2015) Faba beans for acidic soils in southern NSW – yields and time of sowing effects. GRDC Update Paper 17 February 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Faba-beans-for-acidic-soils-in-southern-NSW

8 J Brand, L McMurray, C Walele, M Beveridge, M Rodda, J Paull (2016) Agronomy best practices with pulses – Victoria. GRDC Update Paper 23 February 2016.

The sowing dates in Tables 1 and 2 should ensure that crops:

- flower over an extended period to encourage better podset and produce sufficient growth to set and fill an adequate number of pods; and
- finish flowering before they are subjected to periods of heat stress. This is generally when there are average maximum daily temperatures of 25°C for a week or more.

Faba bean and broad bean seedlings are tolerant of frost. Seed can germinate in soil temperatures from 5°C, but emergence is slow in cold soil. Seedling vigour improves when soil temperatures are at least 7°C.

Faba bean should be sown early in wet areas, on low fertility or acidic soils, and where it is unlikely that the crop will grow excessively tall.[9 10]

IN FOCUS

Dry sowing

Several factors need consideration before choosing to dry sow, including:

- the weed seed burden and weed control options;
- the need for rhizobia to survive in dry soil, particularly if the soil is acidic;
- type of soil and the ease of sowing into that soil when it is dry (including uniformity of sowing depth and soil tilth);
- the ability to enter the paddock after rain to perform operations in a timely manner;
- evenness of the soil after sowing and the impact of this on herbicide application and harvest operations; and
- the need for additional levelling to flatten any ridges, cover press-wheel furrows or flatten clods.

4.1.2 Sowing too early

Sowing too early, before the preferred sowing window, increases the risk of yield loss from both frost damage and disease.[11] It is better to stick to the recommended sowing date and change varieties if needed. Sowing before the recommended sowing window tends to result in crops suffering from:

- poor early pod-set because of low light or low temperatures (10°C or less) during early flowering;
- higher risk of chocolate spot at flowering and during pod development;
- excessively tall crops, more prone to lodging with a dramatically increased chance of fungal diseases in medium to high-rainfall districts;
- increased frost risk at flowering and early podding;
- high water use prior to effective flowering and the earlier onset of moisture stress during flowering and podding;
- increased risk of Ascochyta blight in susceptible varieties; and
- potentially, poor weed control.

Faba bean sown in trials at Wagga Wagga, NSW, during the first week of April grew too tall and lodged in 2010 and again in 2014. In 2010, plants lodged as early as

9 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

10 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

11 M Richards, E Armstrong, L Gaynor, N Graham, N Coombes (2016) Sowing time and variety selection in southern NSW. GRDC Update Paper 16 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Sowing-time-and-variety-selection-for-faba-bean-in-southern-NSW

September. In the 2014 trial, PBA Rana⟑ and Farah⟑ were most vulnerable to lodging under ideal early growing conditions.[12 13 14]

4.1.3 Sowing too late

Sowing later than the sowing window can expose slower-maturing crops to moisture and heat stress during flowering and podding. This results in shorter plants, lower height of bottom pods creating harvest difficulties, reduced biomass, less flowering nodes, fewer pods and low yields. [15 16]

Late-sown crops are more likely to suffer from more *Helicoverpa* spp. pressure and less branching and flowering sites, unless the plant population is increased.

4.1.4 Disease risk with early sowing

Sowing times in southern Australia may need to be delayed in some circumstances to reduce the risk of chocolate spot infection. Most faba bean varieties are either susceptible (S) or moderately susceptible (MS) to chocolate spot. Figure 1 shows the effect of time of sowing on yield of a chocolate-spot-susceptible variety, with different disease control strategies.

In the future, varieties with resistance to chocolate spot will enable earlier sowing in most areas. In the interim, wide row spacing (skip row or wider) is being used with early sowing to delay canopy closure to lessen disease risk (see Section 2 Planning and paddock preparation for more information).

Most new faba bean varieties are either resistant or moderately resistant to Ascochyta blight. Sowing times in southern Australia do need to be delayed to specifically reduce the risk of Ascochyta blight infection with these varieties. A 2010 trial at Tarlee in SA's HRZ showed the varieties Fiord and Nura⟑ had more Ascochyta blight infection when sown early.[17]

12 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

13 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

14 E Armstrong, L Gaynor, G O'Connor, S Ellis, N Coombes (2015) Faba beans for acidic soils in southern NSW – yields and time of sowing effects. GRDC Update Paper 17 February 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Faba-beans-for-acidic-soils-in-southern-NSW

15 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

16 M Richards, E Armstrong, L Gaynor, N Graham, N Coombes (2016) Sowing time and variety selection in southern NSW. GRDC Update Paper 16 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Sowing-time-and-variety-selection-for-faba-bean-in-southern-NSW

17 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

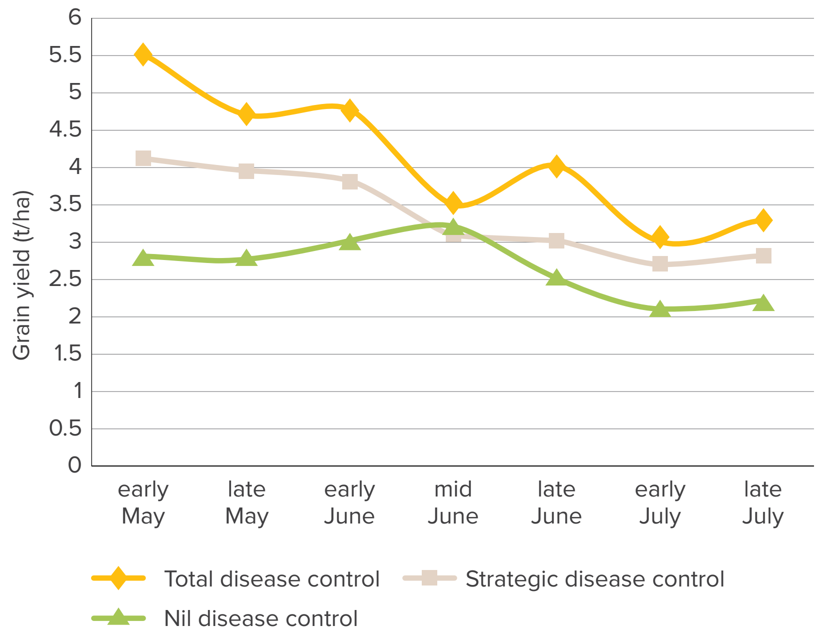


Figure 1: *The interaction between sowing date and fungicidal disease control on grain yield (t/ha) in Struan, south-east South Australia, with a chocolate-spot-susceptible variety (Fiord).*

Note: Early sowing produced highest yields only when disease was well controlled.

Source: Grain Legume Handbook (2008)

4.1.5 Early weed control *v.* early sowing

While timely sowing is important, good early weed control is also crucial because there are limited post-emergence broadleaf herbicide options for faba bean. To allow for sowing as close as possible to the ideal date, plan to manage weeds and prepare the seedbed.[18]

4.1.6 Variety and time of sowing interaction

Some varieties, such as Fiesta VF faba bean and Aquadulce broad bean, respond less to early sowing because they do not set pods early under cool conditions.

In trials at two sites in SA's Mid North in 2015 the early-flowering and early-maturing breeding line AF09167 was most responsive to mid-April sowing in 2015 (Table 3). This was followed by the mid-flowering PBA Rana⸰, which also responded to early sowing. PBA Samira⸰ and the new variety PBA Zahra⸰ yielded similarly over the three sowing times (mid April, early-to-mid May, late May) and generally the same as Nura⸰ and Farah⸰.[19 20]

4.1.7 Low-rainfall-zone time of sowing

In low-rainfall areas, faba bean must be sown early to minimise heat and moisture stress (Tables 1 and 2). Hot winds in spring cause faba bean to wilt, stop flowering and prematurely ripen. Compacted soils that inhibit root penetration will exacerbate this problem.

18 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

19 C Walela, L McMurray, S Day, A Pearce, J Paull, J Brand (2016) Maximising pulse performance in South Australian farming systems. GRDC Update Paper 9 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Maximising-pulse-performance-in-South-Australian-farming-systems

20 C Walela, L McMurray, J Paull (2015) Variety and agronomic performance of faba beans in medium and high rainfall zones in SA. Hart Trial Results 2015. Hart Field Site, http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results_Variety_and_agronomic_performance_of_faba_beans_in_medium_and_high_rainfall_zones_in_SA.pdf

While faba bean is the least susceptible of the pulse crops to frost, it does not tolerate high temperatures during flowering and podding on shallow soil.[21 22]

4.1.8 Medium-rainfall-zone time of sowing

Generally, early sowing within the preferred sowing window is best for the medium-rainfall zone (Tables 1 and 2).

Trials in 2015 at Hart in the medium-rainfall zone in SA's Mid North compared six varieties with three times of sowing in a below-average season with a very hot, dry and early finish (Table 3). At Hart, plots were sown on 14 April, 6 May and 27 May. Early sowing benefited yields in the less favourable low/medium-rainfall environments where biomass production was lower.

While the results showed that early-sown faba bean often do not provide a yield benefit compared with late-sown faba bean, they generally do not lead to a decrease in yields either. Researchers aimed to understand the performance of beans under these conditions and whether changes in phenology and morphology can improve performance.[23]

They found faba bean plots with mid-April sowing began flowering in mid-winter, while later sowing resulted in flowering during late winter and early spring.[24]

Table 3: Grain yield (t/ha) of faba bean varieties sown at three different times at Hart and Tarlee in 2015, Mid North South Australia.

Variety	Time of sowing (TOS)		
	TOS 1*	TOS 2*	TOS 3*
PBA Zahra⁽ᴾ⁾	1.81	1.85	1.87
AF09167	2.74	1.95	1.62
Farah⁽ᴾ⁾	2.05	1.86	1.75
Nura⁽ᴾ⁾	1.84	1.90	1.70
PBA Rana⁽ᴾ⁾	1.96	1.42	1.39
PBA Samira⁽ᴾ⁾	1.92	1.90	1.89
LSD=0.26			

*Hart TOS1 = 14 April; TOS2 = 6 May; TOS3 = 27 May
*Tarlee TOS1 = 15 April; TOS2 = 17 May; TOS3 = 25 May

Note: Growing-season rainfall was below average (228 mm at Hart and 329 mm at Tarlee). Biomass was higher at the Tarlee site.
Source: Walela *et al*. (2015) and Walela *et al*. (2016)

A trial at Vectis, near Horsham, Victoria, compared breeding lines and varieties with mid-May and late June sowing in 2010 (Figure 2). Mid-May sowing was optimal for all genotypes.

21 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

22 L McMurray, M Lines, A Ware, R Matic, S Nagel (2013) Best bet practices for pulses in the Mallee. GRDC Update paper 15 August 2013, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/08/Best-bet-options-and-practices-for-pulses-in-the-Mallee

23 C Walela, L McMurray, S Day, A Pearce, J Paull, J Brand (2016) Maximising pulse performance in South Australian farming systems. GRDC Update Paper 9 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Maximising-pulse-performance-in-South-Australian-farming-systems

24 C Walela, L McMurray, J Paull (2015) Variety and agronomic performance of faba beans in medium and high rainfall zones in SA. Hart Trial Results 2015. Hart Field Site, http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results_Variety_and_agronomic_performance_of_faba_beans_in_medium_and_high_rainfall_zones_in_SA.pdf

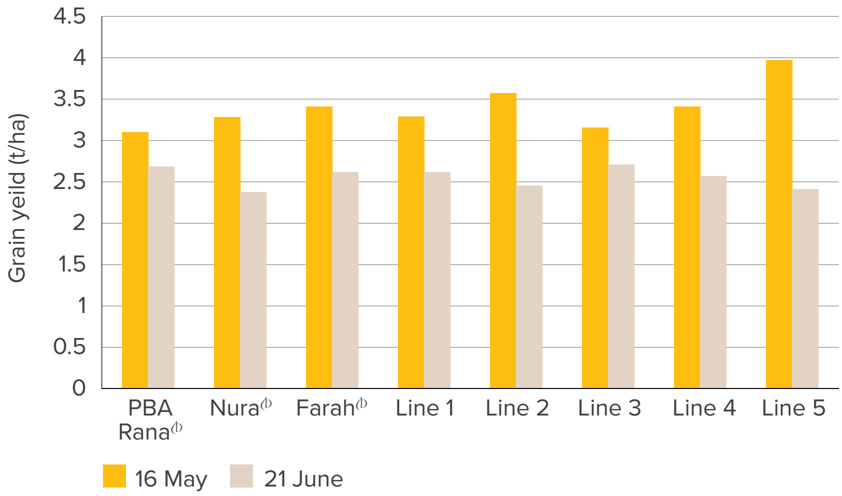


Figure 2: *Yields of different faba bean varieties at two times of sowing at Vectis, Victoria, 2010.*

Source: J Brand, Southern Pulse Agronomy Project

In southern NSW, sowing time is the most critical management factor for growing faba bean. Growers are recommended to sow between 20 April to 15 May in the region, preferably aiming for the first half of this window, especially in western areas. This maximises yield in crops that produce 6–9 t/ha dry matter (DM) with harvest indexes (HI per cent) of 30–35%.

In 2011, faba bean varieties were sown in a trial on 7 May and 10 June at Wagga Wagga, NSW. For each week's delay in sowing, yield was reduced by an average 0.21 t/ha.

Trials at three sites in southern NSW in 2015 found that yields declined by:

- 25% when delaying sowing from 1 May until 18 May at Wagga Wagga;
- 45% when delaying sowing from 16 April until 6 May at Junee Reefs; and
- 26% from 23 April to 13 May at Lockhart.[25]

In contrast, in 2014, a similar trial at Wagga Wagga produced reasonable yields but no significant differences between varieties and sowing times. Researchers suggested that moisture and temperature stress imposed a 'ceiling' to potential yield, as all treatments ran out of moisture.[26]

In 2010, yields were generally highest with the third time of sowing in a faba bean trial at Wagga Wagga, with sowing dates of 6 April, 29 April, 28 May and 16 June (Figure 3) In the high-yielding trial, plots with the first two sowing dates suffered severe lodging, causing major yield losses. Disease was also an issue in early-sown plots.[27]

25 M Richards, E Armstrong, L Gaynor, N Graham, N Coombes (2016) Sowing time and variety selection in southern NSW. GRDC Update Paper 16 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Sowing-time-and-variety-selection-for-faba-bean-in-southern-NSW

26 E Armstrong, L Gaynor, G O'Connor, S Ellis, N Coombes (2015) Faba beans for acidic soils in southern NSW – yields and time of sowing effects. GRDC Update Paper 17 February 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Faba-beans-for-acidic-soils-in-southern-NSW

27 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

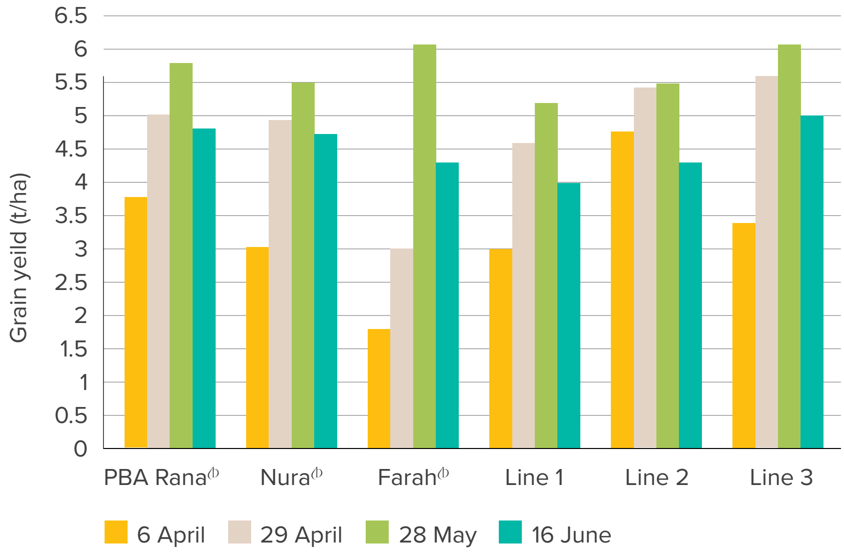


Figure 3: *Yields of different faba bean varieties at four times of sowing at Wagga Wagga, New South Wales, 2010.*

4.1.9 High-rainfall-zone time of sowing

Long-term analysis of faba bean sowing date trials has generally found no yield response to sowing date in higher-rainfall areas. However, between individual years, yield responses to sowing time have been highly variable.

In high-rainfall areas, early sowing can lead to high biomass production and poor harvest index (grain yield to biomass ratio).

Trials and local knowledge indicate that May sowing is best for faba bean in the HRZ of Victoria. This is provided soil moisture is adequate; for example, a mid-May sowing into insufficient moisture roughly halved the yield of Manafest faba bean in a field trial, compared with early August sowing.[28]

However, more recently, research has encouraged HRZ growers to sow faba bean early, between mid-April and early May. Sowing has traditionally been delayed to minimise disease risks and improve weed control. Better adapted varieties, improved disease resistance and weed management tools can now overcome these risks.

For example, a trial sown at Westmere, Victoria, in 2015 yielded 2.6 t/ha when sown in April compared with 1.9 t/ha with May sowing.[29] Of note, 2015 was a below-average season. Other researchers suggest that it may be necessary to delay sowing in certain areas of the HRZ. Frost and cold conditions during flowering, as well as chocolate spot, can be important factors affecting yield in areas with long growing seasons, and may be reduced by later sowing.

A trial in 2015 at Tarlee, SA, found that yield of early-sown (15 April) faba bean did not increase compared with later sowing dates (17 and 25 May), regardless of variety and in a below-average season with a hot, dry finish. The second and third sowing dates produced similar yields (Figure 4).[30] (Of note, yields were affected by pod losses in the early sown plots, due to strong winds in late November.[31])

28 M Slatter (2004) Pulse agronomy trials – Gnarwarre (Landmark). Trial Results 2003. Southern Farming Systems Limited. pp 78–79, http://www.farmtrials.com.au/trial/15604

29 J Brand, L McMurray, C Walele, M Beveridge, M Rodda, J Paull (2016) Agronomy best practices with pulses – Victoria. GRDC Update Paper 23 February 2016.

30 C Walela, L McMurray, J Paull (2015) Variety and agronomic performance of faba beans in medium and high rainfall zones in SA. Hart Trial Results 2015. Hart Field Site, http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results_Variety_and_agronomic_performance_of_faba_beans_in_medium_and_high_rainfall_zones_in_SA.pdf

31 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

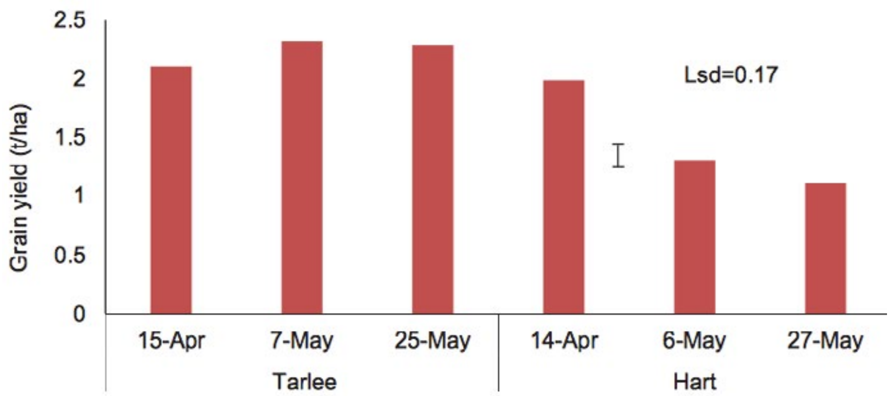


Figure 4: *Grain yield (t/ha) averaged across six faba bean varieties sown at three different sowing dates at Tarlee and Hart, South Australia, 2015.*

Source: Walela *et al.* (2016)

An earlier trial in Tarlee in 2010 found that faba bean yield was highest when sown in late May rather than two weeks earlier (Figure 5). The exceptions were Farah⁽ᵈ⁾ and Fiord, which showed no difference in yield at either sowing date. Ascochyta levels were higher in Fiord and Nura⁽ᵈ⁾ when sown too early.[32]

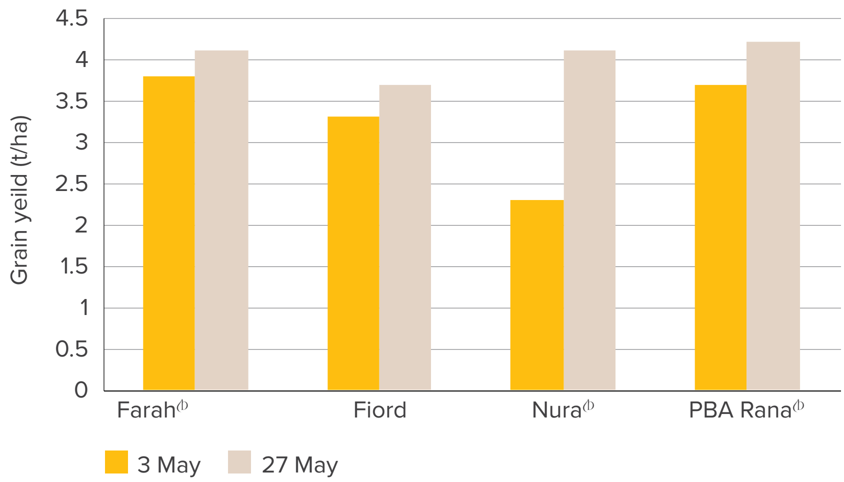


Figure 5: *Sowing in late May provided similar or higher yields for four varieties at a trial in 2010 at Tarlee, Mid North South Australia, compared with early May.*

Note: In the high-rainfall zone, yield results vary between seasons in response to time of sowing.
LSD (p<0.05) = 0.46 t/ha

Source: M Lines and L McMurray, Southern Pulse Agronomy Project

32 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

FEEDBACK

A trial at Moyhall in south-east SA showed that delaying sowing from mid-May until early June reduced yields by 12–42% in three varieties (Table 4). Early sowing also resulted in increased plant height and height of the lowest pod. However, the plants were more likely to lodge (Table 4). At the Conmurra site, yield was reduced with mid-June sowing in one breeding line, while differences for other varieties were not statistically significant (Table 4).

Table 4: Effect of time of sowing and variety on faba bean yield and lodging at Moyhall and Conmurra in south-east South Australia in 2010.

Variety	Moyhall, SA, 2010				Conmurra, SA, 2010			
	Yield (t/ha)		Lodging score (0–9)		Yield (t/ha)		Lodging score (0–9)	
	14 May	3 June	14 May	3 June	19 May	15 June	19 May	15 June
Breeding line	5.60	4.98*	7.1	8.0*	6.43	5.90*	8.5	9.0
Aquadulce					7.18	6.19	7.7	8.8
Farah⟨PBR⟩	5.08	4.71ns	4.8	7.3*	6.95	6.51	5.3	8.3
Fiord	5.31	3.06*	8.1	8.7ns				
Nura⟨PBR⟩	5.58	4.78*	6.7	8.8*	6.64	6.84	4.8	8.3
PBA Kareema⟨PBR⟩					5.56	5.66	7.8	8.7
LSD interaction (p<0.05)	0.53 (comparing different time of sowing (TOS)) or 0.33 (same TOS)		0.7 (different TOS), 0.8 (same TOS)		1.40 (different TOS), 0.55 (same TOS)		0.8 (different TOS), 0.9 (same TOS	

Lodging: 0 = plants horizontal, 9 = vertical (lodged)
* = statistically significant difference for same variety but different times of sowing at a single site, ns = no significant difference
Note: While earlier sowing increased yields in most cases, plants were more likely to lodge.

Source: Lines and Potter (2010)

At Conmurra in 2011, a much drier season, yield was generally maximised with mid-May sowing compared with mid-June in the broad bean varieties. This was not necessarily observed in the faba bean varieties, particularly Nura⟨PBR⟩ (Figure 5).

Because broad bean varieties mature later than faba bean varieties, they may need to be sown earlier than faba bean in some more 'marginal' districts for broad bean. Sowing in traditional, higher-rainfall areas is often delayed until late May or early June.[33]

33 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

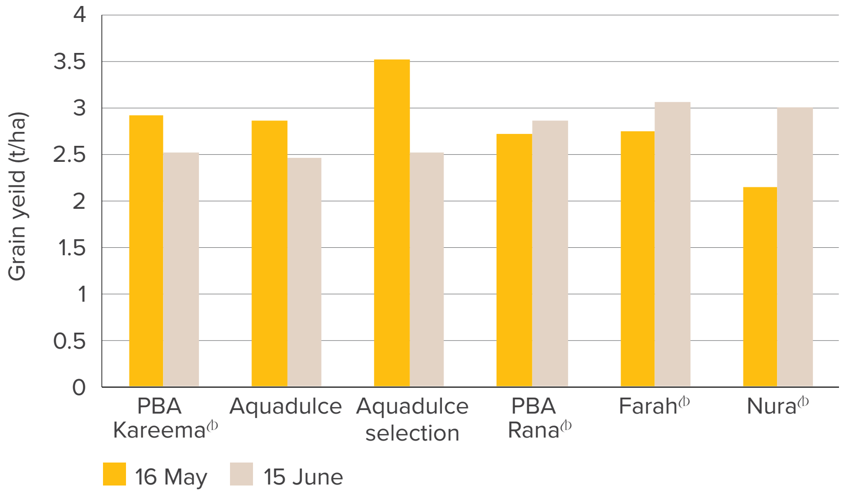


Figure 6: *Yields of different faba bean varieties responded differently to time of sowing at Conmurra, south-east South Australia in 2011, a dry season with several frost events.*

Source: M Lines & L McMurray, Southern Pulse Agronomy Project

In 2012 at Bool Lagoon, in south-east SA, delaying sowing from late May to late June caused a marked reduction in yield in a season with below-average growing-season rainfall and low disease levels. In seasons with favourable finishes, delayed sowing had less impact on faba bean grain yield in the region.

The variety Nura⊕ showed the greatest benefit from early sowing at the Bool Lagoon trial in 2012. Nura⊕ is suited to early sowing due to a combination of short height, mid flowering and improved chocolate spot and rust resistance. These characteristics favour this variety in short seasons with a dry finish, and where late-season humidity-driven diseases such as chocolate spot and rust are common.[34]

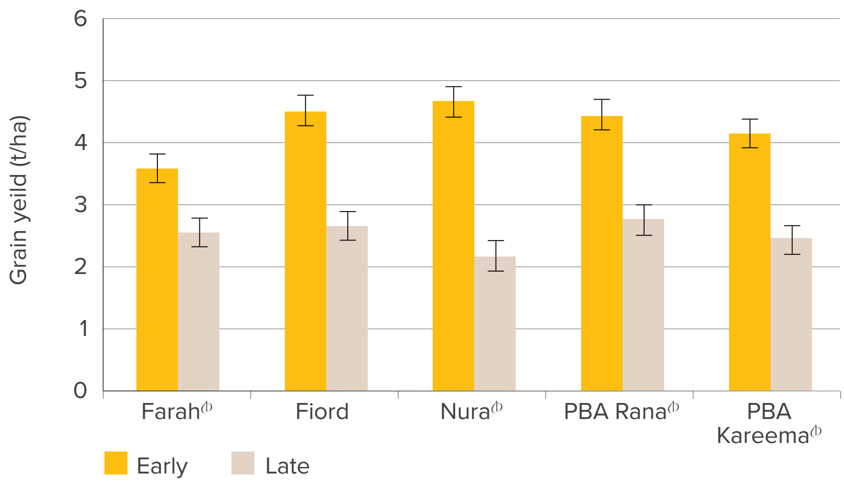


Figure 7: *Delayed sowing from 21 May to 27 June significantly lowered yields in four faba bean and one broad bean variety at Bool Lagoon in south-east South Australia.*

Source: Lines *et al.* (2013)

34 M Lines, L McMurray, J Paull, C Jeisman (2013) Faba bean varieties and management, 2012, Trials Results Book, MacKillop Farm Management Group, www.mackillopgroup.com.au/media/2012TrialBook/faba_beans.pdf

4.1.10 Spring sowing in the high-rainfall zone

Sowing in late winter to early spring (ideally late August), is also an option in the HRZ where there are deep soils.

Although not usually sown in spring, faba bean and broad bean, can be sown in August to September on deep, fertile soils that retain moisture. Yields may be compromised by delayed sowing; low crop height and hot conditions become yield-limiting factors. Other pulses are sometimes sown in August or September to avoid waterlogging and to reduce foliar diseases.[35]

In trial plots in southern Victoria, Manafest faba bean sown as late as 27 September yielded 1.4 t/ha, despite a very dry spring. August sowing also allows the crop to avoid the slow growth period over winter, which can cause disease and weed problems. August sowing allows for better weed control to manage herbicide resistance, as well as splitting the workload at sowing and harvest time.[36] [37]

4.2 Sowing rates and plant density

4.2.1 Recommended sowing rates and plant density

Sowing rate can have a major effect on crop yields. Sowing rates will vary with the size of the seed. Sowing rates for different seed sizes and target plant densities are shown in Table 5.

Be aware of very large differences in seed size between individual faba bean varieties. The size of faba bean can range from 35–160 g per 100 seeds depending on the type, variety and location it is grown.

Plant density requirements for faba bean also vary with time of sowing. Lower plant densities apply to early sowing (April to early May in Victoria) and the higher rates to late sowing (late May to June in Victoria).[38]

In general, faba bean plant populations in southern Australia should target between 20–30 plants/m^2. This equates to a sowing rate of 150–200 kg/ha for Fiesta VF, Farah⍭ or Nura⍭ with 85% germination, but only 100–160 kg/ha of a smaller variety such as Fiord.

35 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

36 M Slatter (2003) Pulse agronomy trials: Spring sown pulse trial (Gnarwarre). Trial Results 2002. Southern Farming Systems Limited. pp 92, http://www.farmtrials.com.au/trial/15546

37 M Slatter (2004) Pulse agronomy trials – Gnarwarre (Landmark). Trial Results 2003. Southern Farming Systems Limited. pp 78–79, http://www.farmtrials.com.au/trial/15604

38 B Robinson, M Raynes (2013) Growing faba bean, Agnote, AG0083. Victorian Department of Environment and Primary Industries, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-faba-bean

Table 5: Sowing rate (kg/ha) required for targeted plants/m² for a range of faba and broad bean varieties and sizes at 85% germination and 95% establishment (in general, plant density should be between 20–30 plants/m²).

Example variety	Average size range (g/100 seeds)	Seed weight used (g/100 seeds)	Required plants/m²*			
			10	18	25	32
Fiord	35–55	45	56	100	139	178
Farah⒲, Fiesta VF	55–75	65	80	145	201	258
PBA Rana⒲, PBA Samira⒲	80–90	85	105	189	263	337
Aquadulce (small seed)	100–160	100	124	223	310	396
PBA Kareema⒲ (large seed)	100–160	150	186	334	464	594

* = targeted seeds/m²
Source: Pulse Australia (2016)

In most locations and rainfall areas, faba bean has shown yield increases in populations up to 30–35 plants/m². [39] A target population of 30 plants/m² is generally recommended as it generally produces the highest yields in southern Australia.[40]

Trials at Moyhall in south-east South Australia showed a trend of increased yield with higher plant density from 16 plants/m² to 32 plants/m², over two years and averaged across four varieties and two sowing dates (Table 6). Lowest pod height and plant height increased with more dense plants.[41]

In contrast, in a trial at Tarlee in SA's Mid North, increasing target plant density of PBA Samira⒲ beyond 24 plants/m² led to large increases in biomass production at flowering time; increasing target plant density from 24 to 32 plants/m² produced an extra 1 t/ha biomass. Despite this, different densities from 12–32 plants/m² had no effect on final grain yield in 2015 across a range of sowing dates. The hot, dry seasonal finish had a greater effect on faba bean yield than any traditional agronomic management practices. [42] [43]

Table 6: Faba bean yield increased with plant density to 32 plants/m² at Moyhall, south-east South Australia in 2010, using four varieties and two times of sowing.

Plant density (plants/m²)	Grain yield (t/ha)
16	4.43
24	4.87
32	5.36
L.S.D. ($p<0.05$)	0.20

Source: Lines and Potter (2010)

Lower plant populations tend to be used in the lower-rainfall areas. A low sowing rate also reduces the cost of seed per hectare. It is important for crops to have sufficient

39 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

40 Pulse Australia (2016) Best management guide. Faba bean production: Southern and Western Region. Pulse Australia, 15 January 2016, http://pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/southern-guide

41 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

42 L McMurray, M Lines, A Ware, R Matic, S Nagel (2013) Best bet practices for pulses in the Mallee. GRDC Update paper 15 August 2013, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/08/Best-bet-options-and-practices-for-pulses-in-the-Mallee

43 C Walela, L McMurray, J Paull (2015) Variety and agronomic performance of faba beans in medium and high rainfall zones in SA. Hart Trial Results 2015. Hart Field Site, http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results_Variety_and_agronomic_performance_of_faba_beans_in_medium_and_high_rainfall_zones_in_SA.pdf

plant numbers to compete with weeds. The initial cost of buying seed can be a limitation to growers.

The plant density of broad bean needs to be reduced to as low as 10–15 plants/m^2 as it is grown in areas with long, cool growing seasons or 8–12 plants/m^2 in high-rainfall areas (sowing rate about 200 kg/ha).[44] Higher rates are not necessarily cost effective or practical. The recommended plant densities will reduce the seed cost per hectare, reduce the density of the crop and help reduce the risk of foliar disease in broad bean.[45]

Use the same size seed for sowing broad bean as the intended harvested seed size; for example use 65–70 grade seed for sowing if that is the size seed being marketed.

In other literature, the recommended plant density for faba bean in Victoria is:

- 20–30 plants/m^2 for the small-seed types, such as the old varieties Fiord and Ascot VF;
- 18–23 plants/m^2 for medium-seed varieties, for example, Farah$^{\Phi}$ and Fiesta VF; and
- 15 plants/m^2 for large-seeded broad bean (this is equivalent to 7 seeds/m, at a row spacing of 18 cm).[46 47]

For SA, recommendations for plant density in the high and medium-rainfall zone are:

- 24 plants/m^2 for faba bean; and
- 12 plants/m^2 for broad bean.[48 49]

For small and medium-sized varieties such as Fiord, Fiesta VF and Farah$^{\Phi}$, growers commonly target more than 20 plants/m^2 in the medium to high-rainfall areas of southern Australia.

In the low to medium-rainfall areas, 15–20 plants/m^2 is often used to reduce the impact of moisture stress associated with the first hot winds of the season. A 2015 sowing rate trial in the Victorian Mallee found that 20 plants/m^2 was the optimum plant density.[50]

Avoid using use small (graded) seed to increase plant populations or reduce seed costs. Small seed has poorer vigour and yields. Continued use of small seed fractions after grading will genetically select for smaller-seeded line plant types.[51] This is particularly relevant for broad bean growers who may consider marketing the larger sized seed portion and retain the smaller-sized leftovers ('screenings') for seed.

4.2.2 Calculating sowing rate

Calculate the sowing rate based on a desired plant population, rather than kilograms of seed per hectare. Adjust the sowing rate to achieve a target plant population based on seed size and germination percentage. Be aware of the significant difference in seed size between individual varieties and the impact that variable seasons can have on grain size of even the same variety.

44 Pulse Australia (2016) Best management guide. Faba bean production: Southern and Western Region. Pulse Australia, 15 January 2016, http://pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/southern-guide

45 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

46 B Robinson, M Raynes (2013) Growing faba bean, Agnote, AG0083. Victorian Department of Environment and Primary Industries, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-faba-bean

47 A Pearce, A Ware, R Kimber, J Paull (2015) Faba bean variety sowing guide 2015. Sowing Guide 2015. South Australian Research and Development Institute. pp 56–58, www.pir.sa.gov.au/__data/assets/pdf_file/0006/237903/faba_beans.pdf

48 C Walela, L McMurray, J Paull (2015) Variety and agronomic performance of faba beans in medium and high rainfall zones in SA. Hart Trial Results 2015. Hart Field Site, http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results_Variety_and_agronomic_performance_of_faba_beans_in_medium_and_high_rainfall_zones_in_SA.pdf

49 M Lines, L McMurray, J Paull, C Jeisman (2013) Faba bean varieties and management, 2012, Trials Results Book, MacKillop Farm Management Group, www.mackillopgroup.com.au/media/2012TrialBook/faba_beans.pdf

50 J Brand, L McMurray, C Walele, M Beveridge, M Rodda, J Paull (2016) Agronomy best practices with pulses – Victoria. GRDC Update Paper 23 February 2016.

51 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

Before deciding on a sowing rate take a representative sample, have it sized and then germination and vigour tested.

Sowing rate for the target plant density can be calculated using germination percentage, 100 seed weight and establishment percentage. Optimum plant populations vary with the location grown, the variety sown and the variety being sown.[52]

Sowing rate calculation

Sowing rate can be calculated by these steps:

1. Decide desired number of plants/m^2.
2. Weigh 100 seeds (in grams)# of a representative sample.
3. Obtain germination percentage from a seed test using a representative sample.
4. Estimate establishment likely during emergence (which will depend on conditions)*. Note: establishment percentage of 90–95% is a reasonable estimate, unless sowing into adverse conditions.
5. Sowing rate (kg/ha)

$$= \frac{\text{100 seed weight (grams)}^{\#} \times \text{target plant population (per m}^2\text{)} \times 1000}{\text{germination \%} \times \text{estimated establishment \%}}$$

For example:

100 seed weight = 60 grams

Target plant density = 25 plants/m^2 (i.e. 250,000 plants/ha)

Germination % = 90%

Estimated establishment %* = 95%

$$\text{Sowing rate (kg/ha)} = \frac{60 \times 25 \times 1000}{90 \times 95} = 175 \text{ kg/ha}$$

If using seeds per kilogram from a laboratory test, this can be easily converted to 100 seed weight, as follows:

$$\text{100 seed weight} = \frac{1000 \text{ X } 100}{\text{seeds per kg}}$$

4.2.3 Plant density x time of sowing interaction

Higher plant density with early-sown crops can encourage pods to develop higher up the plant. When the variety Fiord was sown at six plant densities from 20–56 plants/m^2 researchers found that early-sown plants at high density had fewer pods per node at the lower nodes. They also had more pods at the higher nodes than plants at low density.[53] However, using a high sowing rate with early sowing can lead to dense, vigorous crops early in the season that shade the flowers, reducing pod-set and leading to more foliar disease.[54]

Sowing date by plant density trials at HRZ sites in SA have shown that later-maturing crops with a large biomass generally show the highest yield losses from delayed sowing.[55]

52 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

53 T Adisarwanto, R Knight (1994) Effects of sowing date and plant density on yield and yield components in the faba bean. Australian Journal of Agricultural Research 48. pp 1161–1168, www.researchgate.net/publication/248896911_Effect_of_sowing_date_and_plant_density_on_yield_and_yield_components_in_the_faba_bean

54 GRDC (2014) GrowNotes™: Faba bean (northern region). Grains Research and Development Corporation, https://grdc.com.au/Resources/GrowNotes™

55 M Lines, L McMurray, J Paull, C Jeisman (2013) Faba bean varieties and management, 2012, Trials Results Book, MacKillop Farm Management Group, www.mackillopgroup.com.au/media/2012TrialBook/faba_beans.pdf

Under conditions of very early sowing the optimum sowing rate for small-seeded faba bean can be 20 plants/m^2 in southern Australia, rather than the usual 30–35 plants/m^2.[56] Conversely, late sowing in the HRZ may require higher sowing rates (32–25 plants/m^2), as shown in a Southern Farming Systems trial (Table 7) and trials at Bool Lagoon (Figure 8 and Figure 9).[57]

Table 7: Interaction between time of sowing and plant density on yield (t/ha) of early-to-mid-maturity faba bean varieties Farah⌽ and Nura⌽ in Victoria's high-rainfall zone. While later sowing reduced yields on average, a high plant density was important to offset yield loss.

Plant density Time of sowing	15 plants/m^2	25 plants/m^2	35 plants/m^2
1 June	1.70	1.99	2.17
4 July	1.25	1.15	1.94

Least significant difference (L.S.D.) for interaction ($p<0.05$) = 0.36
Source: Brand *et al.* (2006)

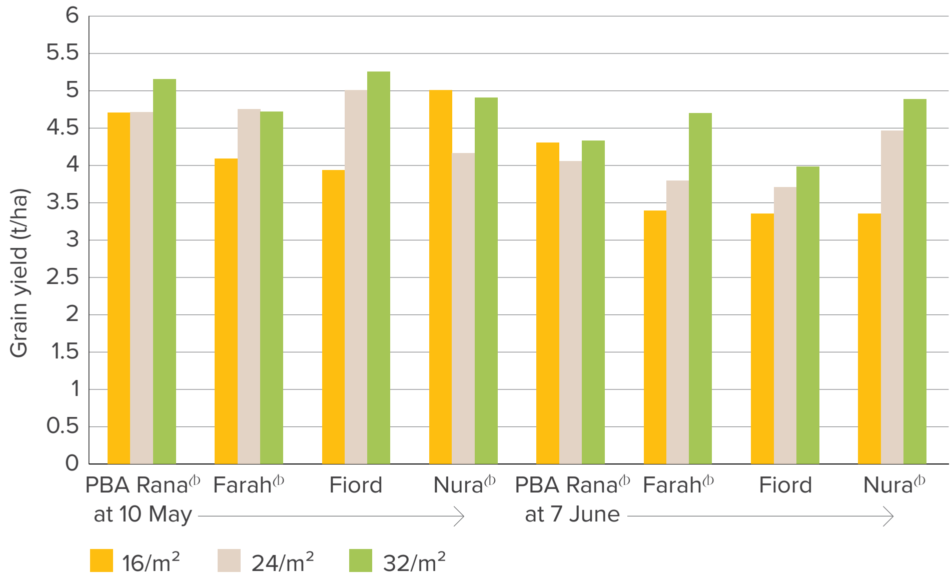


Figure 8: *With the exception of PBA Rana⌽, later-sown faba bean were more responsive to plant density and a greater need for higher plant populations to maximise yields at Bool Lagoon, South Australia, in 2011 in a Southern Pulse Agronomy Project trial.*

Source: Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4.

56 GRDC (2008) Seeding. Grain Legume Handbook. Grains Research and Development Corporation, https://grdc.com.au/resources-and-publications/all-publications/publications/2008/03/2008-grains-legume-handbook

57 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia

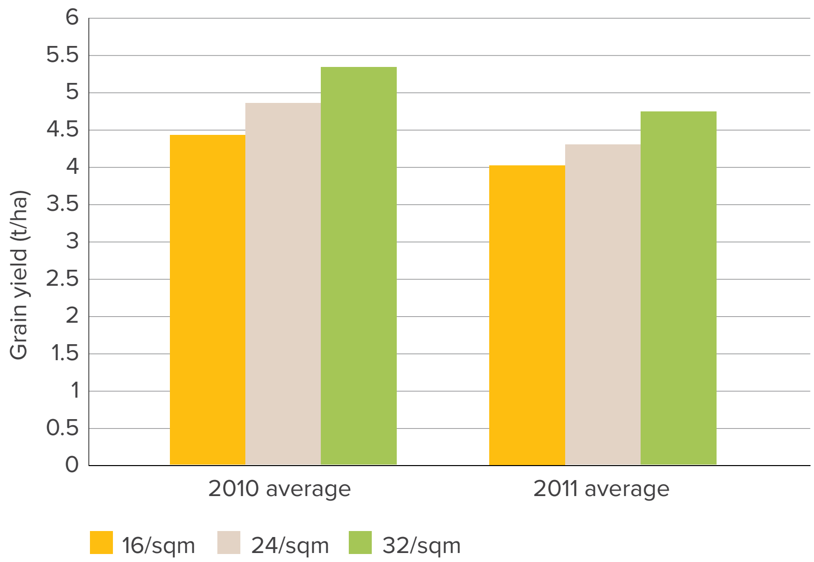


Figure 9: *The effect of plant density on average grain yield (t/ha) across four faba bean genotypes and two seeding dates Bool Lagoon, South Australia, in 2010 and 2011.*

Source: M. Lines, Southern Pulse Agronomy Project

4.2.4 Plant density x row spacing interaction

Sowing rate trials in 2015, which included the modern varieties PBA Zahra$^{\phi}$ and PBA Samira$^{\phi}$, support the traditional recommendation of 20 plants/m^2 when sowing in narrow rows. However, when using wider rows, yields were not reduced with 15 plants/m^2. A lower density of 10 plants/m^2 caused yields to fall by 20%.[58]

4.2.5 Plant density x disease interaction

Lower plant density can significantly reduce foliar disease levels by reducing the crop density, particularly in areas with long, cool growing seasons.[59]

In a trial in the HRZ at Tarlee in SA's Mid North in 2010, chocolate spot and Ascochyta infection increased with plant density.

Increasing plant density increased Ascochyta blight infection, likely resulting from increased canopy humidity. Chocolate spot infection averaged across all varieties was:

- 22% of plot infected at 16 plants/m^2;
- 29% at 24 plants/m^2; and
- 34% at 32 plants/m^2.

In spite of the additional disease burden, the highest sowing density produced the highest yield in this trial.[60]

4.2.6 Plant density effect on ease of harvest

Faba bean crops with low plant density may have pods close to ground level (Table 8), which can make harvest more difficult.

58 J Brand, L McMurray, C Walele, M Beveridge, M Rodda, J Paull (2016) Agronomy best practices with pulses – Victoria. GRDC Update Paper 23 February 2016.

59 Pulse Australia (2016) Best management guide. Faba bean production: Southern and Western Region. Pulse Australia, 15 January 2016, http://pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/southern-guide

60 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

Increasing plant density from a low level can also increase plant height (Table 8). If plants become very tall, they are more prone to lodging. At Tarlee, SA, lodging was worse for early-sown faba bean sown at a higher plant density, particularly at wider row spacing in PBA Rana⁽ᴾ⁾ and Farah⁽ᴾ⁾ due to their bulkier canopies.

Table 8: Height of lowest pods and plant height increased with plant density from 16 to 24 plants/m^2 and was unaffected by higher plant density.

Plant density (plants/m^2)	Height of lowest pods (cm)	Plant height (cm)
16	27.3	107
24	34.4	111
32	34.4	112
L.S.D. ($p<0.05$)	2.8	4

Data from a trial at Moyhall, South Australia, Southern Pulse Agronomy project.
Source: Lines and Potter (2010)

4.3 Row spacing

4.3.1 Range of row spacing

Due to faba bean's indeterminate growth pattern, the crop is relatively adaptable to a range of row spacings and sowing rates.

Trials have mostly shown only small differences in yields with row spacings from 20–38 cm. Row spacing in faba bean crops commonly ranges from 15–25 cm, and up to 55 cm in broad bean. However, wider rows with stubble retention are becoming increasingly popular. Yield responses to row spacing in trials are inconsistent and vary with the system and location.

For faba bean, using wider row spacing (25–60 cm) may assist with control of the disease chocolate spot, by delaying canopy closure and reducing humidity between rows.

Some growers are now using row spacing of 75–100 cm, or using paired rows, to improve pod-set and delay canopy closure, with the intention of minimising disease. Wide rows may also lead to crop lodging; however, it can exacerbate disease. On the other hand, wide rows do allow herbicides to be sprayed between rows with hooded shields or targeted row spraying with fungicides to reduce the amount of chemical applied.[61] Retention of standing stubble is important with wide rows[62] (see Section 2 Planning and paddock preparation for more information).

4.3.2 Calibration of seeder with wide rows

Be aware of changes needed for sowing rate calibrations; for example, if row spacing is doubled, the sowing rate per row must also be doubled to maintain plant density.

The same considerations apply for fertiliser rates, but sowing into wider rows may require deep placement or side banding of the fertiliser; the risk of toxicity to the seed increases when fertiliser is more concentrated in the sowing furrow.

4.3.3 Time of sowing x row spacing

A trial at Tarlee in the HRZ in SA in 2009 and 2011 found that yields were highest with early time of sowing and narrow row spacings (Table 9).

With early sowing, the taller varieties Farah⁽ᴾ⁾ and PBA Rana⁽ᴾ⁾ yielded 13–15% more, on average, while Fiord and Nura⁽ᴾ⁾ yielded 3–5% more, with 22.5 cm rows compared with 45 cm rows.

61 Pulse Australia (2016) Faba bean: Integrated disease management. Australian Pulse Bulletin. Pulse Australia, http://www.pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/idm-strategies

62 J Brand, L McMurray, C Walele, M Beveridge, M Rodda, J Paull (2016) Agronomy best practices with pulses – Victoria. GRDC Update Paper 23 February 2016.

Table 9: Row spacing had a bigger effect on faba bean yield than time of sowing at Tarlee in South Australia's high-rainfall zone, 2011.

Time of sowing (TOS)	22.5 cm	45 cm
Sown 29 April	5.55a	4.31 c
Sown 26 May	5.21 b	4.27 c
L.S.D. ($p<0.05$) =	0.24 TOS x row; 0.21 same row space	

Note: Narrow row spacing often maximises yields at high-yielding sites.
Source: Southern Pulse Agronomy project

4.4 Inoculation

4.4.1 Rhizobia and nitrogen fixation

Symbiotic nitrogen (N) fixation is the result of the mutually beneficial relationship between the pulse host and *Rhizobium* bacteria. These bacteria colonise legume roots soon after seed germination then form root nodules. Rhizobia live in the soil, on plant roots and in legume nodules, but only fix nitrogen when inside a legume nodule. Rhizobia in the nodules are dependent on the host plant for water, nutrients and energy, but in return supply the plant with available nitrogen for growth. This 'fixed' nitrogen is derived from the gaseous nitrogen in the air.

Nitrogen fixation by legumes does not happen as a matter of course. Compatible, effective rhizobia must be present in the soil in which the legume is growing before nodulation and nitrogen fixation can occur. When a legume is grown for the first time in a paddock, it is highly likely that compatible, effective rhizobia will not be present. In such circumstances, the rhizobia must be supplied in highly concentrated form as inoculants.

A well-nodulated and productive crop of faba bean or broad bean will fix up to 200 kg of N/ha. After grain harvest, more than 150 kg fixed N can remain in the stubble and roots which, when mineralised, becomes available to following crops: "on average, concentrations of soil mineral N after legumes [including bean] can be expected to be 25–35 kg N/ha higher than following cereals".[63]

4.4.2 Inoculants for faba bean

Faba bean, in common with lentil, field pea and vetch, are nodulated by *Rhizobium leguminosarum* bv. *viciae*. This species of rhizobia is produced and sold commercially as inoculant Groups E and F (Table 10).

Table 10: Inoculation Group E and Group F.

Field pea and vetch	Strain: SU303 (Group E)
Pisum sativum, *Vicia* species	*Rhizobium leguminosarum* bv. *viciae*
Faba bean, broad bean and lentil	Strain: WSM 1455 (Group F)
Vicia faba, *Lens culinaris*	*Rhizobium leguminosarum* bv. *viciae*

Source: D. Drew *et al.* (2012) Inoculating legumes: A practical guide

63 M Peoples *et al* (2015) Legume effects on soil N dynamics – comparisons of crop response to legume and fertiliser N. GRDC Update Paper 2015, https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2015/02/legume-effects-on-soil-n-dynamics-comparisons-of-crop-response-to-legume-and-fertiliser-n

Group F (strain WSM1455) inoculant is recommended for faba bean. Faba bean can also be nodulated by strain SU303 (e.g. from a background population of rhizobia in a soil where field pea or vetch have been grown) but inoculation with this strain is not recommended.

Faba bean are not nodulated by the rhizobia that nodulate chickpea (Group N), lupin (Group G) or pasture legumes.

4.4.3 Inoculation in practice

Bean will be responsive to inoculation if they (or lentil, field pea and vetch) has not previously been grown in the paddock. Faba bean are also likely to be responsive to inoculation on acidic soils, because the rhizobia of these legumes are moderately sensitive to soil acidity. Faba bean rhizobia may be absent or their number may be suboptimal where soil pH ($CaCl_2$) is less than 6.0, even where there has been recent history of legumes that support bean rhizobia. See Table 11 for likelihood of response to inoculation.

Recent research in southern Australia has found a very strong negative correlation between soil pH in the top 10 cm of soil and faba bean nodulation.[64]

Table 11: Likelihood of response to inoculation for bean.

Likelihood of response to inoculation for sown pea, faba bean, lentil and vetch	
High	Soils with ph ($CaCl_2$) below 6.0 and high summer soil temperatures (>35°C for 40 days); or Legume host (pea, faba bean, lentil, vetch) in host not previously grown.
Moderate	No legume host (pea, faba bean, lentil, vetch) in previous 4 years (recommended pulse rotation); or Prior host crop not inoculated or lacked good nodulation.
Low	Loam or clay solis with neutral or alkaine pH and a recent history of host crop with good nodulation.

Source: D. Drew *et al.* (2012) Inoculating legumes: A practical guide

Inoculation of faba bean is generally not necessary where well-nodulated faba bean (or lentil, field pea or vetch) has been grown in the preceding 5 years and soil conditions are favourable to the survival of the rhizobia. Loam or clay soils with neutral or alkaline pH are favourable to the survival of bean rhizobia.

If paddock conditions and legume history indicate a likelihood of a response to inoculation (Table 11) then the following guidelines should be followed:

- Inoculate with inoculants approved by the Australian Inoculants Research Group (AIRG) ('Green Tick' logo). AIRG is part of the NSW Department of Primary Industries.
- Use Group F inoculant for faba bean.
- Do not expose inoculants to direct sunlight, high temperatures (>30°C), chemicals or freezing temperatures (they contain *live* bacteria).
- Always use inoculants before their expiry date has passed.
- Keep inoculants dry and cool. Reseal opened bags of inoculant and refrigerate; use resealed bags within a short time (days).
- Follow instructions on recommended rates of inoculation.
- Consider doubling the inoculation rate in very acidic soils or where faba bean, lentil, vetch, or field pea have not been grown previously. Start with a small batch of seed to establish that it can be satisfactorily dried in order to avoid auger and seeder blockages.
- Always sow freshly inoculated seed as soon as possible, within 24 hours.

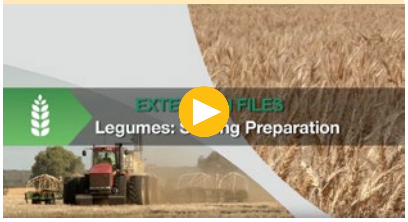
64 H Burns, M Norton (2017) Topsoil pH stratification impacts on pulse production in South East Australia. GRDC Update Paper 2017, https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2017/02/topsoil-ph-stratification-impacts-on-pulse-production-in-south-east-australia

MORE INFORMATION

More information: Section 3.4 Variety performance and yield

VIDEO

GroundCover™ TV: Legumes – Sowing Preparation
https://youtu.be/kcGu2CKwMS8



- When applying liquid or slurry inoculants, use clean, potable *non-chlorinated* water and ensure the mixing tanks are free of toxic chemical residues.
- Do not mix zinc or sodium molybdate with liquid or slurry inoculants.
- Check the product label or contact the manufacturer for compatibility of inoculants with fertilisers and seed dressings.
- Ensure inoculants remain cool in transport and do not leave inoculants or inoculated seed in the sun.

4.4.4 Types of inoculant

A range of different inoculant formulations are available to Australian legume growers (Table 12). Inoculant for faba bean can be obtained as peat, freeze-dried or granular formulations.

Table 12: Inoculant formulations available to Australian growers of faba bean.

Inoculant formulation	Composition
Peat	High organic matter soil, milled and irradiated, with rhizobia added in a nutrient suspension
Freeze-dried	Concentrated pure cells of rhizobia following extraction of water under vacuum
Granular	Clay or peat granules impregnated with rhizobia

Source: D. Drew *et al.* (2012) Inoculating legumes: A practical guide

The different formulations vary in the number of rhizobia they contain and so it is important that recommended application rates are followed.

Peat is the most commonly used formulation and provides reliable nodulation across a range of sowing conditions. Peat inoculants also provide some protection to the rhizobia where they are applied to seed treated with pesticides.

Freeze-dried inoculants should only be used where legumes are sown into moist soils. They provide a good option where liquid injection systems are used to deliver inoculant in furrow.

Granular inoculants can be used where separation between the rhizobia and pesticides or fertilisers is needed.

4.4.5 Storing inoculants

For maximum survival, peat and freeze-dried inoculants should be stored in a refrigerator until used. Both types of inoculant can be kept for many months if stored correctly (4°C–10°C), but pay attention to the date of expiry and do not freeze inoculant. If refrigeration is not possible, store in a cool, dry place away from direct sunlight. Granules also need to be stored in a cool place out of direct sunlight. Opened peat inoculum packets are best discarded, but if resealed and kept cool can be used within a few days.

Discard the inoculant after the expiry date shown because the population of rhizobia may have dropped to an unacceptable level.

4.4.6 Inoculation methods

Inoculation with rhizobia is a numbers game: aim is to get as many rhizobia as possible onto the seed or near the seed to maximise the potential for nodulation. There will always be a loss of rhizobia, but by using appropriate methods these losses can be minimised to obtain prompt and abundant nodulation. It is advisable to use high-quality inoculants, such as AIRG-approved (Green Tick) products.

Beans have historically been inoculated with a slurry of peat inoculant onto the seed. Rhizobia can now also be purchased in a freeze-dried form suitable for application to seed or water injection into the soil, or granules that are sown at same time as the seed from a separate box.

Peat inoculants

Most peat inoculants for bean now contain a pre-mixed sticker, and only require the addition of water to make the slurry. When preparing the slurry **do not** use hot or chlorinated or saline water.

How to apply slurry to the seed through an auger:

- Make sure the auger is turning as slowly as possible, to achieve effective mixing. Reduce the height of the auger to minimise the height of seed fall.
- Meter the peat slurry in, according to the flow rate of the auger (remember 1250 g packet per 500 kg of seed).

How to apply slurry to the seed through a tubulator:

- Similar to applying through an auger, except that the tubulator reduces the risk of damaging the seed. Its mixing ability is not as effective as an auger.

Peat inoculant can also be injected as dilute filtered slurry directly into the sowing furrow, with or below the seed.[65] Agitators and in-line filters may be necessary to avoid blockages to nozzles and capillary tubes. Typically, the peat inoculant is applied in a water volume of 50–100L/ha.

Dry-dusting the peat inoculant into the seed box is **not recommended**. This is not an effective means of getting good contact between rhizobia and seed. Attachment of the rhizobia to the seed can be very poor, and under some conditions rhizobial death is so rapid that no inoculant is alive by the time the seed reaches the soil.

Freeze-dried inoculants

Freeze-dried inoculants can be applied to seed or delivered as a liquid into the furrow. Freeze-dried inoculants are not suitable for application to dry soils.

The rhizobia become active when the inoculant is reconstituted with liquid. The product comes with a protective polymer in a separate packet, which assists survival of the rhizobia. A standard vial of inoculant will treat up to 500 kg of faba bean seed.

Treated seeds need to be sown into moist soil within five hours of application. Contact with seed-applied pesticides and fungicides must be avoided.

For liquid injection into the seeding furrow, add the inoculant suspension to 2 L of cool water containing the protective polymer. Add this solution to the clean spray tank and deliver at 50–100 L/ha into the furrow.

Granular inoculants

Granular inoculants are applied as a solid product directly into the seed furrow, near the seed or below the seed. They avoid many of the compatibility problems that rhizobia have with fertilisers and fungicides. They also eliminate the need to inoculate seed before sowing. Granular inoculants are reported to be effective where dry sowing is practiced.

If granules are mixed with the seed, rather than applied separately, then distribution of both seed and inoculum may be uneven, causing either poor and uneven establishment and/or patchy nodulation. Granules should not be stored in seeding boxes overnight.

Granules contain fewer rhizobia per gram than peat-based inoculants, so they must be applied at higher application rates. The size, form, uniformity, moisture content and rate of application of granules differ among products. Depending on product or row spacing sown, rates can vary from 2–10 kg/ha to deliver adequate levels of rhizobia.

65 J Brockwell, RR Gault and RJ Roughley (1982) Fact sheet: Spray inoculating grain legumes, www.ua.edu.au/legume-inoculation

FEEDBACK

4.5 Inoculant compatibility with pesticides

The survival of rhizobia may be compromised when mixed with pesticides, fertilisers or other amendments. Guidelines are provided by inoculant manufacturers on the compatibility of their specific products with commonly used pesticides and fertilisers. Pesticide labels may show compatibility of their seed dressing with inoculants on seed. For example, Gaucho® 600 Red Flowable Seed Treatment Insecticide (imidacloprid) label states that "Gaucho does not affect the viability of rhizobia when Gaucho® is mixed with inoculant". The guidelines should be strictly followed.

More generally, consideration of the following principles will help reduce the likelihood of killing inoculant rhizobia:

- Direct mixing of rhizobia with amendments in tank mixes or during preparation of the peat slurry is most likely to kill rhizobia.
- Most rhizobia are sensitive to pH below 5 or above 8. Avoid mixing rhizobia with very acidic or alkaline products. Fertilisers and trace elements are often outside this pH range. Material safety data sheets usually contain information on pH of the products.
- Metals such as zinc, mercury, copper and manganese are likely to be harmful. Sodium molybdate is toxic to rhizobia.
- When applying fungicides and insecticides to seed, minimise the time the rhizobia are exposed to the pesticide by applying the rhizobia last to the dried seed and sow as soon as possible. Where possible, sow with 6 hours of rhizobia application.
- Peat inoculant formulations may assist the survival of the rhizobia that come into contact with toxic chemicals.

MORE INFORMATION

GroundCover™ TV: Legume Nodulation – field sampling https://youtu.be/bfnBsEM64t0

GRDC (2014) *Inoculating legumes: a practical guide*, https://grdc.com.au/Resources/Bookshop/2015/07/Inoculating-Legumes

4.6 Check for nodulation

It is important to determine how effective inoculant application has been and if the nodules are actively fixing nitrogen. By checking the number of nodules and their distribution on the roots, you can assess the effectiveness of the inoculum product used and the application method.

If you have not inoculated, it can still be helpful to assess nodulation of your faba bean crop, to assess whether inoculation may be needed in the future.

For bean, 50–100 pink nodules per plant after approximately eight weeks' plant growth is an adequate level of nodulation (Photo 1). A strong pink colour inside the nodule indicates the rhizobia are actively fixing nitrogen for use by the plant (Figure 9).

4.6.1 Sampling and processing

At least 30 plants should be sampled, 10 at each of three locations, spaced 40 m apart in the crop. Plants should be gently dug from the soil and the root system carefully rinsed in several changes of water before estimating nodule number. It is helpful to float the root systems in water on a white background (a cut down, clean chemical drum is easy to use).

4.6.2 Nodule number and distribution

Score each plant for nodulation. At least 50 pink nodules per plant is considered adequate (Photo 1). Separate plants into adequate and inadequate groups. If the adequate group contains more than 70% of the plants then inoculation has been successful.

Photo 1: *Well-nodulated roots of broad bean.*

Photo: Maarten Ryder, University of Adelaide

Observe the pattern of nodules on the root system. Following inoculation, nodules on the main taproot clustered near the seed are a clear indication that nodulation occurred early. These are referred to as 'crown nodules'. If there are no crown nodules, but nodules on the lateral roots, then it is more likely nodulation has been delayed, indicating that there may have been issues with the inoculation process.

Nodules on both the crown and lateral roots indicate that inoculation was successful, and that bacteria have spread in the soil. This is the ideal situation, with the crown nodules providing good levels of nitrogen fixation early in the plant's growth, supported by the lateral root nodules, which may extend nitrogen fixation activity later into the season because they are less affected by drying of the surface soil.

4.6.3 Nodule appearance

If necessary, cut or break open a few root nodules to check the colour: nodules that are actively fixing nitrogen are pink inside (Photo 2). Very young nodules (after a few weeks of plant growth) are usually white because they still need to develop. However, in older plants an abundance of white nodules may indicate the rhizobia in the soil that formed the nodules were poorly effective and they will not fix nitrogen. This is rare for faba bean, but indicates that the crop should be inoculated next time it is grown. White nodules can also result from trace element deficiencies such as molybdenum.

Photo 2: *Bean nodules with pink interior indicating active nitrogen fixation.*

Photo: Maarten Ryder

Sometimes nodules may appear green or grey inside. At the 8-week growth stage, this would likely indicate herbicide damage or that plant has suffered water stress or waterlogging. These nodules are unlikely to recover nitrogen-fixation activity. However, later in the season, as plants approach flowering, the development of green pigmentation in the nodules occurs as a normal part of nodule maturation. Faba bean nodules are indeterminate. This means they continue to grow and form lobed structures with distinctly different zones visible inside the nodule. With maturity, the section of nodule closest the plant root loses its pink colouration, turning grey or green. As long as the section of the nodule furthest from the root retains some pink tissue, the nodule remains actively fixing nitrogen.

If you have spent time and resources on inoculation, it is worthwhile to carry out this nodulation check to determine whether your inoculation has been successful and is likely to provide nitrogen benefits. It may also indicate whether troubleshooting is required, or whether inoculation is needed in future.

4.7 Seed treatments

Seed treatment is very effective against seed rot, but it is not commonly used in faba bean and broad bean. If the seed is treated, it should be planted immediately after inoculation, as seed treatments can be toxic to the inoculant. The longer the inoculant is in contact with the seed treatment, the less effective it will be.

4.8 Sowing depth

4.8.1 Recommended sowing depth

The general recommended sowing depth for faba bean is 5–8 cm. Faba bean is relatively tolerant of deep sowing due to its hypogeal emergence.

Sowing seed outside this range will delay emergence and slow seedling growth. Sowing deeper than the recommended 8 cm can lead to poor establishment and lower seedling vigour.

Sowing depth needs to be varied between paddocks to take into account a range of factors including soil type, herbicides used, diseases likely to be present and the soil temperatures at sowing time, which affect how long the crop will take to emerge.

Fast emergence is needed on hard-setting soils, so that the seedling can germinate before the soil surface seals again after the sowing cultivation.

Sowing depth can also be adjusted if there is a risk of bird problems, such as cockatoos and skylarks, or when mouse numbers are high.[66 67]

4.8.2 Deep sowing

Deep sowing is sometimes used when the surface soil is dry. Burying seed too deep to 'chase' seedbed moisture for early sowing is not necessarily recommended, as this may affect weed control, establishment and possibly nodulation. However, it may sometimes be useful to ensure timely sowing. If there is a policy of 'sow deep, but cover shallow' to chase seedbed moisture at sowing, a deep seeding furrow will be left. This opens the possibility of damage from post-sowing herbicide applications that can wash into the seed furrow after rain.

Deeper sowing may be needed in some districts or seasons to reduce damage caused by birds and mice.

As a general rule, warm, sandy soils tend to suit deeper sowing while heavy, clay and/or hard-setting soils with low temperature will generally require more shallow sowing.

Deep sowing also allows more time in which to apply a knockdown herbicide prior to crop emergence.

4.8.3 Preventing crop damage from herbicides by sowing depth

Shallow sowing can make pulses less tolerant of some herbicides. Where a pre-emergent herbicide has been used, aim for deeper sowing. Lighter-textured soils can be more prone to herbicide leaching in wet winters, therefore deeper sowing in sandier soils is often recommended if applying a pre-emergent herbicide. Faba bean

66 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

67 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

and broad bean are less affected by simazine applied pre-sowing or post-sowing pre-emergence when sown deeper.

Some herbicides leach more than others (see Section 7 Weed Control for more information). This can be exacerbated by heavy rain on a dry soil surface, particularly sand. Leaving the soil ridged increases the risk of post-sowing pre-emergent herbicide washing into the furrow, especially on sand.

4.9 Sowing equipment

The large size of faba bean seed can make sowing with conventional seeders challenging.

The sowing mechanism of the seeder must be able to handle large seeds. Hoses, distributor heads and boots must also be able to handle faba bean and broad bean without blockages or bridging. Bridging in the seed box must also be avoided when sowing inoculated seed, therefore an agitator may be required.

Growers have reported that blockages are lessened by sowing faba bean more slowly than cereals (about 12 km/h slower).[68]

Faba bean can be sown with aggressive discs or narrow points in no-till or full soil disturbance in more conventional or direct-drill systems.[69]

4.9.1 Modifying seeders

If the seeder is not suitable, it may be adapted by:

- modifying the metering mechanism using manufacturer supplied optional parts;
- modifying seed tubes to reduce blockages, particularly on older machines; or
- modifying or replacing dividing heads on air seeders.

Faba bean and broad bean can be sown with a standard air seeder or conventional combine but take care as seeds tend to bridge over the outlets, causing very uneven sowing. This can be overcome by filling the box to only one-third or half capacity, or by fitting an agitator.

Faba bean can also cause problems in some combines but air seeders with adequate metering rollers can sow them successfully as long as the airflow is adequate.

4.9.2 Air seeders

Excessive air pressure in air seeders can cause significant seed damage; use only enough air to ensure reliable operation.

Air seeders using metering belt systems (such as Fusion, Alfarm, Chamberlain John Deere and New Holland) can meter large seed at high rates with few problems.

Air seeders that use peg roller metering systems (such as Napier and Shearer) will handle small faba bean seed without problems due to the banked metering arrangement. The optional rubber star roller is necessary for larger seeds, such as broad bean.

Air seeders with large or very coarse single fluted rollers cannot meter faba bean and broad bean bigger than 18 mm without modifications to the metering roller.

On some air seeders, the dividing heads may need modifying because there is too little room in the secondary distributor heads to allow seeds to flow smoothly. The conversion head increases the bore from 23–41 mm. Four larger hoses replace the original eight while row spacing is increased from 15–30 cm. This conversion allows large seeds such as broad bean to be sown easily.

68 C Collis (2016) Faba beans find a southern home. GroundCover Issue 120 January–February 2016, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-120-Jan-Feb-2016/Faba-beans-find-a-southern-home

69 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

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4.9.3 Combines

Combines with peg roller and seed wheel feeds will sow seed up to the size of faba bean without problems, providing adequate clearances are used around the rollers. Combines with fluted roller feeds have few problems feeding seed of less than 15 mm down to the metering chamber.

Smaller faba bean varieties such as Fiord can be metered with the more aggressive seed wheel system, but peg rollers are best replaced with 'rubber stars' for larger faba bean seed.

Broad bean seed can be metered through the rubber stars but this is not always efficient.

Combines with internal force feed seed meters perform well on small seeds but cannot sow seed larger than 9 mm, because of bridging at the throat leading to the seed meter. The restricted internal clearance in this type of design can damage larger seeds.

4.9.4 Seeder and tyne comparisons

Ensure that the sowing equipment:

- has adequate sowing mechanism (Photos 3, 4, 5, 6 and 7) to handle the faba bean seed without damaging it or bridging or blocking;
- has adequate sizes of tubes and boots;
- has an ability to sow uniformly at the desirable depth;
- covers seeds for good seed to soil contact; and
- uses press-wheels or closers, otherwise a prickle chain or roller may be required afterward.

Photo 3: *A Primary Precision Seeder fitted with Hydraulic breakout for consistent penetration. It is also fitted are narrow points that form an 'inverted T' slot and is capable of deep or side placement of fertiliser.*

Photo: Wayne Hawthorne, formerly Pulse Australia

Photo 4: *A Bio Blade or Cross slotTM disc opener with opening disc and seeding tine, followed by paired press-wheels. Note that the seed and fertiliser tube has sharp bends and may not be wide enough to avoid blockages while faba bean or broad beans are sown.*

Photo: Wayne Hawthorne, formerly Pulse Australia

Photo 5: *A Case IH SDX-40 single disc drill.*

Photo: Wayne Hawthorne, formerly Pulse Australia

Photo 6: *The DBS system parallelogram for uniform seeding depth and deep placement of seed or fertiliser.*

Photo: Wayne Hawthorne, formerly Pulse Australia

Photo 7: *Press-wheels can provide depth control.*

Photo: Wayne Hawthorne, formerly Pulse Australia

Handling faba bean seed

Handle faba bean grain and seed carefully to prevent damage. Seed (for sowing) needs particular care to ensure good germination and vigour.

Augers with screen flighting can damage faba bean and broad bean. This may be partly overcome by slowing the auger. Augers with large flight clearances will cause less damage to large seed.

Tubulators or belt elevators are excellent for handling faba bean as they cause little to no damage. Cup elevators are less expensive than tubulators and cause less damage than augers.

Combine loaders which throw or sling, rather than carry the grain, can cause severe damage to seed and its germination.

Be aware that augers provide better mixing and seed coverage when inoculating faba bean seed than tubulators.[70]

4.10 Rolling

Rolling paddocks can make faba bean harvest more manageable. A flat and firm soil surface free of stumps, stones and clumps is essential for faba bean.

Traditionally, rolling of pulse paddocks has mostly occurred before crop emergence. Faba bean and broad bean can be rolled post-emergence if the plants are not taking the weight of the roller; generally the preferred timing is early post-emergence. However, there is a greater risk of foliar disease if beans are rolled post-emergence.

A flat soil surface at harvest is particularly important in lower-rainfall areas or late-sown crops, if crops are short and the lowest pods are close to the ground. It is also important when crops are tall but have lodged.

The flat surface left by rolling may also prevent herbicides washing into, and accumulating in, seed furrows after post-sowing pre-emergence herbicide application.

70 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

Rolling also improves seed–soil contact in sandy non-wetting soils, although press-wheels or closers on the seeder will normally achieve this.[71 72 73]

4.11 Dry sowing

Faba bean sowing dates are often a compromise between delaying sowing to reduce disease without severely reducing yield potential. Early sowing is a priority in some dry areas or where sowing needs to be early to optimise operations and enable optimum sowing times for other crops.

Dry sowing faba bean before the opening rains is common practice in some areas or years. Often this sowing is by the calendar, or when awaiting sowing rains to arrive. Dry sowing is sowing into completely dry soil before the opening rains, rather than sowing into marginal soil moisture. Dry sowing while awaiting a germinating rain can fit faba bean into the sowing program. This is an option in some seasons or locations, allowing the crop to be sown as early as practical and giving growers more time to sow other crops once the rain arrives.

Several factors need consideration before choosing to dry sow, including:

- the weed seed burden and weed-control options;
- the need for rhizobia to survive in dry soil, particularly if the soil is acidic (therefore the use of granular inoculum is common);
- type of soil and the ease of sowing into that soil when it is dry (including uniformity of sowing depth and soil tilth);
- the ability to enter the paddock after rain to perform operations in a timely manner;
- evenness of the soil after sowing and the impact of this on herbicide application and harvest operations; and
- the need for additional levelling to flatten any ridges, cover press-wheel furrows or flatten clods.,

4.11.1 Avoiding nodulation failure when dry sowing

Dry sowing seed of inoculated faba bean seed is not recommended where faba bean or lentil has not been sown in the paddock before, or where soil conditions are hostile to survival of the rhizobia. However, granular inoculum can be sown dry with faba beans as the inoculum has a longer survival rate in the granule until wetted (see Section 4.4.2 Inoculants for faba bean for more information).

The risk of nodulation failure due to dry sowing is much lower in paddocks where faba bean or lentil are frequently grown and where effective nodulation has been observed recently. These soils are likely to contain effective and compatible rhizobia. The same species of *Rhizobium* that nodulates faba bean and lentil also nodulates field pea and vetch, so soils with a strong history of vetch or field pea may also contain compatible rhizobia, although a different strain of inoculum is now used.

Where dry sowing is unavoidable, minimise the risk of nodulation failure by deep, moisture-seeking sowing and by limiting dry sowing to paddocks where faba bean or lentil have previously grown and were adequately nodulated.

Avoid dry sowing where peat or freeze-dried slurry is used to inoculatethe seed. Rhizobia may rapidly die on the seed in dry soil, resulting in poor nodulation (see Section 4.4.2 Inoculants for faba bean for more information).

71 Pulse Australia (2016) Best management guide. Faba bean production: Southern and Western Region. Pulse Australia, 15 January 2016, http://pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/southern-guide

72 Pulse Australia (2016) General Agronomy. Southern Faba and Broad Bean – Best Management Practices Training Course Module 4. Pulse Australia.

73 B Robinson, M Raynes (2013) Growing faba bean, Agnote, AG0083. Victorian Department of Environment and Primary Industries, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-faba-bean

4.12 Irrigation

Refer to Section 2 Planning and paddock preparation.