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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FABA BEAN

SECTION 3

PLANTING

INOCULATION | SEED TREATMENTS | CROP ESTABLISHMENT | SEEDING RATES | IRRIGATION | PULSES AND HERBICIDE DAMAGE | SOWING AND HANDLING HINTS | SEEDING EQUIPMENT

Planting

3.1 Inoculation

MORE INFORMATION

Australian Pulse Bulletin: Pulse inoculation techniques

Pulses have the ability to fix their own nitrogen (N_2) from the air via nodules on their roots if specific N_2-fixing bacteria (rhizobia) are available (Figure 1).

Faba beans tend to nodulate freely, but agronomists will often suggest inoculation as cheap insurance against poor nodulation performance, especially in acid soils. Inoculating legume seed or soil at sowing provides a large number of effective rhizobia around the emerging legume root to optimise nodulation and N_2 fixation.

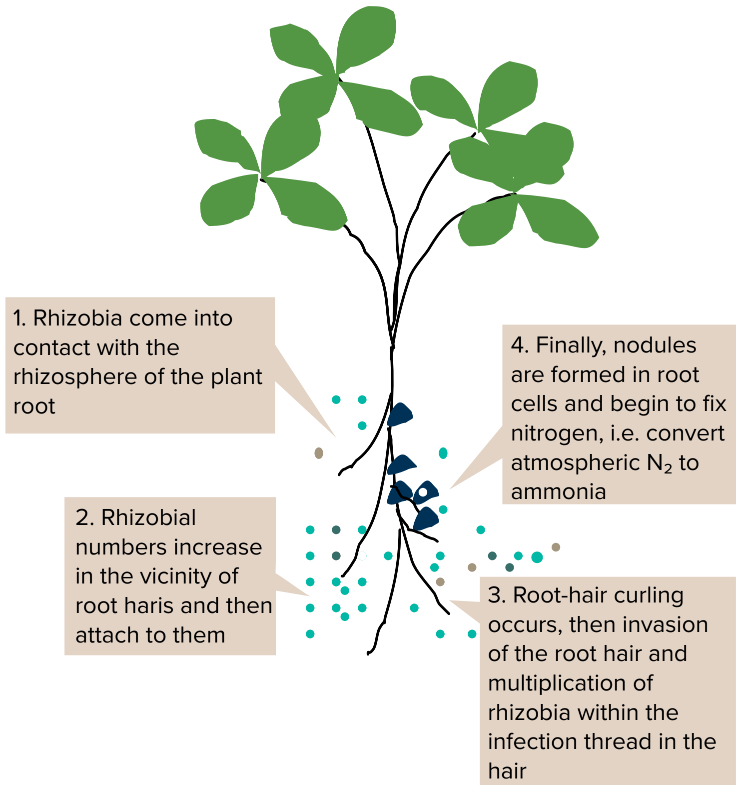


Figure 1: *Schematic representation of the process of nodulation.*

Source: D Herridge (2013) Managing legume and fertiliser N for northern grains cropping. p. 30. GRDC, https://grdc.com.au/uploads/documents/Managing-N-for-Northern-Grains-Cropping.pdf

The strain of rhizobia used to inoculate faba bean, WSM1455, is common to field peas, vetches and lentils. Field peas and vetches are placed under Inoculant Group E, for which both the WSM1455 and SU303 rhizobial strains can be used. Faba beans and lentils are in Group F, which only responds to the use of WSM1455.

Inoculation with the correct rhizobial strain is essential for effective nodulation in some soil types and situations.

High levels of background rhizobia are often common in commercial faba bean crops, and so they nodulate well. However, these native strains do not always provide fully effective nodulation or N_2 fixation. Improvements in nodulation and N_2 fixation can be improved by inoculating with the strain of rhizobia suited to faba bean.

Rotation lengths of 4–5 years are recommended between successive faba bean crops as a disease management strategy (i.e. for Ascochyta blight). At this re-cropping interval in some more 'hostile' situations (e.g. acid soils), it us unlikely that sufficient levels of Group F rhizobia will survive for effective nodulation.

The Group F rhizobia are regarded as an 'aggressive nodulator'. This effectively means that nodulation will be successful in meeting the crops N requirements provided:

- Inoculants are handled and stored in a manner that will ensure bacterial survival, i.e. they should be kept cool.
- Growers adopt effective inoculation practices on-farm.
- Inoculated seed is planted into moisture within 12 h of treatment—the sooner the better, as fungicide seed dressings and warm temperatures can affect survival of the bacteria.

Group F rhizobia are extremely sensitive to the level of available nitrate-N in the soil.

While high levels of nitrate-N have no significant effect on both the initial formation and number of nodules, they do markedly reduce both nodule size and activity.

Nodules remain inactive until the soil nitrate supply is exhausted (ineffective nodules remain white inside from the absence of leghaemoglobin). Effective N_2-fixing nodules, on the other hand, are rusty red or pink inside (Figure 2).

Figure 2: *Active nodules have a pink centre.*

Photo: G. Cumming, Pulse Australia

Growing faba beans on long fallows or in a situation with high residual N (e.g. after cotton) will substantially reduce N_2 fixation.

Where the host legume plant is grown infrequently in the cropping rotation, re-inoculation can be beneficial. Use of a commercial inoculant will ensure that nodulation is prompt, nodules are abundant, and the strain of rhizobia forming the nodules is effective at fixing N_2.

When the legume germinates, the rhizobia enter the plant's roots, multiply rapidly and form a nodule. Effective nodule formation and function requires good growing conditions, the appropriate rhizobia and a host plant (Figure 3). [1]

1 Northern Faba Bean—Best Management Practices Training Course. Pulse Australia 2014.

Figure 3: *Well-nodulated faba bean roots.*

Source: D Herridge (2013). Managing legume and fertiliser N for northern grains cropping. p. 29. GRDC, https://grdc.com.au/uploads/documents/Managing-N-for-Northern-Grains-Cropping.pdf

3.1.1 When to inoculate

The WSM1455 rhizobia have been widely distributed following decades of cultivation of its host species, particularly field peas and vetch. Combined sowings of field peas, faba beans and lentils are ~600,000 ha/year. Spread and survival of the rhizobia has also been assisted by vetch, which is broadly naturalised and is sown as a forage–green manure crop.

Although the rhizobia have been widely distributed, their moderate sensitivity to soil acidity means that their populations are sometimes below what is needed for optimal nodulation. Rhizobial numbers may be suboptimal or rhizobia may be absent where soil pH is <6.0, even where there has been a recent history of the legume host.

Growth and yield of crops grown on red soils in northern New South Wales (NSW) have been increased by seed inoculation, but responses on black soils of the Liverpool Plains have been mixed. [2] Trials at Coonamble and Walgett in 2009 found no response to inoculant application at those trial sites (heavy clay soils), likely due to rhizobial survival from naturalised vetch populations and possibly the movement of rhizobia in floodwater.

However, it is not possible to be sure that the rhizobia are present across a whole paddock or region, so inoculation with Group F inoculant is recommended. [3]

If the paddock has previously grown the legume (or one from the same inoculant group), the number of rhizobia remaining in the soil will be affected by the time since the legume was last grown, the type of rhizobia, and soil pH and texture (Figure 4). Field pea and faba bean rhizobia (Groups E and F) survive well in neutral to alkaline soils with good texture (loams or clays). A response to inoculation is less likely on

2 P Matthews, H Marcellos (2003) Faba bean. Agfact P4.2.7. 2nd edn. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/winter-crops/pulses/beans/faba-bean

3 GRDC (2010) Faba beans for the Central West and Northwest Plains Regions of NSW. GRDC Update Papers 6 September 2010, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2010/09/FABA-BEANS-FOR-THE-CENTRALWEST-AND-NORTHWEST-PLAINS-REGIONS-OF-NSW

these soil types if these crops have been grown in the paddock in the previous four years. If soil pH is <6.0, the crop is best inoculated, especially on light-textured soils.

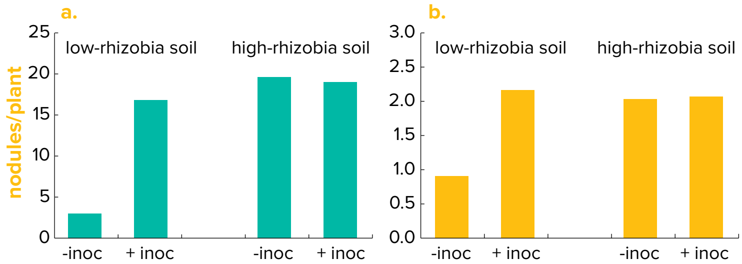


Figure 4: *Effects of inoculation on (a) nodulation and (b) grain yield of faba bean in low-rhizobia and high-rhizobia soils. Data aggregated from 18 experiments in the National Rhizobium Program (NRP) across Western Australia, Victoria and New South Wales during 1997–2003.*

Source: GRDC Rhizobial inoculants Fact Sheet, http://www.grdc.com.au/GRDC-FS-RhizobialInoculants

MORE INFORMATION

http://www.grdc.com.au/GRDC-Booklet-InoculatingLegumes

http://www.grdc.com.au/GRDC-FS-RhizobialInoculants

3.1.2 Inoculant types

A diverse range of inoculant products with different methods of application is available (Table 1, Figure 5), including:

- Becker Underwood (Nodulaid™). Peat and liquid inoculants, applied as a slurry/powder/liquid to the seed or 'in-furrow' to the soil and peat granular inoculants (Nodulator™), to be applied in-furrow to the soil.
- New-Edge Microbials (EasyRhiz™). Freeze-dried inoculants made up into a liquid and applied to the seed or in-furrow by water injection into the soil.
- ALOSCA Technologies (ALOSCA®). Dry clay (bentonite) granular inoculants, applied in-furrow to the soil.
- Brushmaster (Inoculeze™). Peat inoculants in a 'tea bag' extract applied to the seed just before sowing with a special applicator.
- Novozymes Australia (N-Prove™). Peat-based inoculant, applied as a slurry/powder/liquid to the seed or in-furrow to the soil. Also available are in-furrow granular formulations to be applied to the soil in the seed furrow.

The inoculant type will depend on product availability, relative cost, and efficacy, ease of use and machinery availability. Granular products vary and may be dry or moist, uniform, variable, powdery, coarse or fine.

Table 1: *Rhizobial inoculants available for use in Australia.*

Manufacturer	Brand	Formulation	Application
Becker Underwood	Nodulaid™	Peat	Slurry on seed; slurry/liquid in furrow
	Nodulaid™	Liquid	On seed; in furrow
	Nodulator™	Clay granule	In furrow
	BioStacked®	Peat (rhizobia) plus liquid (*Bacillus subtilis*)	Slurry on seed; slurry/liquid in furrow
New-Edge Microbials	EasyRhiz™	Freeze-dried	Liquid on seed; liquid in furrow
	Nodule N™	Peat	Slurry on seed; slurry/liquid in furrow

Manufacturer	Brand	Formulation	Application
Novozymes Biologicals Australia	N-Prove®	Peat	Slurry on seed; slurry/liquid in furrow
		Peat granule	In furrow
	TagTeam®	Peat (rhizobia) plus (*Penicillium bilaii*)	Slurry on seed; slurry/liquid in furrow
	TagTeam®	Peat granule (rhizobia) plus (*Penicillium bilaii*)	In furrow
ALOSCA Technologies	ALOSCA®	Clay granule	In furrow
Brushmaster	Inoculeze™	Peat	'Tea extract' on seed via an applicator

Source: D Herridge (2013). Managing legume and fertiliser N for northern grains cropping (GRDC).

Figure 5: *Different forms of rhizobia. Left to right: EasyRhiz® freeze dried, Nodulator® granules, Alosca® granules, N-Prove® granules and Nodulaid® peat inoculant.*

Photo: M. Denton, formerly Vic DPI

Figure 6 shows nodule development with peat and granular inoculants, and Figure 7 the effect of level of inoculant, both in acid soils.

Figure 6: *Faba beans on acid soil inoculated with peat inoculant showing few nodules (left panel) compared with those inoculated with granular inoculant (right panel). Note that nodulation is still less than would be experienced on more neutral or alkaline soils*

Photo: W. Hawthorne, Pulse Australia

Figure 7: *Faba beans on acid soil inoculated at different rates of inoculant. Plots inoculated with low numbers of rhizobia show as yellow, poorly nodulated plants with less biomass.*

Photo: W. Hawthorne, Pulse Australia

3.1.3 Newer inoculation methods

With new inoculants types and technologies, an appreciation is needed of each type's strengths and limitations. Rhizobial survival becomes more important under more 'difficult' circumstances, for example, placement in dry soil, prolonged dry soil conditions, use of a seed treatment of fungicide or trace elements, and acidic soil. Survival is associated with the degree of protection the rhizobia have against drying or adverse conditions. Ease of inoculant application is increasingly important and needs to be accounted for in costing. [4]

3.1.4 In-furrow water injection

Injection of inoculants mixed in water is becoming a more common practice. It can be used where machines are set up to apply other liquids at seeding, such as liquid N or phosphorus. See Figures 8–11 for photos of liquid injection set-ups on seeding equipment. Figure 11 shows the liquid stream.

Water injection of inoculant requires at least 40 L water/ha, and is better with more water. The slurry–water suspension is sprayed under low pressure into the soil in the seed row during seeding. Benefits of the new inoculants over peat are that they mix more readily, and do not have the requirement for filtering out peat. Compatibility of the inoculant with trace elements is not yet known, but cautious is advised, because water pH is critical, and trace element types, forms and products behave differently between products and inoculants groups.

4 Northern Faba Bean—Best Management Practices Training Course, Pulse Australia. 2014.

Figure 8: *A seeding bar setup with Atom Jet narrow points, gang press wheels and liquid injection for either inoculum or trace element application during sowing.*

Photo: W. Hawthorne, Pulse Australia

Figure 9: *Tanks mounted on the seeding bar for liquid injection of rhizobia or trace elements during seeding. Agitation is required. Note the tubes and manifold. Inoculum must be applied under low pressure only. Some machines have their tanks set up as a separate, trailed tanker.*

Photo: W. Hawthorne, Pulse Australia

Figure 10: *A disc seeder set up with Yetter trash clearing wheels and tubing for liquid injection of inoculum or trace elements during sowing. Note also the closer, to cover the seeding slot and act like a press-wheel from the side.*

Photo: W. Hawthorne, Pulse Australia

Figure 11: *In-furrow liquid injection: Note the droplets from liquid injection, which can be used for inoculating pulses or applying liquid trace elements.*

Photo: W. Hawthorne, Pulse Australia

3.1.5 Granular inoculants

Granular inoculants are applied like fertiliser as a solid into the seed furrow, near to the seed or below. 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 inoculant may also be better where dry sowing is practiced or when sowing into acidic soils, because the rhizobia survive better than on seed. A third, small seed box is required to apply granular inoculum (Figure 12). This is because rhizobial survival is jeopardised if the granular inoculum is mixed with fertiliser. If it is mixed with the seed, then distribution of both seed and inoculum is affected, causing poor and uneven establishment and/or patchy nodulation.

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

Figure 12: *An 'after-market' third box fitted to a Flexicoil box to enable application of granular inoculum. Note that granular inoculum cannot be applied mixed with the seed (uneven distribution of seed and/or inoculums occurs). Rhizobia survival is severely jeopardised if granular inoculum is applied mixed with fertiliser.*

Photo: W. Hawthorne, Pulse Australia

3.1.6 Inoculant and fungicide compatibility

Caution should be used when treating pulse seed with a fungicide. Some insecticide and seed treatments can also cause problems. See Table 2 for an example with chickpea. Check the inoculant and chemical labels for compatibility of the inoculant and fungicide or insecticide seed treatments, and the planting window (time) for either sequential or simultaneous application of seed treatments and seed-applied inoculants.

Table 2: *Effects of seed dressings on plant growth and nodulation in chickpea.*

Treatment	Fresh weight (g)			Height (cm)	Nodulation score
	Shoot	Root	Total		
Nil	106	142	248	47	1.0
Inoculum only	130	244	374	57	4.5
Inoculum plus thiram	103	182	285	55	1.8
Inoculum then thiram	119	208	327	58	3.2
Thiram then inoculum	117	212	329	55	3.8
Inoculum plus metalaxyl	106	173	279	54	1.8
Inoculum then metalaxyl	114	207	321	59	3.3
Metalaxyl then inoculum	113	206	319	55	3.6
l.s.d. (P = 0.05)	19	33	31	9	0.6

Source: T. Bretag, formerly DPI Victoria.

3.1.7 Compatibility with trace elements

Rhizobia can be compatible with some specific trace element formulations, but many are not compatible for rhizobial survival. Mixing of inoculants with trace elements should only occur if the trace element formulation being used has been laboratory-tested against the rhizobial type (Table 3).

Table 3: *Rhizobial compatibility with different trace element (TE) products after 24 h of tank mixing.*

TE formulation	Inoculant strain (by crop)				
	Field peas	Faba beans	Chickpeas	Lupins	Soybean
Manganese 1	×	×	×	✓	✓
Manganese 2	✓	✓	✓	✓	✓
Zinc 1	×	×	×	×	✓
Zinc 2	×	×	×	×	✓
Zinc 3	×	×	×	×	✓
Zinc 4	×	✓	×	✓	✓
Zinc 5	×	✓	×	✓	✓

Note the differences between inoculant types for a given TE product, as well as differences between TE products with a given inoculant

Source: Becker Underwood Pty Ltd.

3.1.8 Inoculation checklist

- When purchasing inoculants:
- Check the expiry date on packet.
- Note how it been has been stored.
  - » Packets should be stored at ~4°C.
  - » Do not freeze (below 0°C) or exceed 15°C.
- Choose Group F faba bean inoculum.
- Prepare slurry and apply in the shade. Avoid exposure to high temperatures (>30°C), direct sunlight, and hot winds.
- Accurately meter adhesive slurry onto the seed. Too much water means sticky seeds and blockages in the seeder.

- Avoid high-speed mixing in augers.
- Sow inoculated seed immediately. Never delay more than 12 h.
- Check air-seeders for excessively high temperatures in the air stream. Temperatures >50°C will kill the rhizobia. [5]

3.1.9 Rating nodulation and nitrogen fixation (effectiveness)

The amount of N_2 fixed is strongly correlated with nodule rating (0–5) as detailed in the photo standards outlined in the TopCrop publication 'Growers guide to assessing nodulation in pulse crops'.

When using this rating system, plants should be gently dug from the soil and the root system rinsed in water before scoring the level of nodulation.

Obvious signs of nodulation should be visible by 6 weeks after sowing (even in high soil nitrate situations).

Rate the level of nodulation using the photo standards provided (see Figure 13). This is based on nodule number and position on the root system.

The pattern of nodules on the root system should be observed. Nodules on the main taproot clustered near the seed are an indication that nodulation occurred because of the inoculation process. These are referred to as 'crown nodules'.

If there are no crown nodules but nodules on the lateral roots, it is more likely that they have formed from native soil bacteria that are usually less effective at fixing N_2, even in faba beans.

Nodules on both the crown and lateral branches indicate that inoculation was successful and that bacteria have spread in the soil. The faba bean rhizobia are not very 'aggressive' and do not spread more than very short distances in the soil.

Inspect nodules for nitrogen-fixation activity by assessing their internal 'pink' (leghaemoglobin) colour. The best method is to slice a few nodules open with a razor blade or sharp knife and examine their colour.

Young nodules are usually white and need to develop. White nodules can also indicate the wrong bacteria in the nodule, and these will not fix N_2. Effective nodules are a rusty red or pink inside, and these are usually actively fixing N_2. Effective red nodules can sometimes turn green when a plant is under water, disease or other stress, or is suffering from nutrient deficiencies. These do not fix N_2, but they can change back to red and begin to fix again if the stress is relieved without too much damage being done. Black nodules are usually dead or dying. These are often seen as the crop matures, or after a crop has suffered severe waterlogging. [6]

MORE INFORMATION

http://www.grdc.com.au/uploads/documents/3%20Seeding.pdf

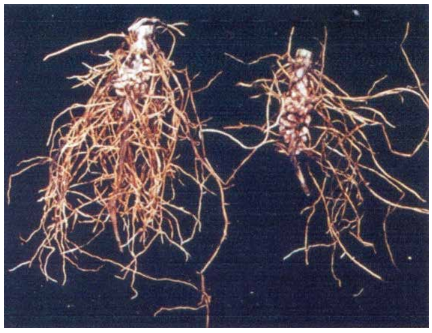
3.1.10 Key for assessing nodulation in winter pulse crops

Scores from 0 to 5 are based on nodulation number and distribution, where 0–1 is inadequate nodulation, 2–3 is adequate nodulation, and 4–5 is good nodulation (Figure 13).

5 Northern Faba Bean—Best Management Practices Training Course Pulse Australia 2014.

6 Northern Faba Bean—Best Management Practices Training Course. Pulse Australia 2014.

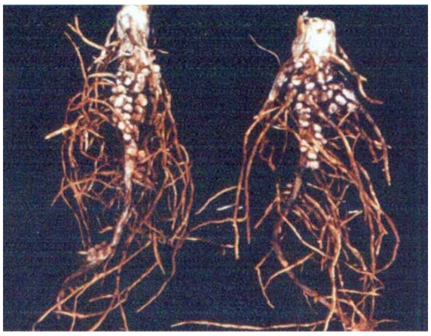
(a) Score 0: taproot, absent; lateral, absent.



(b). Score 1: taproot, few-medium; lateral, absent-few

(c) Score 2: taproot, medium; lateral, absent-low.

(d) Score 3: tap root, medium-high; lateral, low.



(e) Score 4: taproot, high; lateral, medium.

(f) Score 5: taproot, high; lateral, high.

Figure 13: *Visual key for nodulation scores.*

Source: TopCrop 'Growers guide to assessing nodulation in pulse crops'

Points to note:

- Where plant available soil-N is low, the crop relies heavily on good nodulation for its N supply. A score of 4–5 is desirable.
- Where plant-available N is high, nodulation may be partly inhibited, and the crop will depend mainly on the soil for N supply.
- A high score indicates that the crop will yield well and conserve soil N for use by a following crop.
- A low score suggests that the crop will yield poorly and deplete soil N.

3.1.11 Storing inoculants

For maximum survival, peat inoculant should be stored in a refrigerator at ~4°C until used. If refrigeration is not possible, store in a cool, dry place away from direct sunlight. Granules and other forms also need to be stored in a cool place out of direct sunlight. Do not store an opened inoculum packet, as it will deteriorate rapidly.

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

3.1.12 Inoculum survival

Moist peat provides protection and energy while the unopened pack is being stored. Rhizobia can dry out and lose viability once applied to seed and not in moist soil. Granular inoculant forms may not dry out as quickly, and most peat inoculants now contain an adhesive, which delays drying and increases survival of the rhizobia. Use a peat–slurry mix within 24 h and sow seed inoculated with peat slurry as soon as possible or store for up to 3 days in a cool place, away from sunlight.

With non-peat based inoculants, such as freeze-dried rhizobia, it is recommended that treated seed should be sown within 5 h of inoculation.

Lime pelleting is not usual practice with pulse crops, and especially with large-seeded types such as faba bean. If the inoculum is incorporated into lime-pelleted seed, it may survive at cool room temperatures for up to a week.

If inoculated seed is sown into dry soil, the sticker assists in survival of rhizobia until rain, but inoculum viability rapidly diminishes over time in warm, dry soil temperatures. It is difficult to provide guidelines to survival times; however, it is best to sow as close to a rain front as possible. The rhizobia will survive for longer in granules than when applied to seed. Hence, when dry-sowing pulses, granular inoculant is preferred over peat and liquid-injection methods.

MORE INFORMATION

Soil acidity holds back pulse potential

Nodulation failure after dry-sowing of inoculated seed is more likely if the soil has no naturalised rhizobia present.

Dry-dusting the peat inoculant into the seed box is not an effective means of either applying or retaining rhizobia uniformly on seed. Under some conditions, rhizobial death is so rapid where dry-dusting is used that no rhizobia are alive by the time the seed reaches the soil.

3.1.13 Applying inoculant

MORE INFORMATION

http://www.grdc.com.au/uploads/documents/3%20Seeding.pdf

Most commercial inoculants contain a pre-mixed sticker. When mixing the slurry, do not use hot or chlorinated water. Add the appropriate amount of the inoculant group to the solution and stir quickly. Mix into a heavy paste with a small amount of water prior to adding to the main solution. Read the inoculant label before adding any approved insecticides, fungicides, herbicides, detergents or fertilisers into the slurry (see below: 3.2 Seed treatments). Add the inoculant suspension (slurry) to the seed and mix thoroughly until all seeds are evenly covered. A small amount of fine lime can be added after mixing is complete to help dry the seed and prevent tackiness. If adding lime use only calcite lime; agricultural lime is too coarse. Do not use builders lime, hydrated lime or slaked lime—they will kill the rhizobia. [7]

Slurry can be applied to the seed using:

1. A cement mixer. This is practical for small lots only unless a cement truck is used.
2. Through an auger (see Figure 14). Make sure the auger is turning as slowly as possible. Reduce the height of the auger to minimise the height of seed-fall. Perhaps add a slide, e.g. tin, to the outlet end of the auger to stop seed from falling and cracking. Meter the slurry in, according to the flow rate of the auger (about a 250-g packet per 100 kg seed). If the auger outlet is out of reach, e.g.

7 Northern Faba Bean—Best Management Practices Training Course. Pulse Australia 2014.

under a field bin, then use some poly water pipe to run the slurry into the auger. A clean drench pack fixed to a dropper makes a good funnel into the poly pipe.

3. Through a tubulator. Use of a tubulator reduces the risk of damaging the seed, but its mixing ability is not as effective as an auger. Apply the slurry in a similar fashion as with an auger.

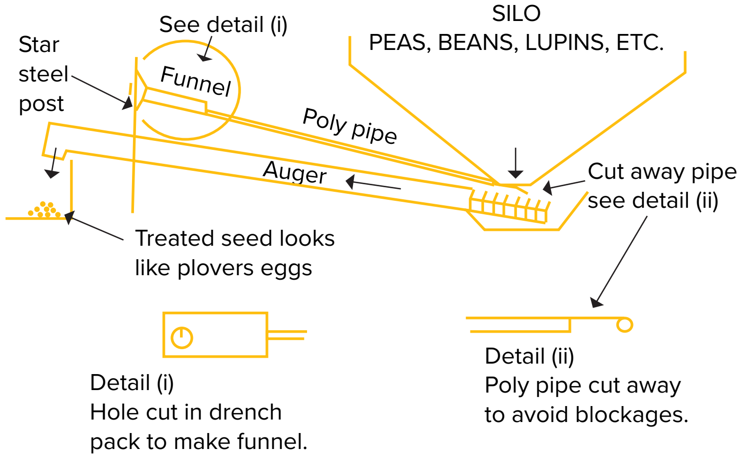


Figure 14: *Applying inoculum through an auger.*

Source: Grain Legume Handbook, http://www.grdc.com.au/uploads/documents/3%20Seeding.pdf, p. 3: 4

3.2 Seed treatments

Fungicide seed dressings are not normally required for faba bean in the northern cropping zone. If a fungicide dressing is to be used, caution is required because of incompatibility between some fungicides and the living bacteria used for inoculations. Some insecticide and seed treatments can also cause problems. Check the inoculant and chemical labels for compatibility of the inoculant and fungicide or insecticide seed treatments. [8]

MORE INFORMATION

Ground Cover: Aphids – to spray or not to spray

3.3 Crop establishment

3.3.1 Stubble retention

Presence of stubble can increase water infiltration and slow moisture loss through evaporation. With standing stubble, lower wind speeds at the soil surface and cooler soil temperatures assist in reducing evaporation, hence increasing soil moisture storage for sowing and afterwards. Winter crops in southern cropping areas are dependent on incident rainfall. Stubble retention ensures that more of this moisture is captured and retained as stored soil moisture for the pulse to benefit. Stubble retention also helps to retain some of the deeper moisture left from summer rains, provided weeds are controlled.

The value of stubble presence to pulse production in drier areas or during drier years has been very apparent with pulses in southern Australia in recent dry years. Stubble retention provides an earlier sowing opportunity than stubble burning, because of preservation of soil moisture in the soil surface (Figures 15 and 16). Stubble retention combined with the ability to sow earlier, perhaps sowing into wider row spacing and achieving greater harvestable height with less lodging, has allowed pulse growers to produce a pulse crop in years that would otherwise have been disastrous.

MORE INFORMATION

Ground Cover: Avoiding stubble trouble

8 GRDC (2008) Grain Legume Handbook. GRDC, https://grdc.com.au/uploads/documents/Index.pdf

Figure 15: *Beans sown into cereal stubble.*

Photo: W. Hawthorne, Pulse Australia

Figure 16: *Beans sown into cereal stubble establish well and lose less soil moisture than those sown into bare soil.*

Photo: W. Hawthorne, Pulse Australia

Table 4: *Effect of stubble retention and fungicide regime on faba bean grain yield (t/ha) at Rupanyup 2011.*

	Grain yield (t/ha)	
	Standing stubble	Burnt stubble
Total disease control: (fortnightly carbendazim + chlorothalonil)	4.7	3.9
Carbendazim × 3 (early, mid, late flowering)	4.5	3.7
Carbendazim × 2 (early and late flowering)	4.1	3.4
Nil fungicide	3.5	3.0
l.s.d. (*P* = 0.05)	0.21	0.22

Separate but adjacent trials were used for stubble treatments
Source: J. Brand, Southern Pulse Agronomy.

In trials at Rupanyup, there were large differences between stubble treatments. Overall grain yield in the standing stubble trial averaged 20% more than in the burnt stubble trial. Maturity of the plots in the standing stubble was up to 2 weeks later than in the burnt stubble. Response to fungicide regimes across varieties was similar in both trials. Compared with the fortnightly regime of total disease control, average yield loss was ~5%for Carbendazim × 3, 12% for Carbendazim × 2, and 23% for the nil fungicide treatment (Table 4).

The relative response of varieties to stubble treatment did not appear to be related to the disease score. Varieties with highest disease scores did not show significantly greater yield loss in the nil treatment than varieties with lowest disease scores. In the standing stubble trial, average disease scores (range 2.7–4.2) were less than in the burnt stubble trial (range 3.1–5.1). Differences were particularly evident in the susceptible variety Farah⌽, which, in the nil fungicide treatment, had scores of ~7 in the burnt stubble trial and 5 in the standing stubble trial.

Average height to the lowest pod in standing stubble (average 32.3 cm) was greater than in the burnt stubble (average 26.1 cm).

Table 5: *Effect of stubble retention and fungicide regime on faba bean grain yield (t/ha) at Lake Bolac (Vic) 2011.*

	Grain yield (t/ha)	
	Slashed stubble	Burnt stubble
Total disease control (fortnightly carbendazim + chlorothalonil)	3.2	3.4
Carbendazim × 3 (early, mid, late flowering)	3.1	3.2
Carbendazim × 2 (early and late flowering)	2.85	3.05
Nil fungicide	2.5	2.65
l.s.d. (*P* = 0.05)	0.21	0.23

Separate but adjacent trials were used for stubble treatments S
ource: J. Brand, Southern Pulse Agronomy.

Effect of stubble retention on faba bean grain yield at the high-rainfall site at Lake Bolac in 2011 was minimal (Table 5). Rainfall during the summer meant that soil moisture profiles were at, or near, field capacity at sowing.

Average grain yields were slightly higher (3–7%) on burnt stubble. Burnt stubble had higher average disease levels (range 4.9–7.6) than those beans on slashed stubble (range 3.5–7.0). Disease, predominately rust, resulted in grain yield losses of 5–35% depending on variety.

There were clear differences in the susceptibility of varieties to the disease present, and this negatively correlated with grain yield. The variety with the lowest disease scores had the lowest grain yield loss in the nil fungicide treatment. [9]

MORE INFORMATION

GRDC Update paper: Faba beans for acidic soils in southern NSW - yields and time of sowing effects

MORE INFORMATION

Ground Cover: Faba bean foray into the north takes hold

MORE INFORMATION

GRDC Update Paper: Chickpea and faba bean agronomy ideal row spacing and populations

3.3.2 Time of sowing

Aim to sow in the earlier part of the sowing window to maximise yield potential. The preferred sowing window in the northern region is typically during April, extending into the first 2 weeks of May for the higher rainfall, longer growing regions of the Liverpool Plains. 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 beans show a marked response to time of sowing, with crops sown 'on time' having an excellent chance of producing very high yields. Crops sown earlier or later than recommended will often suffer reduced yields (Figure 17).

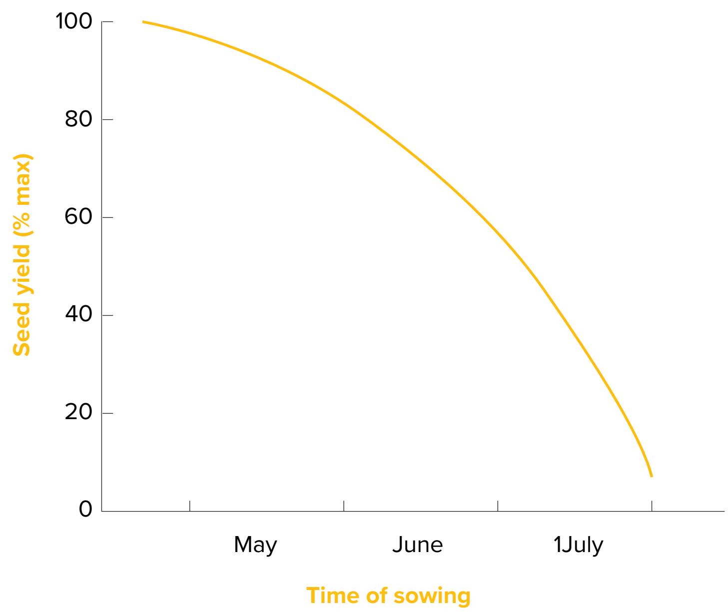


Figure 17: *Influence of delay in sowing on yield of faba beans in northern New South Wales.*

Source: Faba bean Agfact P4.2.7, 2nd edn 2003. p. 7

Water Use Efficiency is commonly in the range 8–12 kg grain/ha.mm for sowings made during the preferred sowing window. This drops to 4–6 kg/mm for very late or very early sowings.

MORE INFORMATION

Minimising frost damage in pulses

Sowings made prior to the recommended sowing window tend to be more vegetative and suffer from:

- poor early pod set because of low light or low temperatures (10°C) at commencement of flowering
- higher risk of chocolate spot at flowering and through podding
- crops more pre-disposed to lodging
- increased frost risk at flowering and early podding
- high water use prior to effective flowering and earlier onset of moisture stress during flowering and podding

9 Northern Faba Bean—Best Management Practices Training Course. Pulse Australia 2014.

- increased risk of Ascochyta blight, chocolate spot and rust in susceptible varieties

Late-planted crops are more likely to suffer from:

- high temperatures and moisture stress during flowering and podding
- greater native budworm pressure
- fewer branching and flowering sites, unless plant population is increased
- shorter plants and lower podset, which is more difficult to harvest

To achieve maximum yields, critical management factors such as weed control and seedbed preparation must be planned to allow crops to be sown as close as possible to the ideal sowing dates.

These ideal sowing dates should ensure that all pulse crops:

- finish flowering before being subjected to periods of heat stress (generally when maximum day temperatures over 1 week average ≥25°C); and
- flower over an extended period to encourage better podset and produce sufficient growth to set and fill an adequate number of pods.

However, sowing must not be too early, otherwise:

- Flowering may be during a frost period.
- Growth may be excessive, resulting in crop lodging and dramatically increasing the likelihood of fungal disease in the medium–high rainfall districts.
- Conditions at seeding time may not be suitable for controlling broadleaved weeds with recommended herbicides, resulting in weedy crops.

In other words, there can be a significant difference between the optimum sowing time (for maximum potential yields) and the ideal sowing time (reducing yield loss factors).

The ideal seeding time for pulses depends largely on where the crops are being grown (Figure 18). Key factors include rainfall and the date of risk periods such as frost and critical heat stress. Soil type and fertility can also influence crop growth. With all pulses, adequate soil moisture at seeding time is essential.

On acidic soils of southern NSW:

- Sow faba bean from 20 April to 15 May on acidic soils of southern NSW.
- Sowing earlier than the above dates can result in excessive lodging and disease risk.
- Sowing later lowers yield and produces shorter plants affecting harvestability.
- Choice of sowing time is far more important than choice of variety. [10]

Optimum temperature for growth is in the range 15–25°C, with flowering ideally occurring from July to late September. Flowering may start in June if sown early in northern NSW and may extend to mid-October in southern NSW. High temperatures and hot, dry winds during flowering will reduce yield. Severe frosts following mild weather often cause elongating stems to develop a bent stick (‘hockey stick’) appearance, blackening of leaf margins and abortion of flowers and pods in some varieties. [11]

Faba bean seedlings are tolerant of frost but can still be affected.

Faba bean seeds can germinate in soil as cold as even 5°C, but emergence will be slow. Seedling vigour will be greater if soil temperatures are at least 7°C.

10 GRDC (2015) Faba beans for acidic soils in southern NSW - yields and time of sowing effects. GRDC Update Papers 28 July 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/07/Faba-beans-for-acidic-soils-in-southern-NSW

11 P Matthews, D McCaffery, L Jenkins (2013) Winter crop variety sowing guide NSW DPI Management Guide. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

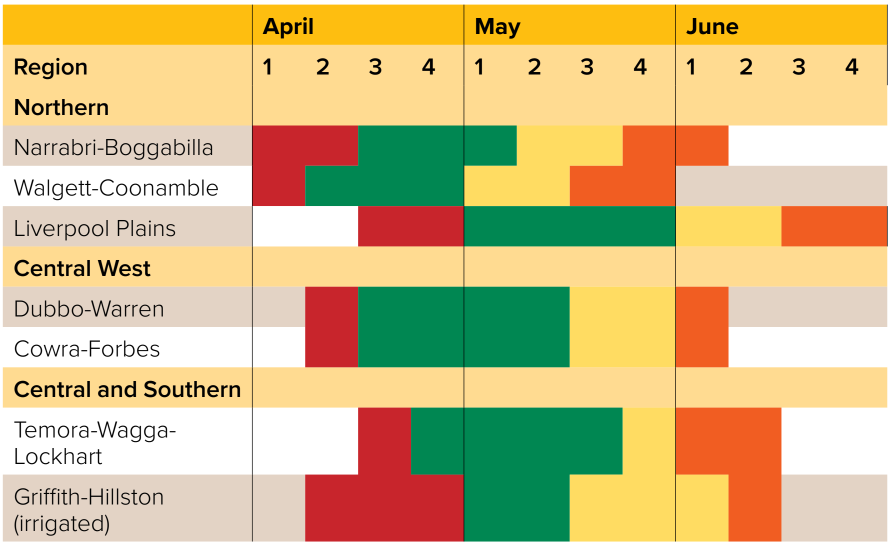


Figure 18: *Suggested sowing times for faba bean in New South Wales.*

Source: Winter crop variety sowing guide, NSW DPI Management Guide 2013, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

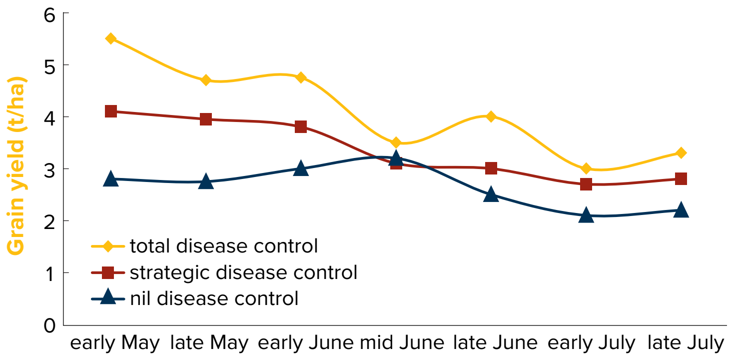


Figure 19: *Interaction between sowing date and fungicidal disease control on grain yield (t/ha) at Struan (South Australia), with a chocolate spot susceptible variety (Fiord).*

Source: Grain Legume Handbook

In low-rainfall areas, faba beans must be sown early. Hot winds in spring cause beans to wilt, stop flowering and prematurely ripen. Compacted soils that do not allow root penetration exaggerate this effect. Sowing also needs to be earlier in wetter areas, soils of lower fertility or acidic condition, or where excessively tall growth of beans is unlikely.

Ultimately, the use of varieties with resistance to chocolate spot will enable earlier sowing in most areas. In the interim, wider row spacing (skip row or wider) is being used in early sowings to delay canopy closure and so lessen disease risk. Fungicidal disease control can have a greater effect on improving yield of earlier sown than mid or later sown crops (Figure 19).

Limited post-emergence broadleaf weed control is available in beans; therefore, it is important to consider achieving good weed control in view of the desire for early sowing.

In the late 2000s, growers in north-western NSW experimented with sowing faba beans in late March–early April, often with considerable success. A trial was set up at Trangie Agricultural Research Centre in 2009 to test two released and four unreleased varieties across a range of sow times (Figure 20). [12]

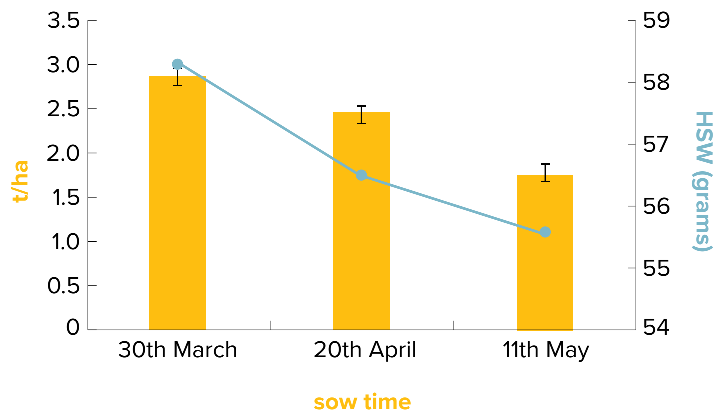


Figure 20: *Effect of sowing time on yield and 100-seed weight of faba beans at Trangie Agricultural Research Centre, 2009.*

Source: http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2010/09/FABA-BEANS-FOR-THE-CENTRALWEST-AND-NORTHWEST-PLAINS-REGIONS-OF-NSW#sthash.26gEqmle

As shown in Figure 20, yield (averaged across all varieties) was highest from the early sowing time (2.87 t/ha), with yield decreasing significantly for the second sowing time (2.46 t/ha), and again for the third sowing time (1.76 t/ha). Hundred-seed weight (which generally correlates to grain size) was also significantly greater from the early sowing than the later sowings.

Previous recommendations have pointed to sowing faba beans from about 25 April in the Macquarie Valley, and from about 10 April for the Coonamble–Walgett regions. Despite this, commercial crops and trials (albeit limited) in the past 2–3 years have had best results when planted in late March–early April. Based on these recent results, there is potential to move the sowing window forward ~15 days for both regions, provided producers are willing to accept the increased risk of frost and diseases (especially rust and viruses). However, the newer varieties such as Doza⚖ and PBA Warda⚖ are quicker in maturity and, hence, should be sown in the traditional planting window for best results.

Further research and commercial experience in the coming seasons will seek to determine more clearly optimal sowing times for the region.

3.4 Seeding rates

Seeding rates (kg/ha) for faba beans vary with the size of the seed being sown (Table 6).

Faba bean plant populations in the northern region should target 12–25 plants/m^2, meaning a typical seeding rate of 120–160 kg/ha depending on variety and seed weight.

Not all seeds are equal—some grow better than others. Before deciding on a seeding rate take a representative sample, have it sized and then germination- and vigour-tested (see GrowNotes Faba beans 2. Pre-planting).

MORE INFORMATION

http://www.dpi.nsw.gov.au/archive/agriculture-today-stories/ag-today-archives/september-2011/broadleaf-weed-trial-in-faba-beans

MORE INFORMATION

Faba bean foray into the north takes hold

12 GRDC (2010) Faba beans for the central-west and north-west plains regions of NSW. GRDC Update Papers 6 September 2010, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2010/09/FABA-BEANS-FOR-THE-CENTRALWEST-AND-NORTHWEST-PLAINS-REGIONS-OF-NSW

Seeding rates can have a significant effect on crop yields (Figure 21). Be aware of the very large differences in seed size between varieties and the impact that variable seasons can have on grain size of even the same variety.

When determining a seeding rate, consider plant populations and not just kg seed per ha. In other words, the kg rate should be adjusted to achieve a target population of plants based on seed size and germination percentage.

Calculating seeding rates

Seeding rate for the target plant density can be calculated using germination percentage, 100-seed weight and establishment percentage:

$$\text{Seeding rate (kg/ha)} = \frac{(\text{100 seed weight (g)} \times \text{target plant population per m}^2 \times 1000)}{(\text{germination\%} \times \text{estimated establishment\%})}$$

Example:
100-seed weight = 60 g
Target plant density = 25 plants/m^2 (i.e. 250,000 plants/ha)
Germination % = 90
Estimated establishment % = 95% (90–95% is a reasonable estimate, unless sowing into adverse conditions)

Seeding rate (kg/ha) = (60 × 25 × 1000) ÷ (90 × 95) = 175 kg/ha

To determine your seed weight, weigh 100 seeds (g). If you have seeds per kg from a laboratory test, this can be easily converted to 100-seed weight, as follows:

100-seed weight = (1000 ÷ no. of seeds per kg) × 100

NOTE: Optimum plant populations vary with the location grown, the variety sown and the pulse crop being sown.

Table 6: *Seeding rate (kg/ha) required for 20 and 30 plants per m^2 for a range of faba bean varieties and sizes at 100% germination and 90% establishment.*

Seeding rates	Average 100 seed weight (g)	Seed rate (kg/ha) 20 pl/m^2	Seed rate (kg/ha) 30 pl/m^2
Establishment %		90	90
Doza⚗	50 (40–60)	111	166
Fiesta VF, Farah⚗, Cairo⚗, Nura⚗	60 (50–75)	133	200
PBA Warda⚗	64 (58–69)	142	212

MORE INFORMATION

http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

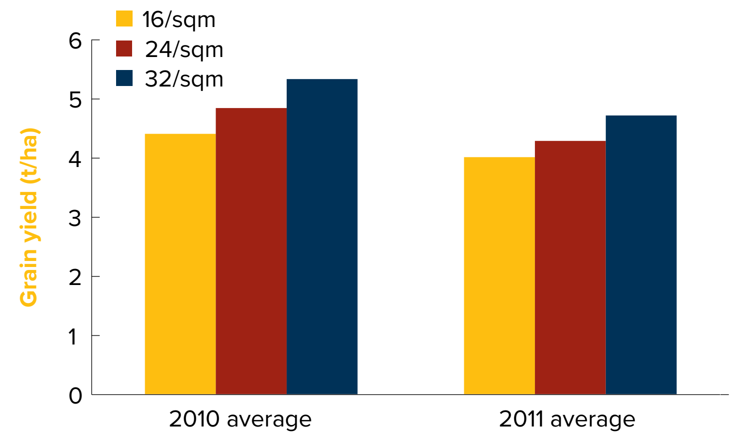


Figure 21: *Effect of plant density on average grain yield (t/ha) across four faba bean genotypes and two seeding dates at Bool Lagoon (South Australia) in 2010 and 2011; l.s.d. (P = 0.05) = 0.20 t.*

Source: M. Lines, Southern Pulse Agronomy Project

MORE INFORMATION

Northern Winter Pulse Agronomy (Walgett 2015): https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Northern-Winter-Pulse-Agronomy-Walgett-2015

GRDC Update Paper: Faba bean density experiments 2015 (Northern Winter Pulse Agronomy)

MORE INFORMATION

GRDC Update Paper: Effect of seed size at sowing on grain yield of PBA Nasma⍉ faba bean

Faba bean – variety x plant density experiments

Faba bean, variety x density, experiments were conducted at three locations across northern NSW in 2015. Three varieties were sown; Doza⍉, PBA Warda⍉ and the new line PBA Nasma⍉. Four target plant densities were examined; 10, 20, 30 and 40 plants/m^2. All five trials were grown under dryland cropping conditions.

The three lines selected represent the two preferred commercial lines (Doza⍉ and PBA Warda⍉) and the new large seeded line PBA Nasma⍉. The difference in seed size for these commercial lines is shown in Figure 22 where PBA Nasma⍉, on average, has seed that is 40% larger than Doza⍉.

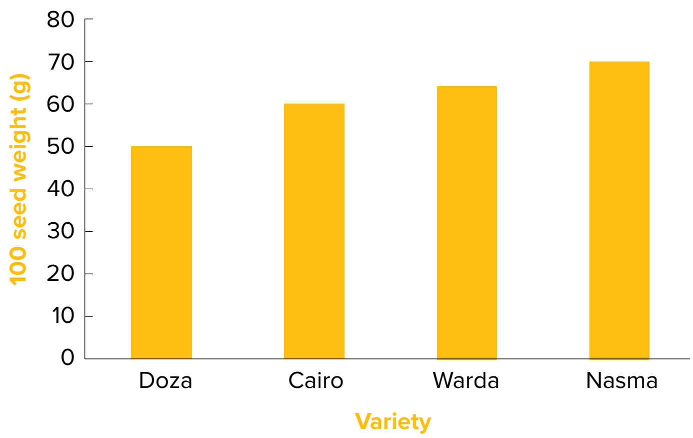


Figure 22: *Average 100 seed weight (g) for selected faba bean varieties. Varieties Doza⍉, Cairo⍉, Warda⍉ and Nasma⍉ shown in the graph above are protected under the Plant Breeders Rights Act 1994.*

Source: GRDC 2016

For grain yield, there were no significant interactions between variety and plant density, only main effects (see Table 7). PBA Warda⍉ and PBA Nasma⍉ out yielded

Doza⫽ at Coonamble, with no significant difference in varieties at Bullarah or Cryon (Table 7). Grain yield had a significant response to plant density at Cryon, plateauing at 20 plants/m^2.

Table 7: *Faba bean grain yield (kg/ha) for the main effects, variety and plant density at three locations in 2015.*

	Grain yield (kg/ha)		
Variety	**Bullarah**	**Coonamble**	**Cryon**
Doza⫽	1602 a	2900 b	1547 a
Warda⫽	1687 a	3280 a	1700 a
Nasma⫽	1685 a	3452 a	1686 a
	Grain yield (kg/ha)		
Plant density (plants/m^2)	**Bullarah**	**Coonamble**	**Cryon**
10	1498 a	3376 a	1373 b
20	1670 a	3411 a	1772 a
30	1768 a	3246 a	1673 a
40	1666 a	3270 a	1745 a

Values with the same letter are not significantly different P=0.05

Source: GRDC 2016

Limited data from the first year of trial results in 2015 suggests that for northern and western sites 20 plants/m^2 is a preferred target plant density for faba beans.

At present, there is no evidence to suggest that seed size at sowing has an impact on grain yield in cultivar PBA Nasma⫽. [13]

3.4.1 Row spacing

There is a trend towards wider row spacing with pulses, especially faba beans. Wider row and 'skip' row pulses (30–54 cm) must be part of an overall system. Stubble retention, preferably standing stubble, is considered essential with wide rows, where retaining soil moisture and ensuring adequate weed control is required. Use of wider row spacing is part of an overall system of production and it should not be considered in isolation. Yield comparisons in research trials can vary depending on the system and location, and there is no one solution that fits all situations.

Reasons for choosing wider rows with pulses vary with location and operator, but key drivers are the combination of:

- yield and yield consistency
- better stubble clearance and other sowing practicalities
- improved Water Use Efficiency (drought tolerance)
- minimise disease risk and easier management
- desire to sow pulses early
- weed control through minimised soil disturbance
- herbicide application options between the rows

If row spacing is doubled, the seeding rate per row must be doubled if the same plant density is to be maintained. This is significant for seeders with one seed meter per row, but relatively unimportant in air seeders where one meter supplies all.

MORE INFORMATION

GRDC Update Paper: Impact of row spacing on chickpea fababean and mungbean

MORE INFORMATION

Southern Pulse Bulletin – Wider Row Pulses and Stubble Systems

MORE INFORMATION

Australian Pulse Bulletin: Wide row pulses and stubble retention

13 A Verrell, L Jenkins (2016) Effect of seed size at sowing on grain yield of PBA Nasma⫽ faba bean. GRDC Update Papers, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Effect-of-seed-size-at-sowing-on-grain-yield-of-PBA-Nasma-faba-bean

MORE INFORMATION

GRDC Update Paper: Impact of row spacing on chickpea and faba bean

MORE INFORMATION

GRDC Update Paper: Chickpea and faba bean agronomy ideal row spacing and populations

3.4.2 Row spacing trial results

Northern region data are currently being generated however trials on the Darling Downs showed narrow row spacing (25–50 cm) consistently yielded higher than wider row spacings (75 cm and above) for faba beans. [14]

This effect was seen across 2 years and differing seasons and environments. Row spacing has a larger effect on yield than plant population.

In 2006 at Roseworthy, South Australia, a dry-season faba bean sown into standing cereal stubble showed an increase in yield relative to the conventional 18-cm sowing arrangement. By contrast, there was a small yield penalty growing cereals on wide rows. These results provide some confidence that wide-row cropping could be used for the management of difficult-to-control weeds with inter-row herbicide application without compromising crop yield and profitability.

There were differences between crop species in their yield response to the different row spacing treatments (Figure 23). Grain yield of faba bean increased significantly at 36-cm (24%) and 54-cm (20%) spacing relative to 18-cm row spacing, which yielded 0.79 t/ha. The penalty in grain yield for cereals in 36-cm rows was only 2% for barley and 5% for wheat. However, this yield penalty increased to >20% when row spacing increased to 54 cm in cereals.

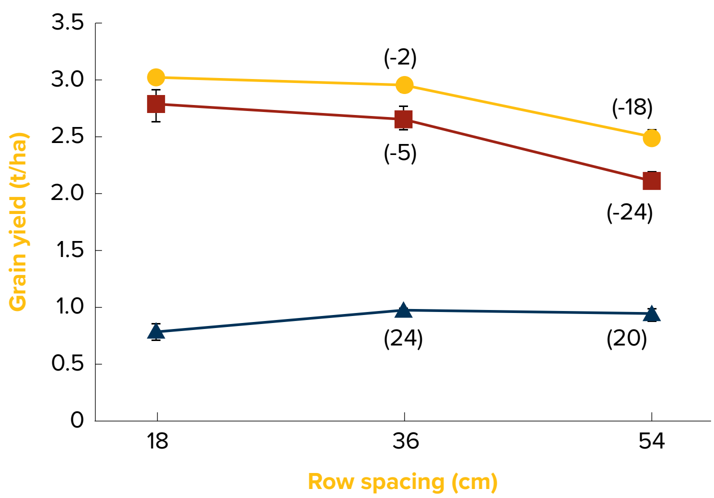


Figure 23: *Yield response of Pugsley wheat, Sloop SA barley and Fiesta faba bean grown on row spacings of 18, 36 and 54 cm sown into standing cereal stubble at Roseworthy (South Australia) in 2006. Values in parentheses are relative grain yield (%) compared with 18-cm spacing.*

Source: Kleeman and Gill 2008

Water use by wheat and barley over the growing season was unaffected by row spacing; however, both were more effective than faba bean at extracting soil water (Figure 24). Faba bean used 50 mm less water than cereals, which was related to its inability to extract water below 85 cm depth and its failure to dry soil below 20% volumetric water content. This additional soil water could be of benefit to the following wheat crop in dry seasons if it could be stored in the profile until the next growing season.

14 R Raymond, R Rachaputi (2016) Faba bean agronomy: Ideal row spacing and time of sowing. GRDC Update Papers, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/03/Faba-bean-agronomy-Ideal-row-spacing-and-time-of-sowing.

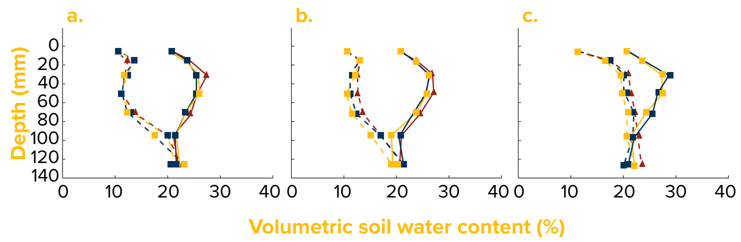


Figure 24: *Change in volumetric soil water with depth from May (—) to October (– – –) for (a) Pugsley wheat, (b) Sloop SA barley and (c) Fiesta faba bean at three different row spacings (18, 36 and 54 cm) at Roseworthy in 2006.*

Source: Kleeman and Gill 2008

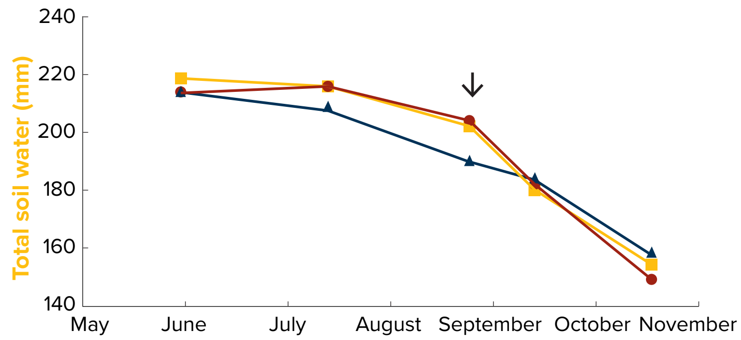


Figure 25: *Change in total soil water for Fiesta faba bean at three different row spacings (18, 36 and 54 cm) during the 2006 growing season. Arrow indicates start of flowering. (Source Kleeman and Gill 2008)*

Faba beans grown in wider rows used 10–15 mm less water between the rows during the early vegetative phase than the crop grown at 18-cm row spacing (Figure 25), deferring some of the water use until its reproductive phase. This is in contrast to wheat and barley. Change in water-use pattern may have contributed to the increased pod density and subsequent grain yield responses observed in faba bean in wider rows (Figures 26, 27, 28).

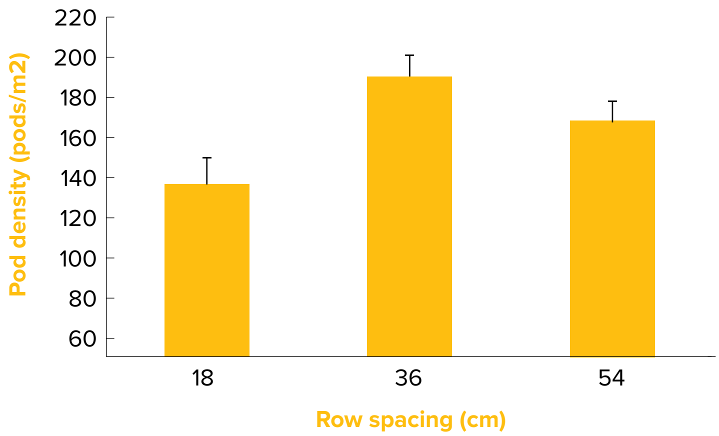


Figure 26: *Effect of row spacing on pod density (pods/m²) of Fiesta faba bean at Roseworthy in 2006.*

Source: Kleeman and Gill 2008

Figure 27: *Wide ('skip') rows are starting to be used in faba beans.*

Photo: W. Hawthorne, Pulse Australia

Figure 28: *Wide ('skip') rows in faba beans allow easier sowing into heavy cereal stubbles, assist in weed control, promote better pod set and delay canopy closure to assist in disease control and fungicide application.*

Photo: W. Hawthorne, Pulse Australia

MORE INFORMATION

BJ Scott, P Martin, GP Riethmuller (2013) Row spacing of winter crops in broad-scale agriculture in southern Australia. Graham Centre Monograph No. 3, https://www.csu.edu.au/research/grahamcentre/publications/monograph/row-spacing-monograph

S Kleeman, G Gill (2008) Row spacing, water use, and yield of wheat (*Triticum aestivum*), barley (*Hordeum vulgare*) and faba bean (*Vicia faba*). Australian Agronomy Conference, http://www.regional.org.au/au/asa/2008/poster/agronomy-landscape/5752_kleemannsgl.htm

3.4.3 Sowing depth

Faba beans have a hypogeal pattern of emergence (they leave their cotyledons below the soil surface) and therefore are able to emerge from deeper in the soil than plants with an epigeal emergence pattern (e.g. lupins) (Figure 29). Faba beans are also large-seeded and produce a relatively strong seedling, which further enable seedlings to emerge from deeper in the soil (Table 8).

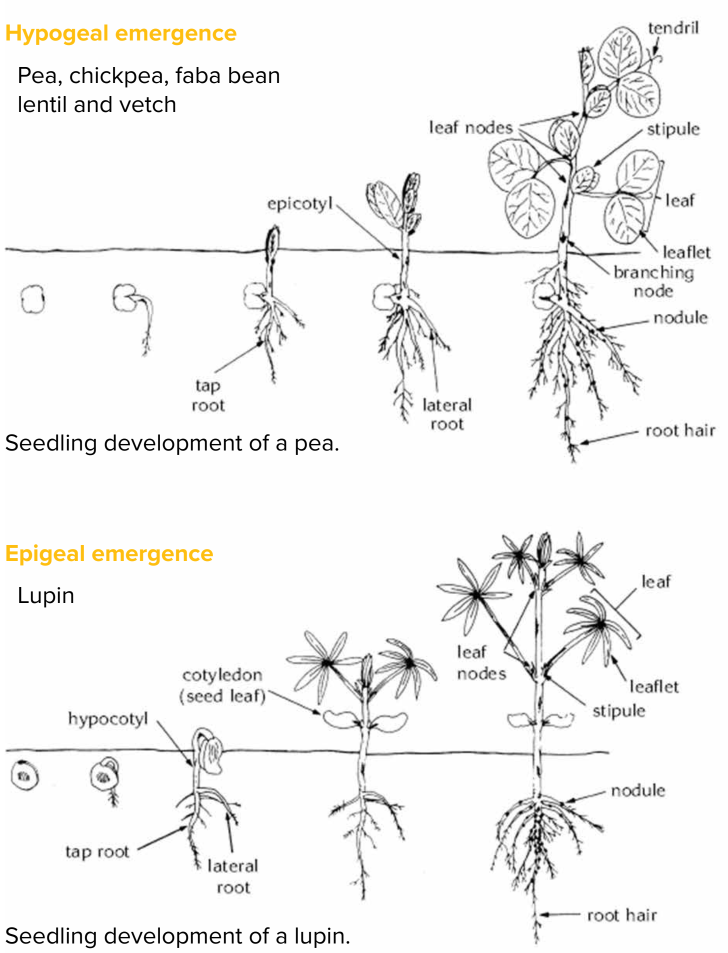


Figure 29: *Epigeal versus hypogeal emergence patterns.*

Source: GRDC Grain Legume Handbook—Seeding, http://www.grdc.com.au/uploads/documents/3%20Seeding.pdf

Sowing depth of pulse seed needs to be varied to take into account crop type, soil type, herbicide used, diseases likely to be present, and soil temperature at sowing time, i.e. how long the crop will take to emerge. Lighter textured soils can be more prone to herbicide leaching in wet winters; hence, deeper sowing in sandier soils is often recommended if applying a pre-emergent herbicide. The deepest sowings tend to be in sandy soil with warm soil temperatures and if dry-sowing. The shallowest sowings will be in heavy soils with cold soil temperatures or late sowing; however, there are exceptions.

Table 8: *Sowing depth ranges (cm) for pulses.*

Crop	General recommended sowing depth range
Chickpeas	3–5 cm
Faba beans	5–8 cm
Lentils	2–6 cm
Lupins	1–3 cm
Peas	3–5 cm
Vetch	3–5 cm

Note that if applying a pre-emergent herbicide the greater depth should be used

Figure 30: *Faba beans are much more tolerant of deeper sowing than are lupins, because of their hypogeal emergence. The lupins shown were sown too deep (greater than 5 cm). Note the stunted first true leaf and lack of early vigour.*

Photo: Grain Legume Handbook

There is a maximum depth at which the pulse crop can be safely sown to avoid poor establishment and lower seedling vigour (Figure 30). Sowing seed outside the suggested range (see Table 8) will delay emergence and slow seedling growth. Actual sowing depth should be shallower on clay soils and hard-setting soils and deeper on sands. Generally, lupins are least tolerant of deep sowing; lentils, field pea, chickpea and vetch are intermediate; and beans are the most tolerant.

Burying seed too deep to chase seedbed moisture for early sowing is not recommended, particularly because weed control, establishment and possibly nodulation is more likely to be poor. Deeper sowing may be needed in some districts to reduce the damage caused by birds and mice.

In the northern region, faba beans are often planted deep (up to 15–18 cm into the soil) early in the planting window to ensure they go into good soil moisture to get an even establishment. Following planting, the paddock often has Kelly discs (or some leveling implement) put across it to help level the soil surface, which seals the planting slots to stop the clay soils drying out down to the seed and prepares the paddock for harvest, because the crop is often harvested close to the ground.

In northern NSW, planting is typically 7.5–15 cm, and in recently, growers have planted at 20 cm.

Sowing depth and herbicide interaction

Pulses can be more tolerant of some herbicides if shallow sowing is avoided. For example, faba beans are less affected by simazine applied either pre-sowing or post-sowing pre-emergent if they are sown deeper.

The actual depth of sowing will depend on the soil type. Herbicides leach deeper in sands than in clay soils. Some herbicides leach more than others, and heavy rain onto a dry soil surface, particularly on a sand, is worst.

Leaving the soil ridged increases the risk of post-sowing, pre-emergent herbicide washing into the furrow, especially on sands. As pre-sowing applications of herbicide may be less effective in the furrows, a split herbicide application is suggested to ensure effective weed control while avoiding the risk of herbicide damage.

Deep sowing

Deep sowing of faba beans and chickpeas is used in northern Australia to sow into dry surface but wet subsurface moisture. Faba beans can be sown at depth to 15 cm if needed. Deep-sowing or moisture-seeking techniques can be used to ensure timely planting when the soil surface is still dry. The large seed size makes faba beans very suitable for this type of planting system. Deep sowing also allows more time in which to apply a knockdown herbicide prior to crop emergence.

MORE INFORMATION

Pulse Australia Northern Pulse Bulletin 'A growers guide to deep planting chickpea': http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/deep-seeding

3.5 Irrigation

Irrigating faba beans with either full or supplementary irrigation is practiced in Australia where it is economical when grown in rotation with other winter and summer crops. Management requirements for irrigated faba beans are the same as for dryland crops. Faba beans do have a greater sensitivity to foliar diseases under irrigation. Their greater sensitivity to waterlogging under irrigation needs to be considered. Even waterlogging for a short time can result in severe losses, particularly if the crop is stressed (from herbicides, disease, moisture, etc.).

MORE INFORMATION

GRDC Update Paper: Crop sequencing for irrigated double cropping within the Murrumbidgee Valley region

3.5.1 Principles

There are a number of factors to consider when choosing irrigated faba bean production as an option:

- Avoid heavy clay or dense soil types (bulk density >1.5) or those that do not drain freely and are subject to waterlogging.
- Select fields with good irrigation layout such as beds or hills and relatively good grades.
- Border-check layouts steeper than 1 : 800 grade are suitable provided there are short runs and free-draining soils that can be irrigated quickly and do not remain saturated.
- Irrigation can be used in activating and incorporating a number of pre-emergent herbicides.

Irrigation management

- Pre-irrigate to fill the moisture profile prior to planting all faba bean crops unless this has already been achieved by rainfall.
- Watering up can be achieved on beds, rows and under sprinkler irrigation, but is not recommended for border-check layout unless moisture was insufficient to achieve a uniform germination.
- As a rule, in crop irrigation should start early when there is a deficit of 30–40 mm and ~60–70% of field capacity. Moisture scheduling is more important than growth stage.

- Irrigations should also commence prior to flowering to prevent moisture stress and high temperatures affecting yield, quality and grain size.
- For furrow irrigation, water every second row to avoid waterlogging. Doubling up siphons can increase water flow and reduce irrigation time.
- Aim to have watering completed in less than 8 h, and have good tail-water drainage to avoid waterlogging.
- Avoid irrigation if there is likelihood of rain soon after.
- Faba beans are more sensitive to waterlogging during their reproductive stage (flowering, podding). Spring irrigations usually do not pose a risk to crops on beds or rows, however crops on border-check layout with heavy soil types or long runs may be at risk with this practice. If in doubt, do not water.
- Sprinkler irrigation is ideally suited to growing pulses as there is very little risk of waterlogging even during flowering and pod-fill; however, there may be a need for greater disease control against chocolate spot, rust or Ascochyta blight because of more frequent wet conditions. [15]

3.5.2 '*Faba Check*' findings

From 2000 to 2004, NSW Department of Agriculture (now Department of Primary Industries) conducted '*Faba Check*' monitoring of irrigated bean crops in southern NSW. *Faba Check* in southern NSW showed growers and their advisors the way forward in terms of crop management and identified the main factors for success of local irrigated crops. Main lessons learnt were:

Paddocks and layout

- Check soil pH, because faba beans do not like acid soils with pH <5.2 (in $CaCl_2$).
- Do not grow on freshly land-formed paddocks, particularly if there are big cut-and-fill areas.
- Only grow on your best soil types.
- Be aware of potential damage from herbicide residues, particularly from boom spray contamination.
- Irrigation layout is one of the most important factors for the final spring irrigation. Faba beans performed best on bed layouts, with waterlogging in spring a potentially serious issue on contour layouts (Table 8).
- Good weed control in previous crops is highly beneficial.

Sowing

- Calibrate seeders after inoculating to get the correct plant population.
- Check capabilities of seeders; seed size can be an issue for some, often causing blockages or resulting in low plant populations per m^2. It is not advisable to grade out the large seed before sowing.
- Sowing with a spreader (broadcasting) and then harrowing gives variable results leading to poor establishment. Some seed is buried too deep or left sitting on the surface.
- Do not sow too early; crops sown before May can suffer from lodging. Sowing early to mid-May helps to avoid the problem and maximises yield potential.

Crop management

- Growers need make every effort to achieve optimum plant populations.
- Pay close attention to plant nutrition.
- Lodging can prove an issue at harvest and can be worse on beds because plants are harder to pick up from furrows. It is then important to be harvesting one way.
- Thrips can be a problem at flowering, but the benefits of treating them are unclear and control may not be worth it.

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15 Northern Faba Bean—Best Management Practices Training Course. Pulse Australia 2014.

- Budworm (*Helicoverpa*) control is required.

Disease control

- Keep up to date with disease prevention with strategic use of fungicides.
- Even in a dry year, 4 or 5 fungicide sprays may still be required.
- It is best that build-up of disease during winter is effectively prevented and that protection against disease in the spring is provided before each watering when the canopy humidity and disease risk is high.
- Strategic fungicide applications adopted by district growers are outlined below:
  - An application 4–6 weeks after the crop has emerged, targeting mainly *Ascochyta* and more recently *Cercospora*.
  - Number of later applications will depend on the level of disease in the crop and seasonal conditions. Applications throughout the most active growth period must target chocolate spot, but fungicide choice or mix need match the diseases likely present.
  - Final application of fungicide targets rust and *Ascochyta*.

Irrigation

- Timely spring irrigations are important.
- Be able to minimise moisture stress with optimum irrigation layouts.
- Hot conditions experienced during September–October can impact, especially in dry seasons. Crops on beds may require 2 or 3 spring irrigations, after being watered up.
- The move towards more suitable layouts for faba beans has been beneficial, with a higher proportion of crops now grown on beds rather than flat.
- *Faba Check* results in 2003 showed that 82% of beans were on beds and 18% on border-check, with only a small percentage on contours.
- Use of more suitable layouts has given growers flexibility in spring and removes the waterlogging risk, particularly after the last spring irrigation.
- Table 8 shows the break-up of irrigation layout and yields in *Faba Check* from 2000 to 2003.
- *Faba Check* data showed an average Water Use Efficiency of 12.5 kg grain/mm water for faba beans grown on beds, compared to an average of 9.98 kg grain/mm water for those grown on border-check.

Rotation benefits

- Growers need be aware of the benefits that faba beans provide to following wheat crops.

Additional keys to successful irrigated faba bean production

- Faba beans needs to be put in context with other crops; they require a higher level of management input than other winter crops.
- Benchmarking crops against others in the district helped growers to see where improvements in their management systems could be made in order to achieve higher yields and better quality.

Table 9: *Irrigation layout and yield from 'Faba Check' 2000–03.*

Year	Irrigation layout yield (t/ha)			
	Beds	Border-check	Contour	Other
2000	4.57	3.87	3.29	-
2001	4.37	4.04	3.72	3.7
2002	N/A	N/A	N/A	N/A
2003	5.16	3.77	–	–
Average	4.7	3.89	3.51	

N/A, no 'Faba Check' data for 2002; Other, sprinkler irrigation
Source: Faba Check Reports 2000, 2001 and 2003.

Table 9 shows that faba beans grown on beds consistently outperformed faba beans grown on any other layout. *Faba Check* results also showed that the Water Use Efficiency of faba beans grown on beds is higher than of faba beans grown on border check.

The same growers seem to be consistently achieving high yields of 5–6 t/ha for faba beans. Keys to success have been their regular adoption of best management practices in paddock selection, layout selection, good weed, insect and disease control, and spring irrigation requirements. [16]

3.6 Pulses and herbicide damage

Pulses can be affected by application of some post-emergent broadleaf and grass herbicides applied at label rates. Crop effects can be a reduction in plant biomass or N_2 fixation and lower yields. Lower rainfall regions with >250 mm annual rainfall and with sandy calcareous soils are at most risk of experiencing herbicide damage. For example, a single application of some Group A grass herbicides to peas grown at Waikerie (South Australian Mallee) reduced nodulation by 50%, which resulted in a reduction in N_2 fixation of ~50% and no N-benefit to the system for the following crop. A significant reduction in N_2 fixation can mean the difference between a positive and negative economic benefit from a pulse crop, particularly in low-rainfall situations.

The severity of herbicide effects on pulses varies with seasonal conditions and location. When considering pulses as an option in low-rainfall regions, growers should identify the prime reason for choosing a pulse in rotation. If weed and disease control are a priority, a potential decrease in N_2 fixation may be less of a concern. Growers should adopt an integrated weed management (IWM) approach to reduce weed populations on-farm and spray strategically to reduce the number of herbicide applications required in a pulse crop.

Pulses can be damaged by soil-active herbicides, either from leaching into the root-zone or from herbicide residues.

3.7 Sowing and handling hints

The large size, awkward shape and fragile nature of many pulses means that they need careful handling to prevent seed damage. The bigger the grain, the easier it is to damage. Seed grain, in particular, should be handled carefully to ensure good germination and vigour.

Plan ahead so that handling can be kept to a minimum to reduce damage between harvest and seeding.

16 Northern Faba Bean—Best Management Practices Training Course. Pulse Australia 2014.

Handling bulk seed

Augers with screen flighting can damage pulses, especially larger seeded types. This damage can be partly overcome by slowing down the auger. Augers with large flight clearances will cause less damage to large grains.

Tubulators or belt elevators are excellent for handling pulses, as little or no damage occurs. Cup elevators are less expensive than tubulators and cause less damage than augers. They have the advantage of being able to work at a steeper angle than tubulators. However, cup elevators generally have lower capacities.

Auguring from the header should be treated with as much care as later handling and storage, because it has the same potential for grain damage.

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

If inoculating faba bean seed during handling, there is less mixing and poorer seed coverage when using tabulators and elevators than with augers.

3.8 Seeding equipment

Success with pulses may depend on the type of sowing equipment used. The large size of pulses can make sowing with conventional seeders very frustrating.

If the seeder is not suitable for sowing a particular pulse (usually larger seeded types) in standard form there are several options available.

The machine may be adapted by minor modifications such as:

- modifying the metering mechanism with manufacturer-supplied optional parts
- modifying seed tubes to reduce blockages, particularly on older machines
- modifying or replacing dividing heads on airseeders (see Figure 31).

Most pulse seeding problems are related to seed metering and the transfer from seed meter to soil. These problems are caused by the large size of some pulses and the high seeding rates generally used.

Faba beans can be sown with a standard airseeder or conventional combine, but care is needed, because seeds tend to bridge over the outlets, causing very uneven sowing. This difficulty can be eliminated by filling the box to only one-third or one-half capacity or by fitting an agitator.

Faba beans can also cause problems in some combines, but airseeders with adequate metering rollers can sow them successfully if the airflow is adequate.

Airseeders

Air seeders that use peg-roller metering systems (Napier, Shearer) will handle grain up to the size of smaller faba beans without problems, because of the banked metering arrangement. The optional rubber star roller will be necessary for larger seeds.

Airseeders using metering belt systems (Fusion, Alfarm, Chamberlain–John Deere, New Holland) can meter large seed at high rates with few problems.

Airseeders with large or very coarse, single-fluted rollers cannot meter faba beans >18 mm without modifications to the metering roller. Consult a machinery dealer about possible modifications.

On some airseeders, the dividing heads may have to be modified because there is too little room in the secondary distributor heads to allow seeds to flow smoothly. Figure 30 shows a standard secondary distributor head (on the left) and a conversion to suit Connor–Shea airseeders. The conversion head increased the bore from 23 to 41 mm. Four larger hoses replace the original eight, and row spacings are increased from 150 to 300 mm. This conversion allows large seeds to be sown easily.

Significant levels of seed damage can be caused in air-seeders by excessive air pressure, so take care to use only enough air to ensure reliable operation.

Figure 31: *Conversion heads, such as this one for a Connor–Shea air seeder, allow large seeds such as faba beans and Kabuli chickpeas to be sown with ease.*

Source: Grain Legume Handbook

Combine seeders

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

Combines with internal force-feed seed meters perform well on small seeds but cannot sow seed >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.

3.8.1 Seeder and tine comparisons

The key functional or mechanical issues that arise with establishing all crops, especially pulses, are to ensure that the seeding equipment has, or enables:

- Adequate seeding mechanism to handle the pulse seed without damaging it or bridging or blocking, especially when larger seeded types are being sown.
- Adequate sizes of seed and fertiliser tubes and boots to prevent seed blockages and bridging during sowing.
- Ability to sow into stubbles and residues without blockages.
- Sufficient down-pressure to penetrate the soil, sow at the desirable depth, and place all seeds at a uniform depth.
- Ability to cover the seeds so that good seed-to-soil contact or moisture vapour ensures rapid germination.
- Compaction of the soil as required, by press-wheels (Figure 32) or closers. Otherwise, a prickle chain, Kelly discs or roller are required afterwards for many pulses.

- Ability to disturb the soil to the degree required. This means no disturbance in no-till with disc sowing. It may also mean having sufficient soil throw to incorporate herbicides such as trifluralin. This can be achieved by using either aggressive discs or narrow point set-ups in no-till, or full disturbance in more conventional or direct-drill systems.

Inability to achieve adequate plant establishment is one of the bigger problems faced by pulse growers, and it leads to a multitude of other problems. Many different seeding mechanisms or openers are available to pulse growers. Narrow points are widely used in minimum or no-tillage, but there are many different points that can be used. Likewise, with disc seeders (Figure 33), many different types are now available, and they differ greatly in their soil disturbance and soil throw, as well as their ability to handle trash and sticky conditions.

A comparison of the critical functions for seed drills and no-till is shown in Table 10. For interpretation of the functions listed in Table 10 it should be noted that:

- With tines, the slot created is different depending on the type of tine used. Some create a vertical slot, others a 'V', whereas the inverted 'T' (or 'baker boot') (Figure 34) leaves a slot with a narrow entrance and wider trench underneath. These tines perform differently in some functions.
- Residues need to be handled in all conditions, not just when dry.
- 'Hairpins' (stubble is pressed into the slot by the disc ahead of the seed) need to be avoided by placing seeds away from stubble.
- Vertical slots tend not to self-close, especially in wet, clay soils.
- Ability for openers to follow ground surface variation is critical for uniform depth of sowing (Figure 35).
- Springs cannot apply consistent down-force on openers throughout a range of soil conditions.
- Banding of fertiliser away from the seed is important for crop establishment, particularly when high rates or high-analysis products are applied and the seed is in a narrow opening slot.
- Tines handle stones, but bring them up, requiring rolling to press them back again.
- The seeding mechanism of the seeder must be able to handle pulses, which are larger seeded than cereals and oilseeds. Hoses, distributor heads and boots must be able to handle pulses without blockages or bridging. This is especially true for larger seeded types such as faba beans or Kabuli chickpeas.
- Table 10 does not list as a function deep working to assist in rhizoctonia control. This was a weakness of early disc drills compared with narrow points with deep openers. Many newer discs are addressing this issue, including using opening coulters and rippled discs. [17]

17 Southern/Western Faba and Broad Bean—Best Management Practices Training Course—Module 4: Agronomy 2013. GRDC.

Figure 32: *One of several seeding mechanisms for uniform sowing depth using the press-wheel for depth control.*

Photo: W. Hawthorne, Pulse Australia

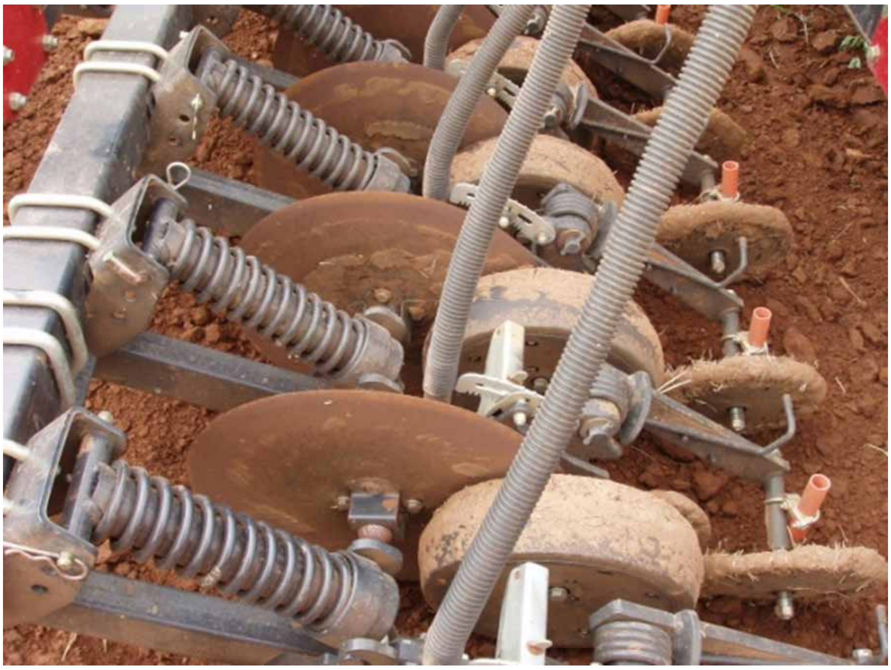

Figure 33: *A Case IH SDX-40 single-disc drill.*

Photo: W. Hawthorne, Pulse Australia

Figure 34: *A primary precision seeder fitted with hydraulic breakout for consistent penetration. Also fitted are narrow points that form an 'inverted-T' slot and are capable of deep or side placement of fertiliser.*

Photo: W. Hawthorne, Pulse Australia

Figure 35: *The DBS system parallelogram for uniform seeding depth and deep placement of seed or fertiliser.*

Photo: W. Hawthorne, Pulse Australia

Table 10: *Comparison scores of no-till openers by function (after Baker 2010).*

Function	Narrow point	Wide point	Sweep	Double disc	Single disc	Slanted disc	Combined winged tine and disc
Mechanically handle heavy residues without blockage	2	1	1	4	4	4	5
Leave 70%+ of original residue in place after drill has passed	3	2	2	5	4	4	5
Trap moisture vapour in the seeding slot in dry soils using residues as slot cover	3	2	3	1	2	4	5
Avoid placing seeds in 'hairpins'	5	5	5	1	2	2	5
Maximise in-slot aeration in wet soils[A]	3	4	3	1	3	3	5
Avoid in-slot soil compaction or smearing in wet soils[A]	1	1	3	1	5	5	5
Maximise soil–seed contact, even in greasy or 'plastic' conditions	4	3	4	3	3	4	5
Self-close the seeding slots	2	1	3	2	3	4	5
Mitigate slot shrinkage when soils dry out after sowing[A]	3	5	5	1	2	4	5
Individual openers faithfully follow ground-surface variations	2	1	2	2	4	2	5
Individual openers have a larger than normal range of vertical travel	2	1	1	2	2	1	5
Maintain consistent down-force on individual openers	3	1	1	2	3	3	5
Openers seed accurately at shallow depths[A]	2	1	1	2	2	1	5
Opener down-force auto-adjusts to changing soil hardness	1	1	1	1	1	1	5
Simultaneously band fertiliser with, but separate from, the seed	5	5	5	1	2	3	5
Ensure that fertiliser banding is effective with high-analysis fertilisers	5	5	51	1	1	2	5
Able to handle sticky soils[A]	5	5	4	1	3	3	2
Able to handle stony soils[A]	4	3	1	4	4	2	4
Avoid bringing stones to the surface[A]	1	1	1	5	5	3	5
Functionality unaffected by hillsides[A]	5	5	4	5	2	1	5
Minimal adjustments required when moving between soil conditions	3	3	3	4	1	1	5
Ability to maintain most critical functions at higher speeds of sowing	3	1	1	4	3	3	5
Wear components are self-adjusting	5	5	5	3	2	2	5
Design life of machine matches that of the tractors that pull it	4	4	4	2	2	2	5
Low wear rate of soil-engaging components	5	4	4	2	3	3	3
Wear components, including bearings, are cheap and easily replaced	5	5	4	2	2	2	4
Requires minimal draft from tractor	4	3	2	5	4	3	3
Proven, positive impact on crop yield	3	2	2	1	3	4	5
Total score (maximum = 140)	93	80	80	68	77	76	131
Rating score as % of maximum possible	66	57	57	49	55	54	94

Rating basis: 1 = poor, 5 = excellent. Combination is otherwise known as the Cross SlotTM or Bio Blade

Source: CJ Baker (2010). SANTFA 12th Annual Conference pp. 7–13.

A Functions that may be deleted in some circumstances, but all other functions are more universal.

NOTE that Table 10 is a broad GUIDE ONLY. Scores given in the table are subjective and may vary with individual openers, etc. You may use your own scores for each function and not count those that are not relevant in your situation. Neither pure disc nor pure tine openers rate highly over all functions in this scoring. Disc openers rated lowest (49–55%), and of the tines (57–66%), narrow points were the best. Best was the combination of winged tine and disc, known as the Bio Blade or Cross Slot™ (94%). It allegedly combines the best attributes of pure disc openers with t he best attributes of pure tine openers, and has some unique features. Its weaknesses included a lesser ability to handle 'sticky' soils, its horse power requirement, and its wear rate of soil-engaging components.