NORTHERN
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GRDC GROWNOTES™

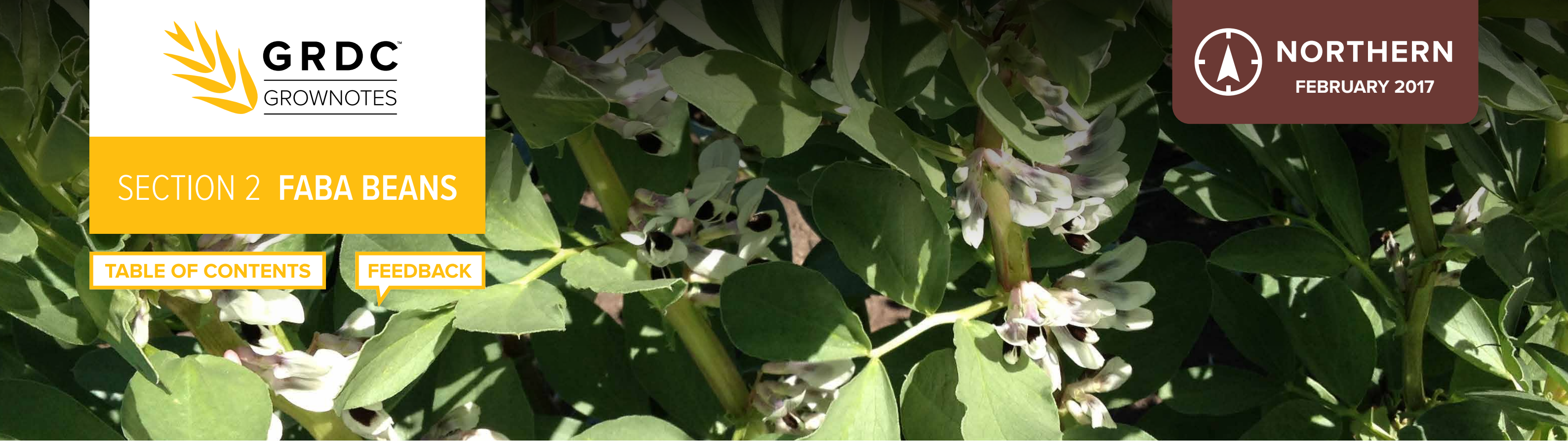
GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FABA BEAN

SECTION 2

PRE-PLANTING

FABA BEAN TYPES | CHOOSING A VARIETY | VARIETAL PERFORMANCE AND RATINGS YIELD | AREA OF ADAPTATION | QUALITY TRAITS | NORTHERN FABA BEAN VARIETIES | CROPMATE VARIETYCHOOSER | SEED QUALITY | SEED TESTING | PERFORMING YOUR OWN GERMINATION AND VIGOUR TEST



Pre-planting

2.1 Faba bean types

The bean (*Vicia faba*) varieties grown in Australia can be divided into two types: the smaller, faba bean types, and the larger, broad bean types.

Colour, size, shape and texture are important attributes in marketability of faba beans.

The requirements of faba beans in terms of size and colour vary between importing countries and according to the end use:

- The predominant colour for international trade is beige or buff, and colour is largely genetically determined and highly heritable.
- Size can vary according to variety.
- Size can also be influenced by the region (rainfall, soil type, etc.) where it is grown and by the season.
- Colour can also be influenced by environment in which the crop is grown, post-harvest handling, time in storage and storage method.

Faba beans have large flat seeds, which are predominantly a beige colour. The seed size can vary from 35 to 100 g/100 seeds according to the variety being grown, the region and season.

Within the faba bean types, several market categories have emerged for Australian growers:

- the traditional, medium-seeded faba bean markets, where seed size and uniformity (50–70 g/100 seeds) is important to attract market interest;
- a large-seeded class (70–90 g/100 seeds) that is sold into bulk Kabuli markets; and
- a small-seeded (35–50 g/100 seeds) class, originally exported for human consumption markets but now considered too small in all but a few niche markets ('Fiord' size).

When choosing a faba bean type, factors that influence the gross margin and risks with each variety must be considered. [1]

MORE INFORMATION

GRDC Update Paper: Profitable integration of pulses in farming systems

2.2 Choosing a variety

When selecting a variety, the season length, seed size with reference to sowing machinery, disease tolerance, seed availability and markets need to be considered.

Varietal resistance to chocolate spot (*Botrytis fabae*) is extremely important because this disease is a potential problem with faba beans in higher rainfall areas, irrigated crops or wetter years. Current varieties do not offer good resistance, and so a strategic foliar fungicide program is essential in most areas. Improvement in varietal resistance is being developed, however, and breeding lines that offer better long-term prospects will eventually be released.

Some faba bean varieties available to growers have limitations with regard to agronomic adaptation and marketability, and they will not suit all areas or situations. When choosing varieties to grow, consider their susceptibility to chocolate spot and rust, along with yield potential, price potential, marketing opportunities, maturity timing, lodging resistance and other agronomic features relevant to your growing

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

MORE INFORMATION

Variety Management Packages (VMPs) available at www.pulseaus.com.au

PBA Warda⒲ VMP

MORE INFORMATION

www.nvtonline.com.au

region. Rust is a major disease in the northern region, especially in mild, wet springs when the disease can spread very quickly; a strategic foliar fungicide program is also imperative.

Fungicide (Dithane®, active ingredient mancozeb) is usually applied as the crop approaches canopy closure to protect the lower leaves from rust. Sometimes this initial fungicide can be included with the grass weed herbicide. Depending on the seasonal conditions, e.g. continued wet conditions, a further fungicide application may be needed. [2]

When comparing yields between varieties, growers need to be aware that under high pressure of chocolate spot or moisture stress, more susceptible varieties are more likely to suffer greater yield loss than less susceptible varieties. [3]

2.3 Varietal performance and ratings yield

Faba beans are grown across the subtropical environments of northern New South Wales and southern Queensland. Faba bean varieties have specific traits to deal with different growing conditions in each zone, such as lengths of growing season or presence of diseases. A variety with a highly specific trait such as disease resistance may not yield as well as another variety bred specifically for yield, but the resistance trait will diminish risk. Varietal selection is a matter of weighing up how yield *v.* risk will affect gross margins.

Grains industry productivity depends on the continued deployment of new technologies, including the adoption of new varieties with superior yield and useful disease-resistance characteristics.

National Variety Trials (NVT) initiative collects the most relevant varieties for each region and tests them alongside the elite lines from breeding programs. To view trials in your region, visit the interactive map of NVT faba bean trials. For more information on the NVT, visit the NVT website.

Most new varieties are protected by Plant Breeders' Rights (PBR) and/or end-point royalties (EPR).

Seed of varieties with PBR protection can be bought only from the owner, commercial partner/licensee or an agent (seed merchant) authorised by the owner. Purchase seed of a PBR cultivar in the name(s) of the entity or entities in which you intend to deliver the product. Retain invoices to prove that you have entitlement to that seed and the crop produced.

Once purchased, growers can maintain seed of a variety with PBR protection to satisfy their seed requirements for the following seasons. Farmers can sell the products of a protected variety for commercial use as feed or food, unless bound by a 'closed loop' or other contract. Farmers cannot sell, trade, or give away the variety for seed. Farmer-to-farmer trading of seed without authorisation from the owner will make them liable for prosecution.

Commercial marketing arrangements between the owners and the licensee can vary between crops and varieties. Farmers must be aware of the conditions of the marketing arrangements. [4]

2.4 Area of adaptation

Faba bean varieties are bred for, and selected in, a range of environments. Hence, individual varieties have specific areas of adaptation for maximised yield and reliability. Specific adaptation of a variety depends on rainfall, geography, temperatures, disease pressure, and soil types at the site of cropping.

2 G Onus. Fababean Growing Program. Landmark Moree.

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

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

The national pulse production area has been categorised by Pulse Breeding Australia (PBA) into five regions based on rainfall and geographic location (see Figure 1 below):

- Region 1, low rainfall tropical
- Region 2, medium rainfall, subtropical
- Region 3, low rainfall, subtropical
- Region 4, medium–high rainfall, Mediterranean–temperate
- Region 5, low–medium rainfall, Mediterranean–temperate

These regions cross state borders, and are target zones for national breeding and variety evaluation. Breeding trials and NVT results help to indicate specific adaptation even within a region. Some variety releases have been specific for northern Australia (Doza⦸ and PBA Warda⦸). Other varieties have been found to be better adapted to specific parts of regions (e.g. PBA Rana⦸ and PBA Kareema⦸ in southern high-rainfall areas).

The area of adaption is specified for each variety so that potential users are aware of the best fit. [5]

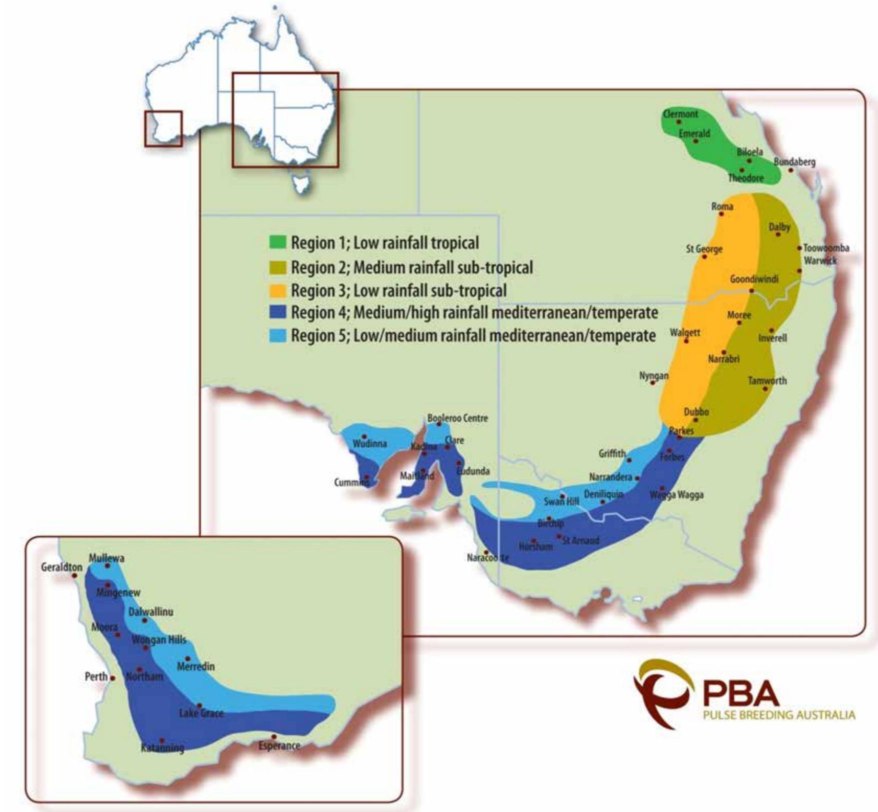


Figure 1: *PBA regions used to describe variety area of adaptation.*

2.5 Quality traits

Variety choice will be influenced by market acceptability and susceptibility to factors that downgrade grain quality, especially disease (Table 1). Small beans such as the old variety Fiord are less acceptable in major export markets. Medium–small beans (e.g. PBA Warda⦸) are sought because of their size and light colour. Medium-sized beans (e.g. Cairo⦸) and broad, large beans (e.g. Aquadulce) remain acceptable because of their size and colour.

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

Although seed size and colour are factors influencing quality, and these are largely determined by genetics, sound management from seeding to delivery can affect quality downgrading caused by shrivelling, seed discoloration, breakage and insect damage. Discoloured and small, shrivelled faba beans may result not only in seed being downgraded from human consumption but also in poor emergence and vigour for next year's crop. [6]

Seed staining in beans is caused by:

- genetics—natural ageing, and high tannin grains are more likely to discolour
- late rain on maturing or mature crops
- Ascochyta blight—susceptible varieties are more prone to discoloration
- exposure due to pod splitting—commonly caused by chocolate spot infection
- frost
- other diseases—Pea seed-borne mosaic virus (PSbMV) and Broad bean stain virus (BBSV)
- poor storage conditions, including high moisture or exposure to sunlight

Table 1: *Summarised yield data and disease traits across faba bean varieties and sites using NSW DPI, PBA and NVT trials from 2008–2015.*

					Disease			Yield							
								North east		North west		South east		South west irrigated	
								Yield as % of Cairoⓓ		Yield as % of Cairoⓓ		Yield as % of Farahⓓ		Yield as % of Farahⓓ	
Variety	**PBR**	**Maturity**	**Seed colour**	**Seed size (g/100 seeds)**	**Ascochyta**	**Chocolate spot**	**Rust**	**%**	**No. Trials**	**%**	**No. Trials**	**%**	**No. Trials**	**%**	**No. Trials**
								Cairoⓓ = 2.78 t/ha		Cairoⓓ = 2.16 t/ha		Farahⓓ = 2.82 t/ha		Farahⓓ = 4.20 t/ha	
Cairoⓓ	yes	mid–late	buff	50–75	VS	VS	MS	100	29	100	48	91	3	–	–
Dozaⓓ	yes	early	light buff	40–60	VS	MS	MR-R	105	29	104	48	93	16	95	3
Farahⓓ	yes	mid	light buff	60–75	R–MR	S	S	–	–	–	–	100	31	100	9
Fiesta VF	no	mid	buff	60–75	MR–MS	S	S	101	17	100	25	101	31	100	9
Fiord	no	early–mid	buff	33–55	MS	VS	S	98	20	99	30	95	11	–	–
Nuraⓓ	yes	mid	light buff	50–65	R–MR	MS	MS	88	11	89	10	97	31	95	9
PBA Nasmaⓓ	yes	early	beige to brown	61–79	S	MS	MR	112	28	110	46	104	16	–	–
PBA Ranaⓓ	yes	mid–late	light buff	75–90	R	MS	MS–MR	–	–	–	–	106	6	94	9
PBA Samiraⓓ	yes	mid	light buff	60–80	R	MS	MS	–	–	–	–	95	31	101	5
PBA Wardaⓓ	yes	early	beige to brown	58–70	S	MS	MR–R	100	30	108	49	98	15	102	4
PBA Zahra	yes	mid-late	light buff	65–85	MR	MS	S	–	–	–	–	106	16	101	5

VS, very susceptible; S, susceptible; MS, moderately susceptible; MR, moderately resistant; R, resistant; –, insufficient data

Source: NSW Department of Primary Industries Winter crop variety sowing guide 2016.

6 W Hawthorne (2008) Faba beans—for quality markets, Australian Pulse Bulletin No.14. Pulse Australia, http://pulseaus.com.au/storage/app/media/crops/2008_APB-Faba-beans-quality-markets.pdf

2.6 Northern faba bean varieties

Cairoⲑ

Released for the northern region and superior to Fiord and Barkool for yield, seed size and quality, Cairoⲑ also had better rust resistance and tolerance to stem collapse from frost (Figure 2). It is now outclassed for yield and rust resistance by Dozaⲑ and PBA Wardaⲑ. It is not generally recommended for southern regions where Ascochyta blight and chocolate spot are major problems. Released in 2004. Area of adaptation: Regions 2 and 3.

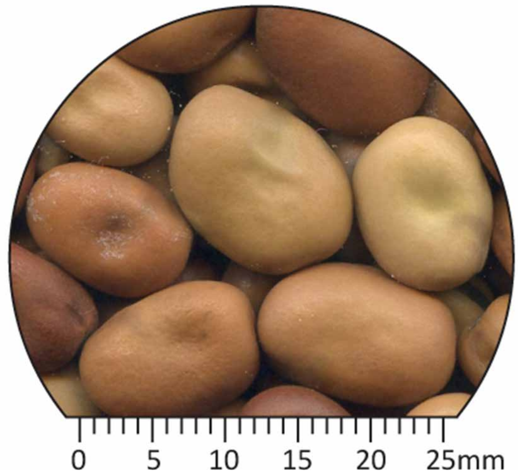


Figure 2: *Cairoⲑ. Released: 2004. Seed size: 55–75 g/100.*

PBA Nasmaⲑ

PBA Nasmaⲑ is an early maturing variety, similar to PBA Wardaⲑ. It is well adapted to the growing season in northern New South Wales and southern Queensland. This variety is not recommended for southern New South Wales where Ascochyta blight and chocolate spot are significant diseases.

Extensive yield evaluation of PBA Nasmaⲑ in northern New South Wales, at Pulse Breeding Australia (PBA) and National Variety Trial (NVT) sites, shows that its yield is on average 3% greater than PBA Wardⲑ. This yield advantage has been obtained in both rain fed and irrigated trials. PBA Nasmaⲑ is suggested as an alternative to PBA Wardaⲑ for growers in northern New South Wales and southern Queensland who are targeting larger seed size for premium markets.

Variety PBA Nasmaⲑ is moderately resistant to faba bean rust, the major fungal disease in northern New South Wales and southern Queensland and is moderately susceptible to chocolate spot. It has a similar level of tolerance to BLRV as that of PBA Wardaⲑ, which will benefit growers in areas prone to virus infection. PBA Nasmaⲑ is susceptible to Ascochyta blight, but this is not considered to be a major disease in northern New South Wales. Released in spring 2015. Area of adaptation: Regions 2 and 3.

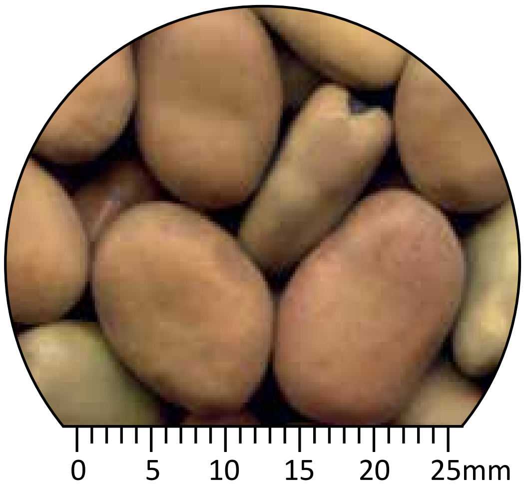


Figure 3: *PBA NasmaⒹ*

DozaⒹ

DozaⒹ (SP01040) is a medium-sized faba bean released for the subtropical environments of northern New South Wales and southern Queensland (Figure 4). Early flowering enables it to better adapt to warmer spring temperatures, along with higher yielding and improved rust resistance over CairoⒹ. Seed size is slightly smaller but uniformity of seed size and a light buff seed coat is a significant improvement for this region. It has good resistance to 'hockey stick' and stem collapse from frost, which is an important trait in this environment. It exhibits reasonable resistance to chocolate spot but is very susceptible to Ascochyta blight, and consequently not likely to have a large role in southern Australia. Released in 2008. Area of adaptation: Regions 2 and 3.

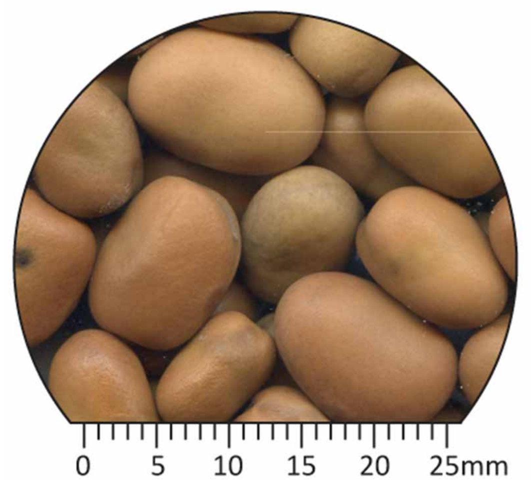


Figure 4: *DozaⒹ. Released: 2008. Seed size: 35–55 g/100.*

PBA WardaⒹ

Released for the northern region, PBA WardaⒹ is superior to DozaⒹ for yield, seed size and disease resistance (Figure 5). It is expected to replace DozaⒹ and CairoⒹ in these regions. This variety is less suited to southern and western regions because of its susceptibility to Ascochyta blight and its poorer yields.

Variety PBA WardaⒹ is moderately resistant–resistant to rust, equivalent to DozaⒹ, and has a higher level of tolerance to *Bean leafroll virus* (BLRV) than DozaⒹ. It has similar flowering and maturity time to DozaⒹ, but bigger and more uniform seed size. Released in 2012. Area of adaptation: Regions 2 and 3.

MORE INFORMATION

Ground Cover: Northern expansion stretches to Egypt

Long-term yield data for these varieties in NVT assessments are presented in Figure 6.

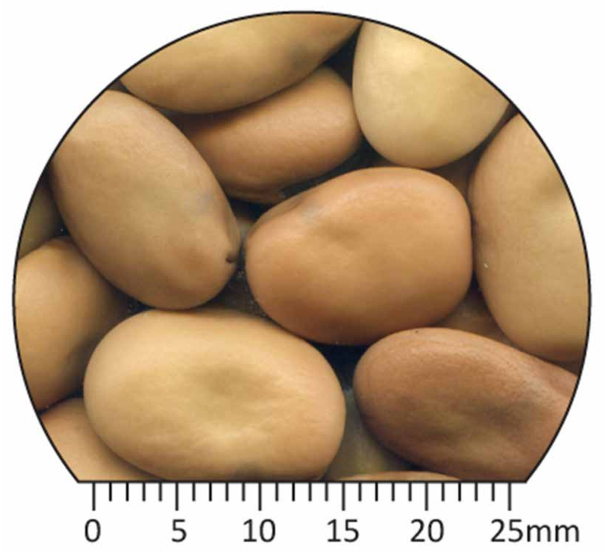


Figure 5: *PBA Warda⦇. Released: 2012. Seed size: 55–75 g/100.*

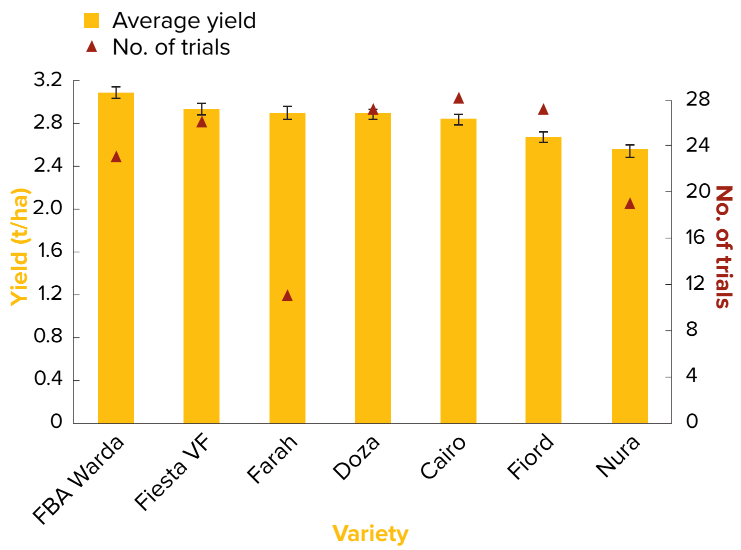


Figure 6: *National Variety Trial (NVT) adjusted average long-term yield report 2005–12 for north-eastern New South Wales.*

http://www.nvtonline.com.au/google-maps/2012/Faba%20BeanMaNE.pdf

MORE INFORMATION

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

2.6.1 Faba bean variety agronomic traits

A summary of agronomic traits for the three varieties Doza⒟, Cairo⒟ and PBA Warda⒟ is provided in Table 2.

Table 2: *Faba bean agronomic traits.*

Variety	Maturity	Seed colour	Seed size (g/100)	Height	Ascochyta blight		Chocolate spot	Rust	Cercospora	PSbMV seed staining
					Foliage	Seed				
Doza⒟	Very early	Buff	40–60	Medium	VS	VS	MS	MR–R	S	–
Cairo⒟	Early	Buff	50–70	Med.–tall	VS	VS	VS	MS	–	–
PBA Warda⒟	Very early	Buff	50–70	Medium	S	S	MS	MR–R	S	–
PBA Nasma⒟	Very early	Buff	60-80	Medium	S	S	MS	MR-R	S	–

These varieties are protected by PBR. VS, Very susceptible; S, susceptible; MS, moderately susceptible; MR, moderately resistant; R, resistant

Source: Pulse Breeding Australia.

2.6.2 Faba bean variety seed availability

Access details for the four varieties Doza⒟, Cairo⒟, PBA Warda⒟ and PBA Nasma⒟ are shown in Table 3.

Table 3: *Availability of faba bean varieties.*

Variety	PBR	Licensee or agency	Commercial partner	Seed supplying agents	Telephone	EPR ($/t incl. GST) and market restriction
Cairo⒟	Yes	DPI NSW	Viterra	Seedmark	1800 112 400	$3.30, none
Doza⒟	Yes	DPI NSW	Viterra	Viterra	1800 018 205	$3.63, none
PBA Warda⒟	Yes	University of Adelaide	Seednet	Seednet	(03) 5381 0406	$3.85, none
PBA Nasma⒟	Yes	University of Adelaide	Seednet	Seednet	1800 018 205	$3.85, none

EPR, End-point royalties

MORE INFORMATION

See Variety Central www.varietycentral.com.au

2.7 CropMate VarietyChooser

CropMate VarietyChooser (Figure 7) is a free iPhone app decision tool developed by NSW Department of Primary Industries to help farmers choose varieties of faba beans, barley, canola, chickpeas, field peas, lupins, oats, triticale and wheat. Choose variety characteristics and desired disease resistance levels, and see comparative yield trials for your region to narrow down your choices and see details of each variety.

MORE INFORMATION

https://itunes.apple.com/au/app/cropmate-varietychooser/id476014848?mt=8

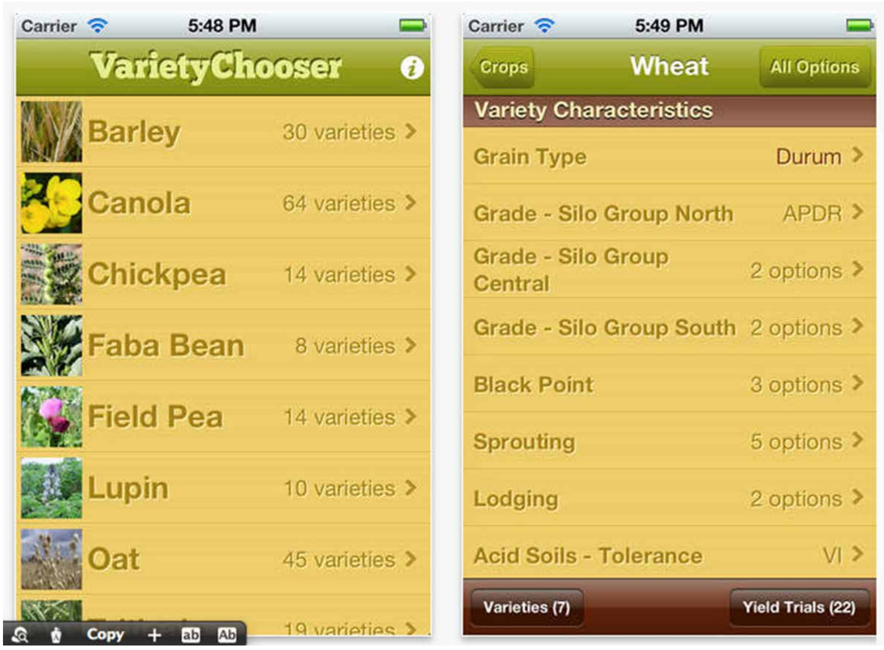


Figure 7: *Screenshots of the CropMate VarietyChooser.*

2.8 Seed quality

High-quality seed is essential to ensure the best start for your crop. Grower-retained seed, if not tested, may be of poor quality with reduced germination and vigour, as well as being infected with seed-borne pathogens.

- All seed should be tested for quality including germination and vigour.
- If grower-retained seed is of low quality, then consider purchasing registered or certified seed from a commercial supplier. Always ask for a copy of the germination report regardless of the source.
- Careful attention should be paid to the harvest, storage and handling of seed intended for sowing.
- Calculate seeding rates in accordance with seed quality (germination, vigour and seed size).

Good establishment with correct plant density and good seedling vigour is important to maximise yields of pulse crops. A targeted density can only be achieved by having quality seed with good vigour and a known germination percentage to accurately calculate seeding rates. A slight variation in seed size due to seasonal conditions or an incorrect germination percentage can make a significant difference in the final plant density.

Many seed buyers are unaware that the minimum germination requirement for certified pulse seed is 70%, compared with 80% in cereal grains, and is far less than the 90% or more often obtained in pulse seed. Test results must be made available under the Seeds Act, and Australian Seeds Federation guidelines; ensure that you receive a copy.

Problems with seed quality often occur when the crop is not harvested under ideal moisture or seasonal finishing conditions. A sharp seasonal finish, a wet harvest or delayed harvest can have a big effect on seed quality, as can poor insect control during the podding stage of the crop.

Low germination rates and poor seedling vigour can cause slower and uneven emergence, which can result in sparse establishment and a weak crop. The crop can also be more vulnerable to virus infection, fungal disease and insect attack, and less competitive with weeds. Any of these can result in significantly lower yields.

The large size or fragile nature of pulse seed, particularly faba bean, Kabuli chickpea and lupin, makes them more vulnerable to mechanical damage during harvest and handling. This damage is not always obvious, and can be reduced by slowing header drum speed and opening the concave, or by reducing auger speed and lowering the flight angle and fall of grain. Rotary harvesters and belt conveyers are ideally suited to pulse grain. They can reduce seed damage that often results in abnormal seedlings, which germinate but do not develop further.

Under ideal conditions, abnormal seedlings may emerge but will lack vigour, making them vulnerable to other rigours of field establishment. Factors such as low temperature, disease, insects, seeding depth, soil crusting and compaction are more likely to affect the establishment of weak seedlings. Abnormal seedlings that do emerge are unlikely to survive for long, and those that do survive are likely to have reduced biomass and make little or no contribution to the final yield. [7]

2.8.1 Grower-kept sowing seed

The best area of a paddock should be selected and marked out well before harvest. Choose areas where weeds and diseases are absent and the crop is vigorous and healthy and likely to mature evenly and have good grain size. Also select areas at least 500 m away from other faba bean varieties, to reduce cross-pollination and hence contamination. Seed from this area should be harvested first, ideally at 11–13% moisture to avoid low-moisture grain that is susceptible to cracking.

If desiccation is required, do not use glyphosate to treat the area that will be kept for seed, because it will severely affect the germination, normal seed count and vigour. Read the glyphosate label.

Seed-borne diseases can lower germination levels. Specialist laboratories can conduct tests for the presence in seed of a number of diseases, such as Ascochyta blight and botrytis (chocolate spot or grey mould) in faba bean and chickpea, *Cucumber mosaic virus* (CMV) in narrow leaf lupin, and bacterial blight in field pea.

Seed with poor germination or high levels of seed-borne disease should not be sown. The cheaper cost of retaining this seed will often be offset by higher sowing rates needed and the potential risk of introducing further disease into the crop.

The only way to assess accurately the germination rate, vigour and disease level of seed is to have it tested.

2.8.2 Safe storage of seed

Retained seed must be stored correctly to ensure that its quality is maintained. Ideal storage conditions for pulses are at ~20°C and 12.5% moisture content.

Faba beans may be stored in sheds, bunkers and silos. They do not suffer from pea weevil infestations; therefore, a sealed silo is usually not necessary. [8]

As with other grains, faba bean seed quality can deteriorate in storage, and the most rapid deterioration occurs under conditions of high temperature and moisture. Crops grown from seed stored under these conditions may have poor germination and emergence.

It is best not to store faba beans in bunkers or in 'sausage bags' for any length of time, because pockets of moisture can quickly lead to black, mouldy grain, which can contaminate the remainder of product. Black, mouldy grain can also taint the sample with an unpleasant odour, rendering it unacceptable for consumption. [9]

Reducing moisture and temperature increases longevity of the seed, although storage at very low moisture contents (<10%) may render faba bean more vulnerable

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

8 Victoria DEPI (2013) Growing faba bean. Note AG0083. Department of Environment and primary Industries, State Government of Victoria, http://www.depi.vic.gov.au/agriculture-and-food/grains-and-other-crops/crop-production/growing-faba-bean

9 W Hawthorne (2008) Faba beans—For quality markets. Australian Pulse Bulletin No.14. Pulse Australia http://pulseaus.com.au/storage/app/media/crops/2008_APB-Faba-beans-quality-markets.pdf

to mechanical damage during subsequent handling. See Table 4 for an example with chickpea.

Table 4: *Effect of moisture content and temperature on storage life of chickpea seed.*

Storage moisture (%)	Storage temperature (°C)	Longevity of seed (days)
12	20	>200
	30	500–650
	40	110–130
15	20	700–850
	30	180–210
	40	30–50

Note: Most sowing seed will need to be stored for a period of ≥180 days
Source: Ellis et al. 1982.

Storage at >13% moisture under Australian conditions is not recommended. Reducing temperature in storage facilities is the easiest method of increasing seed longevity. Not only will it increase the viable lifespan of the seed, it will slow the rate at which insect pests multiply in the grain.

To reduce temperature in grain silos:

- Paint the outside of the silo with white paint. This reduces storage temperature by as much as 4–5°C and can double the safe-storage life of grains.
- Aerate silos with dry, ambient air. This option is more expensive, but in addition to reducing storage temperatures, it is effective in reducing moisture of seed harvested at high moisture content.
- Heat drying of faba bean sowing seed should be limited to temperatures <40°C. [10]

2.8.3 Handling bulk seed

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

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

Augers with steel flighting can damage pulses, especially larger seeded types such as faba beans. This problem 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, with little or no damage occurring. 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 during 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 germination.

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

2.9 Seed testing

2.9.1 Germination testing

Germination tests can be conducted by a simple home test (see next section, 2.10), or ideally by sending a representative sample to seed-testing laboratories for germination and vigour tests. For faba beans, chickpeas, lupins, field peas and vetch, the sample size required is 1 kg for every 25 t of seed. For lentils, take 1 kg for each 10 t of seed.

Sampling should be random and include numerous subsamples to give best results. It is easier and more accurate to take numerous samples while seed is being moved out of the seed cleaner, storage or truck or by sampling from numerous bags if stored this way.

Do not sample from within a silo; this is dangerous for the operator, and it is difficult to obtain a representative sample because samples are taken from the bagging chute. Mix subsamples thoroughly and take a composite sample of 1 kg. Failure to sample correctly or test your seed could result in poor establishment in the field.

If an issue is suspected with kept grain, it is wise to get a sample tested early. Testing prior to grading and seed treatment could give a big saving if the quality is found to be unsatisfactory, and it enables more time to source replacement seed. If the germination and vigour are below optimal, or marginal, or the crop was weather-damaged at harvest, it is advisable to have it re-tested closer after storage, handling and grading have occurred.

2.9.2 Vigour testing

In years of drought or a wet harvest, seed germination can be affected, but more importantly, seedling vigour can also be reduced. Poor seedling vigour can impact heavily on establishment and early seedling growth. This can often occur under more difficult establishment conditions such as deep sowing, crusting, compaction, and wet soils or when seed treatments have been applied. Some laboratories also offer a seed vigour test when doing their germination testing. Otherwise conduct your own test by sowing seeds into a soil tray that is kept cold (<20°C) and observing not only the germination but also speed and uniformity of emergence and any abnormal shoot and root development.

Vigour represents the rapid, uniform emergence and development of normal seedlings under a wide range of conditions. Several different tests are used by seed laboratories to establish seed and seedling vigour.

2.9.3 Accelerated ageing vigour test

Accelerated ageing estimates longevity of seed in storage. It is now also used as an indicator of seed vigour and has been successfully related to field emergence and stand establishment. This tests seed under conditions of high moisture and humidity. Seeds with high vigour withstand these stresses and deteriorate at a slower rate than those with poorer vigour. Results are reported as a percentage, and the closer the accelerated ageing number is to the germination result, the better the vigour. Results are expressed as a percentage normal germination after ageing (vigorous seedlings). [11]

2.9.4 Conductivity vigour test

The conductivity test measures electrolyte leakage from plant tissues and is one of two International Seed Testing Association (ISTA) recommended vigour tests. Conductivity test results are used to rank vigour lots by vigour level.

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Information is interpreted for field pea as follows:

- <25 µS/cm.g. Nothing to indicate seed is unsuitable for early sowing or adverse conditions.
- 25–29 µS/cm.g. Seed may be suitable for early sowing, but there is some risk of poor performance under adverse conditions.
- 30–43 µS/cm.g. Seed is not suitable for early sowing especially under adverse conditions.
- >43 µS/cm.g. Seed is not suitable for sowing.

It is important to have a germination test done as well, because a conductivity test cannot pick up all seed-borne chemical and pathogen scenarios.

2.9.5 Cool germination and cold tests

A cool or cold test is used to evaluate the emergence of a seed lot in cold, wet soils, which can cause poor field performance. The cold test simulates adverse field conditions and measures the ability of seeds to emerge. It is the most widely used vigour test for many crops, and is one of the oldest vigour tests.

This test can:

- Evaluate fungicide efficacy.
- Evaluate physiological deterioration resulting from prolonged or adverse storage, freezing injury, immaturity, injury from drying or other causes.
- Measure the effect of mechanical damage on germination in cold, wet soil.
- Provide a basis for adjusting seeding rates.

This test usually places the seed in cold temperatures (5–10°C) for a time, which is then followed by a period of growth. Then the seed is evaluated relative to normal seedlings according to a germination test. Some laboratories also categorise the seedlings further into vigour categories and report both of these numbers.

2.9.6 Tetrazolium test (TZ) as a vigour test

The TZ test is used to test seed viability, but is also useful as a rapid estimate of vigour of viable seeds. It is conducted in the same manner as a germination test, but viable seeds are evaluated more critically into categories of:

- High vigour. Staining is uniform and even, tissue is firm and bright.
- Medium vigour. Embryo completely stained or embryonic axis stained in dicots; extremities may be unstained; some overstained–less firm areas exist.
- Low vigour. Large areas of non-essential structures unstained; extreme tip of radicle unstained in dicots; tissue milky, flaccid and over stained.

Results have shown good relationships with field performance, and are useful for pulses.

2.9.7 Other

Another example of a vigour test used by some Australian laboratories is to test germination at 7°C for 12–20 days in the dark and under low-moisture conditions. If seed vigour is acceptable, then this germination result should be within 10% of the regular germination test.

2.9.8 Weed contamination testing

Sowing seed free of weeds cuts the risk of introducing new weeds. It also reduces the pressure on herbicides, especially with increasing herbicide resistance. Tests for purity of a seed sample, including the amount and type of weed seed contamination, can be conducted if requested.

2.9.9 Disease testing and major pathogens identified in seed tests

Seed-borne diseases such as CMV in lupin and lentil, and Ascochyta blight in chickpea, faba bean and lentil, pose a serious threat to yields. Seed-borne diseases can strike early in the growth of the crop when seedlings are most vulnerable and can result in severe plant losses and hence lower yields.

Testing seed before sowing will identify the presence of disease and allow steps to be taken to reduce the risk of disease. If disease is detected, the seed may be treated with a fungicide before sowing or a clean seed source may be used (Table 5).

For a disease test, 1 kg of seed is required, except for anthracnose (lupin) which requires 2 kg. [12]

Table 5: *Major pathogens identified in seed tests on faba bean.*

Pathogen	Disease
Botrytis fabae	Chocolate spot
Ascochyta fabae	Ascochyta blight
Ditylenchus dipsaci	Stem nematode
BBSV	Broad bean stain virus

Refer to GrowNotes Faba bean 6—Disease management. Check test number against the laboratories that do seed tests

Laboratories that will test for some or all of the above diseases include:

SARDI Field Crops Pathology
GPO Box 379, Adelaide, SA 5001
Telephone (08) 8303 9384
Facsimile (08) 8303 9393
Web: www.sardi.sa.gov.au/diagnostic_services/Crop_diagnostics

Futari Consulting (Qld) Pty Ltd
P.O. Box 7135
South Toowoomba
Qld 4350
Ph: (07) 4697-5340
Email: Ken@futariqld.com.au

2.10 Performing your own germination and vigour test

A laboratory seed test for germination should be carried out before seeding to calculate seeding rates. However, a simple preliminary test on-farm can be done in soil after harvest or during storage. Results from a laboratory germination and vigour test should be used in seeding rate calculations.

For your own germination test, use a flat, shallow seeding tray about 5 cm deep. Place a sheet of newspaper on the base to cover drainage holes. Use clean sand, potting mix or a freely draining soil. Testing must be at a temperature <20°C, so doing it indoors may be required. Randomly count out 100 seeds per test, but do not discard any damaged seeds.

After the tray has been filled with soil, sow 10 rows of 10 seeds in a grid at the correct seeding depth (Figure 8). Do this by placing the seed on the levelled soil surface and gently pushing each in with a pencil marked to the required depth. Cover seed holes with a little more soil and water gently.

Alternatively, place a layer of moist soil in the tray and level it to the depth of sowing that will be required. Place the seeds as 10 rows of 10 seeds in a grid on the seedbed formed. Then uniformly fill the tray with soil to the required depth of seed coverage

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(i.e. seeding depth). Ensure that the soil surface is uniformly levelled, and water gently if required.

During the test, keep the soil moist but not wet. Overwatering will result in fungal growth and possible rotting. After 7–14 days, the majority of viable seeds will have emerged. Count only normal, healthy seedlings. The number of normal and vigorous seedlings that you count will be the germination percentage.

This germination test is partly a form of inbuilt vigour testing because it is done in soil. To further establish vigour under more adverse conditions, a second germination test done under colder or wetter conditions could be used as a comparison to the normal germination test done at the same time. [13]

Figure 8: *Doing your own germination test.*

Photo: E. Leonard, AgriKnowHow

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