



WESTERN
SEPTEMBER 2018

GRDC™ **GROWNOTES™**



GRDC™
GRAINS RESEARCH
& DEVELOPMENT
CORPORATION

CHICKPEA

SECTION 2

PRE-PLANTING

CHOOSING A VARIETY | VARIETAL PERFORMANCE AND RATINGS YIELD |
PLANTING SEED QUALITY | FUTURE BREEDING DIRECTIONS

Pre-planting

Key messages

- In variety choice, consider yield and adaptation to the area, disease resistance, grain quality, marketability and proximity to receival point.
- Be aware of the specific management needs for the variety chosen through its variety management package (VMP).¹
- Kabuli chickpea provides a very profitable cropping option to Western Australian grain growers when produced under the right conditions and management.
- Test for seed quality in terms of germination and vigour prior to sowing. Only sow the highest quality seed.
- If using grower-retained seed, ensure it has been stored correctly; i.e. at the right moisture and temperature, and for no longer than 12 months. This is because rapid deterioration of grain quality occurs under conditions of high temperature/moisture and with poor seed quality including weathered, cracked and diseased seed.

Agronomist's tip: It is recommended that any seed stored longer than 12 months be tested for viability, especially if storage facilities may not be up to recommended storage standards.

2.1.1 Choosing a variety

Choosing a variety that has been bred for, and proven in, the western grains region is the first step in successful chickpea production (Figure 1). Understanding varietal ratings with respect to diseases and their control is a key part of risk management.



Figure 1: Chickpea trials test for varietal differences.

Source: Flickr

¹ DAFWA. Desi Chickpea Essentials. <https://www.agric.wa.gov.au/chickpeas/desi-chickpea-essentials>

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The availability of varieties resistant to Ascochyta blight now provides growers with low disease-risk options for growing chickpeas in Western Australia (WA). Ascochyta blight of chickpeas has been a widespread and devastating disease in all Australian grain regions, and unless resistant varieties are used, it can be a major limitation when growing this crop.

Chickpea crops in southern Australia and isolated parts of northern Australia are being hit by a more virulent strain of the damaging ascochyta blight. Pulse pathologists in Victoria and South Australia have noted a marked decline in the resistance of several varieties of chickpeas, with varieties previously rated as moderately resistant performing like susceptible lines.² There have been no reported cases of this new Ascochyta blight strain in WA.

Some varieties with Ascochyta blight resistance that are available to growers may have other agronomic, disease or marketability limitations and will not suit all areas or situations.

When choosing varieties to grow, it is essential to consider their susceptibility to Ascochyta blight along with yield potential, price potential, marketing opportunities, flowering cold tolerance, maturity timing, lodging resistance and other agronomic features relevant to your growing region.

When comparing yields between varieties, growers need to be aware that where Ascochyta blight pressure is high, varieties with moderate resistance, or less, are more likely to suffer greater yield losses than the resistant lines, even with regular applications of foliar fungicides.

Area of adaptation

Chickpea varieties are bred for and selected in a range of environments. Hence, individual varieties have specific adaptations to help maximise yield and reliability under particular conditions. These conditions include rainfall, geography, temperatures, disease pressure and soil type.

The national chickpea area has been categorised by Pulse Breeding Australia (PBA) into five regions based on rainfall and geographic location. The Western Australia growing region includes:

- 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 programs and variety evaluation. Breeding trials and National Variety Trial (NVT) results help indicate specific adaptation, even within a region. The area of adaptation is specified for each variety so potential users are aware of their best fit.³

Evaluation of yield potential

When choosing a variety, many factors must be considered, including disease susceptibility, paddock suitability, seed availability, seed size and sowing rate (with reference to sowing machinery), seed cost, harvesting ease and marketing options.

The most accurate predictor of a variety's performance is a stable yield in many locations over several years. Yield results from Pulse Breeding Australia (PBA) and National Variety Trials (NVT) are available from the [NVT website](#), as well as from the specific [Pulse Variety Management Package \(VMP\) brochure](#).⁴

Long-term yields can be represented in several different ways but are typically displayed either as site-specific, averaged over multiple years, or for each year averaged over multiple sites for a region.

² Heard G. (2016). Ascochyta pressure on chickpeas <http://www.stockandland.com.au/story/4085979/ascochyta-pressure-on-chickpeas/>

³ G Cumming (2014) Chickpea varieties selecting horses for courses. GRDC Update Papers 5 March 2014, <http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Chickpea-varieties-selecting-horses-for-courses>

⁴ G Cumming (2014) Chickpea varieties selecting horses for courses. GRDC Update Papers 5 March 2014, <http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Chickpea-varieties-selecting-horses-for-courses>

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In association with Pulse Australia and its commercial seed partners, PBA launches its new varieties at targeted pulse field days during the spring field-day circuit. This gives growers and advisors the opportunity to view and assess the varieties in their growing regions prior to their availability.

A Variety Management Package (VMP) is released with each new PBA variety. The brochures provide information about appropriate agronomic and disease management and disease ratings for each variety.

The information in the brochures is compiled from agronomic and disease management projects funded by the Grains Research and Development Corporation (GRDC) in conjunction with the PBA partner agencies, combined with yield data from variety trials conducted by both PBA and NVT.⁵

2.2 Varietal performance and ratings yield

Table 1: Varieties and varietal traits for chickpeas in WA




Variety	Yield ability	Quality traits	Maturity	Other varietal traits
Desi				
<p>PBA Striker®</p>  <p>PBA Striker® Released: 2012 Seed weight: 21–23 g/100 Production region: South and West</p>	<p>Highest yielding desi chickpea variety across all chickpea-growing areas of Western Australia, and produces high yields in the low-to-medium rainfall areas of southern Australia. Yields of PBA Striker® are substantially higher (7–13%) than PBA Slasher® and Genesis™ 836 in Western Australia</p>	<p>Suitable for both splitting and direct consumption use by traders in India and the Middle East. Medium-sized desi seed with excellent milling quality, larger seed size than PBA Slasher® and Genesis™ 836</p>	<p>Improved early vigour compared to PBA Slasher®, with early flowering and early maturity. PBA Striker® flowers 5–7 days earlier than PBA Slasher® and is earlier maturing than PBA Slasher® and Genesis™ 836</p>	<p>Moderately Resistant (MR) to Ascochyta blight, it is a semi-spreading plant type similar to PBA Slasher®. Plant height and lowest pod height is similar to PBA Slasher®, but lower than Genesis™ 836</p>
<p>PBA Slasher®</p>  <p>PBA Slasher® Released: 2009 Seed weight: 18–22 g/100 Production region: South</p>	<p>Excellent adaptation to all areas of southern and western Australia. Yields of PBA Slasher® are 5–7% higher than Genesis™ 836 in Western Australia</p>	<p>Assessed as suitable for both splitting and direct consumption use by traders in India and the Middle East. Medium-sized desi seed with good milling quality, with higher dehulling efficiency and dhal (splits) yield than Genesis™ 836</p>	<p>Mid-flowering and mid-maturity. PBA Slasher® flowers 3–7 days earlier than Genesis™ 836, and is earlier maturing than Genesis™ 836</p>	<p>Combines Ascochyta blight resistance, rated as Resistant (R) to Ascochyta blight, high yield and good seed quality. Semi-spreading plant type. Plant height and lowest pod height is lower than Genesis™ 836</p>

⁵ Pulse Breeding Australia. PBA Varieties and brochures. GRDC Major Initiatives, <http://www.grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures>

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Variety	Yield ability	Quality traits	Maturity	Other varietal traits
<p><u>Neelam</u>(D)</p>  <p>PBA Slasher(D)</p> <p>Released: 2009 Seed weight: 18–22 g/100 Production region: South</p>	<p>Highest yielding Resistant (R) Ascochyta blight rated desi chickpea variety. Yields of Neelam(D) are 2–5% higher than PBA Slasher(D) in Western Australia</p>	<p>Desi type chickpea suitable for the whole and splitting human food markets. Seed size is 17 grams/100 grams (g), marginally larger than Genesis™ 836, similar to PBA Slasher(D). However, its seed coat colour is lighter than PBA Slasher(D)</p>	<p>Mid-flowering and mid-maturity variety similar to Genesis™ 836</p>	<p>Resistant (R) Ascochyta blight rated. Medium/tall plant height, taller than PBA Slasher(D) and similar to Genesis™ 836</p>
<p><u>Ambar</u>(D)</p>  <p>Ambar(D)</p> <p>Released: 2013 Seed weight: 16–20 g/100 Production region: West and South</p>	<p>Well-adapted to most of southern Australia, particularly suited to the northern wheatbelt of Western Australia. Ambar(D) yields are similar to PBA Slasher(D)</p>	<p>Desi type chickpea suitable for the whole and splitting human food markets. Seed size is similar to Genesis™ 836 at 16 g/100 g. However, its seed coat colour is lighter than PBA Slasher(D)</p>	<p>Earliest flowering and earliest maturing of all current desi chickpea varieties, making it particularly well-suited to shorter growing season (low rainfall) environments</p>	<p>Rated as Resistant (R) to Ascochyta blight. Bushy growth habit with profuse branching, it has a short/medium plant height, slightly shorter than PBA Slasher(D)</p>
<p><u>PBA Maiden</u>(D)</p>  <p>PBA Maiden(D)</p> <p>Released: 2013 Seed weight: 21–25 g/100 Production region: South and West</p>	<p>It is broadly adapted to WA regions and has shown similar yields to PBA Slasher(D)</p>	<p>Largest seed size of current southern desi chickpea varieties (28% larger than PBA Slasher(D)). Targeted for whole seed markets</p>	<p>Moderate early vigour. Early to mid-flowering and maturity. Semi spreading plant type</p>	<p>Moderately Resistant (MR) to Ascochyta blight</p>

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Variety	Yield ability	Quality traits	Maturity	Other varietal traits
<p><u>Genesis™ 510</u></p>  <p>Genesis™ 510 Released: 2008 Seed weight: 14–18 g/100 Production region: West</p>	Highest yielding desi under strong Ascochyta disease pressure	A desi type with small sized grain	Broadly adapted, mid to early flowering variety with medium plant height and good harvestability. It suits many farming systems, including inter-row sowing into standing stubbles and wider (>30 cm) row spacings	Ascochyta resistant desi chickpea release in Western Australia only. Requires one fungicide application for control of Ascochyta blight
<p><u>Genesis™ 836</u></p>  <p>Genesis™ 836 Released: 2006 Seed weight: 16–20 g/100 Production region: West</p>	A tall, erect and high yielding variety in WA, under moderate Ascochyta blight	Small sized desi grain is produced	Broadly adapted, mid to late flowering variety with good plant height and harvestability. It suits many farming systems including inter-row sowing into standing stubbles and wider (>30 cm) row spacings	A desi chickpea with moderately resistance to Ascochyta blight released for WA only. Requires two fungicide applications to control Ascochyta blight
<p>Kabuli</p> <p><u>Genesis™ 079</u></p>  <p>Genesis™ 079 Released: 2010 Seed weight: 20–30 g/100 Production region: South</p>	Highest yields in short season environments than current varieties	Budget for grain prices at lowest end of small kabuli range, due to 6–7 mm seed	A small seeded kabuli (predominantly 6–7 mm) with smaller seed than Genesis™ 090. Early maturity and uniform short plant height offers improved potential for agronomic weed control options under some conditions	Resistant to foliar Ascochyta blight. A small seeded kabuli (predominantly 6-7 mm) with smaller seed than Genesis™ 090 (predominantly 6-7 mm). Susceptible to Phytophthora

Sources: [Pulse Australia](#), DAFWA

2.3 Planting seed quality

High quality seed is essential to ensure the best start for your crop. Grower-retained seed may be of poor quality with reduced germination and vigour, as well as potentially being infected with seed-borne pathogens. No matter whether chickpea seed is acquired commercially or grower retained on-farm, it is important to use the highest possible quality. Poor quality seed can result in low plant establishment due to poor germination, vigour and/or seed-borne diseases such as Ascochyta blight and Botrytis grey mould (BGM).

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- All seed should be tested for quality including germination (high germination—above 80%) and vigour (AA test). Use large, graded seed.
- Use seed at low risk of *Ascochyta* blight infection.
- If grower-retained seed is of low quality, consider purchasing registered or certified seed from a commercial supplier. Always ask for a copy of the germination report.
- Regardless of the source, evenly treat seed with a thiram-based fungicide.
- Careful attention should be paid to the harvest, storage and handling of grower-retained seed intended for sowing.
- Calculate seeding rates in accordance with seed quality (germination, vigour and seed size).

High quality seed is vital (Figure 2). Check seed labels for germination percentage and purity, and ask for the germination certificate. The results of a germination test must be supplied with all seed for sale. Take the additional precaution of having the seed tested for both *Ascochyta* and *Botrytis* grey mould. Harvesting on time minimises the development of disease on seed.⁶



Figure 2: Poor quality seed (left) all sown on the same day.

Source: [Pulse Australia](http://www.pulseaustralia.com.au)

Effect of poor quality seed on yield

Seed quality problems often emerge only if 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 impact on seed quality.

Using severely weather damaged or mechanically damaged seed will result in:

- poor establishment and poor crop performance
- reduced plant vigour (increased susceptibility to soil-borne pathogens during establishment and increased susceptibility to foliar pathogens)
- patchy, uneven plant stands (increased susceptibility to weed competition, aphids and viruses)
- uneven plant development complicating in-crop management (e.g. herbicide applications)
- uneven and delayed crop maturity (e.g. making desiccation timing difficult and leading to a mixed grain sample)
- lower yields from a combination of all of the above

As a general guide, weather damaged seed with lower than normal germination and vigour levels should only be sown under very good conditions (for rapid

⁶ Pulses Australia. Chickpea Production: Southern and Western region. <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/southern-guide>

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[Chickpea: High Quality Seed](#)

establishment) and at a higher seeding rate. Such seed is not recommended for deep sowing or moisture seeking.⁷

The large size or fragile nature of pulse seed, particularly lupin, kabuli chickpea and faba bean, makes them more vulnerable to mechanical damage during harvest and handling. This damage is not always visually apparent and can be reduced by operations such as slowing header drum speed and opening the concave, or by reducing auger speed and lowering the flight angle and fall of grain. A rotary header and a belt elevator are ideally suited to pulse grain and can reduce seed damage, which can result in abnormal seedlings that germinate but do not develop further.

Under ideal conditions, abnormal seedlings may emerge but lack vigour, making them vulnerable to other rigours of field establishment. Factors such as low temperature, disease, insects, seeding depth, and soil crusting and compaction are more likely to affect the establishment of weak seedlings. Those that do emerge are unlikely to survive for long, will produce little biomass and make little or no contribution to final yield.⁸

Grower-retained seed

Grower-retained sowing seed should always be harvested from the best part of the crop where weeds and diseases are absent and the crop has matured evenly. Seed should be harvested first to avoid low-moisture grain, which is more susceptible to cracking. Seed moisture of 11–13% is ideal. Weeds, other grains, or disease contamination from other pulse crops should be avoided when selecting parts of the paddock for seed harvest.

Seed quality may be adversely affected by several factors including:

- early desiccation resulting in high levels of green immature seed and smaller seed size (affecting both germination and vigour)
- cracking of the seed coat, if the seed is exposed to several wetting and drying cycles. As the seed coat absorbs moisture, it expands and then contracts as it dries. This weakens the coat, increasing the risk of mechanical damage during harvesting and handling operations
- mechanical damage can result in reduced germination and vigour and increased susceptibility to fungal pathogens in the soil at sowing (exacerbated if establishment is delayed into cold wet soils)
- delayed harvest due to wet weather can lead to increased *Helicoverpa* (Native budworm or heliothis) damage, mould infection, and risk of late *Ascochyta* seed infection
- harvesting at a moisture content >15% can lead to problems with moulds and fungal pathogens colonising on the seed coat during storage
- harvesting at a moisture content <10% can result in mechanical damage to the seed coat and/or seed splitting, which is compounded each time the seed is handled
- poor (temporary) storage in the rush to get harvest done in wet weather can reduce viability of the seed resulting in poor germination and emergence
- using chickpea seed which was 'shot and sprung' when harvested is not recommended. The chickpea is a relatively large seed that requires considerable moisture for germination to begin. Unlike cereal grains with higher starch content, once the chemical process has started and an embryo formed, the seed will continue to germinate, use up its energy reserves and die due to lack of follow-up moisture while in storage
- seed-borne diseases such as *Ascochyta* blight and *Botrytis* grey mould (and/or in contamination with *sclerotinia*) all reduce the viability of the seed (germination

⁷ L Jenkins, K Moore, G Cumming. Pulse Australia. Chickpea: High Quality seed. <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/high-quality-seed>

⁸ Pulse Australia (2013) Northern chickpea best management practices training course manual—2013, Pulse Australia Limited.

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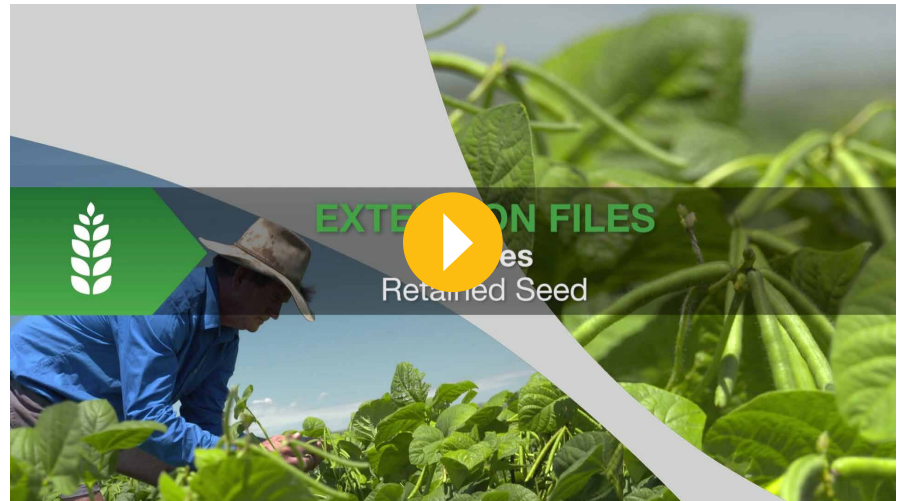
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and vigour). Crop establishment is reduced, and any surviving infected seedlings act as an inoculum source to initiate disease infection within the new crop⁹

NOTE: Do not use any seed that has come from pulse crops harvested from a paddock that was desiccated with glyphosate. Germination, normal seedling count and vigour are affected by its use. Read the glyphosate label.

WATCH: [GCTV16: Extension Files – Retained Pulse Seed](#)



Grading

Chickpea seed for sowing should be professionally graded (preferably using a gravity grader) to provide a uniform seed lot and remove all small or split seeds, trash and weed seeds. A gravity grader is more efficient at removing lighter seeds, which are often disease infected. A higher proportion of small, shrivelled and light-weight grain can be expected in crops that have experienced high incidences of *Ascochyta* and or *Botrytis* grey mould.

Handling seed

The large size, awkward shape and fragile nature of many pulses mean 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.

- Plan ahead so that handling can be kept to a minimum, to reduce damage between harvest and seeding.
- Augers with screen flighting can damage pulses, especially to larger seeded crops. This problem can be partly overcome by slowing down the auger.
- 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.
- Augering 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.

⁹ L Jenkins, K Moore, G Cumming. Pulse Australia. Chickpea: High Quality seed. <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/high-quality-seed>

2.3.1 Testing for seed quality

The only way to accurately know the seed's germination rate, vigour, and disease level is to have it tested. Seed-borne diseases can lower germination levels, and testing for presence in seed can be conducted by specialist laboratories for a number of diseases such as *Ascochyta* blight in chickpeas. Seed with poor germination potential or high levels of seed-borne disease should not be sown. Cheaper costs of this seed will be offset by higher sowing rates needed to make up for the lower germination and there is potential to introduce further disease on to the property.

For more information, see Section 2.3.3 Seed germination and vigour, below.

2.3.2 Seed size

Seed size can affect the seedling vigour in grain legumes where large seed produce more vigorous plants and may affect yield.¹⁰

Seed size can be quickly calculated at home by counting out 200 seeds and weighing—multiply the weight (grams) by five to get a 1000-seed weight. Or divide 200,000 by the weight (grams) to get number of seeds per kilogram (depending on your preferred method of calculating seeding rates).

Conducting both the germination test and seed size test on several batches of seed (i.e. at least twice) is recommended, to get a more accurate assessment of the sample.

2.3.3 Seed germination and vigour

Grain legumes often have poor seedling vigour which may reduce their competitiveness with weeds and pests. Low seedling vigour can also cause low Water Use Efficiency because of the long time to full canopy closure. Efforts that lead to improved seedling vigour among grain legumes may therefore be useful to improve yield and Water Use Efficiency. It has been suggested that there are inherent genetic differences in seedling vigour both between species and between varieties.¹¹

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.

Grower retained seed should be tested for germination and vigour at least twice:

- Immediately post-harvest, to assess if the seed is worth retaining or better sold for grain or fed to livestock.
- Just before sowing, after grading and treatment with fungicide seed dressing, so seeding rates can be adjusted to compensate for any decline in quality during storage over summer.

Weather-damaged seed deteriorates quicker than usual in storage and a third test in mid-storage is advised. This will indicate if the seed is still suitable for sowing and if not, allows time to consider other options.

Pulse seed should have a minimum germination of 80% to be kept for sowing. Seeds that do germinate from a tested batch with only a 50% germination rate will have low vigour. Avoid using seed with such low rates of germination.

Whilst increasing the seeding rate of poor quality seed may seem reasonable, it carries a high risk of seedling disease. If the poor quality is caused by seed-borne pathogens, the seed will be a source of infection for healthy seed and seedlings.

Simple germination tests can be done at home at any time over summer as temperature does not affect the results. For beans, chickpea, lupins, peas and vetch,

¹⁰ J Kamboozia, G McDonald, H Reimers. (1993). The effect of seed size, seed protein and genotype on seedling vigour in some grain legumes. 7th Aust. Agron. Conf.©, SARDI.

¹¹ J Kamboozia, G McDonald, H Reimers. (1993). The effect of seed size, seed protein and genotype on seedling vigour in some grain legumes. 7th Aust. Agron. Conf.©, SARDI.

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the sample size required is 1 kg for each 25 t of seed. There are two quick methods that both require 100 seeds for the test:

- Method 1: Place 100 seeds between at least four sheets of paper towel, roll up, fold the ends over and soak in fresh water for 30 minutes. Drain, put the 'seed doll' in a tray and place on the kitchen bench or workshop table. Ensure 'seed doll' does not dry out. After three, four, and five days unwrap 'doll', remove germinated seeds, taking a note of their vigour and re-wrap the 'doll'. After the fifth day, count the non-germinated and mouldy seeds.
- Method 2: Fill a flat shallow (5 cm deep) garden tray or non-rusty baking tray with clean sand, potting mix or freely draining soil. On the soil surface arrange your 100 seeds in 10 rows and push the seeds into the soil with a pencil marked to a depth of 3 cm (Figure 1—right). Cover with a little more sand/soil and water gently. Keep soil moist but not wet as overwatering will result in fungal growth and possible rotting.

A germination test does not always accurately predict emergence. For a valuable crop like chickpeas a laboratory test should be used. Growers can also conduct their own emergence test, as per method 2. If this is conducted in the intended paddock this will also help to identify potential herbicide residue problems.

After 7–10 days the majority of viable seeds will have emerged (Figure 3—left). Count only the normal and healthy seedlings. If left for another few days you will also be able to assess how many of the germinated seeds are actually deformed (e.g. missing cotyledons or mould/disease affected), which will also give some indication of vigour.¹²



Figure 3: *Doing your own germination test (left) Seedling growth after 12 days and after 5 days (right)*

Photo: E. Leonard, Kevin Moore. Source: [Pulse Australia](http://www.pulseaustralia.com.au)

Sampling should be random and numerous subsamples should be taken to give best results. Sample either while seed is being moved out of the seed cleaner, storage or truck, or otherwise from numerous bags. Do not sample from within a silo or a bagging chute, as it is difficult to obtain a representative sample and is dangerous. Failure to sample correctly or test your seed could result in poor establishment in the field.

If an issue is suspected with kept grain, then it is better to get a sample tested early to avoid the cost of grading and time lost to procure suitable seed.

Testing seed vigour

Seed vigour is more accurately assessed by commercial laboratories as the assessment method is both temperature and time based. The seedling vigour test will also provide a better indication of the number of abnormal seeds present in addition to the germination percentage.

In years of drought or a wet harvest, seed germination can be affected, but also more importantly, seedling vigour can be reduced. Poor seedling vigour can heavily affect establishment and early seedling growth. This can often occur under more difficult

¹² L Jenkins, K Moore, G Cumming. Pulse Australia. Chickpea: High Quality seed. <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/high-quality-seed>

establishment conditions such as deep sowing, crusting, compaction, wet soils, or when seed treatments have been applied. Some laboratories also offer a seed vigour test when doing their germination testing. Vigour represents the rapid, uniform emergence and development of normal seedlings under a wide range of conditions. Several tests are used by seed laboratories to establish seed and seedling vigour.

Cool germination and cold tests

A cool or cold test is done 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. It is also one of the oldest vigour tests.

This test is used to:

- 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, with variations between laboratories) for a period, 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.

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 of normal germination after ageing (vigorous seedlings).

Conductivity vigour test

The conductivity test measures electrolyte leakage from plant tissues and is one of two ISTA-recommended vigour tests. Conductivity test results are used to rank vigour lots by vigour level. It is important to have a germination test done too, because a conductivity test cannot always pick up all chemical and pathogen scenarios, which may be seed-borne.

Tetrazolium test (TZ) as a vigour test

The tetrazolium test is used to test seed viability, but is also useful as a rapid estimation of vigour of viable seeds. It is done in the same way 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 is completely stained or embryonic axis stained in dicots. Extremities may be unstained. Some over-stained or less firm areas exist.
- Low Vigour—large areas of non-essential structures unstained. Extreme tip of radicle unstained in dicots. Tissue is milky, flaccid, and over-stained.

Results have shown good relationships with field performance, and the test is useful for pulses.

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 can be conducted if requested, including the amount of weed seed contamination. Do not plant seed contaminated with weed seeds.

Disease testing

Seed-borne diseases such as ascochyta blight pose a serious threat to yields. Seed-borne diseases can strike early in the growth of the crop when seedlings are most vulnerable and 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 disease risk. If disease is detected, the seed may be treated with a fungicide before sowing or a clean seed source may be used.

2.3.4 Seed purity

Seed should only be purchased from reliable sources. If growers have any doubts about a seed source then do not use seed. If growers decide to store their own seed they should ensure to keep good records and abide to seed storing recommendations for their area.

Agronomist's view

Accurate identification of chickpea varieties is critical to Ascochyta blight management in commercial crops.

Australian chickpea varieties differ in their reaction to Ascochyta blight. Varieties released before 2005 are susceptible to Ascochyta blight, and (in seasons conducive to disease) require intensive management with foliar fungicides. Most cultivars released in 2005 and later have improved Ascochyta blight resistance, and require fewer fungicide sprays.

Contamination between seed varieties has been found to lead to higher than expected disease susceptibility in moderately resistant crops. Contamination or a mix-up in source of planting seed might account for the observed differences in Ascochyta blight levels in chickpea crops grown from grower-retained seed. This is part of the large issue of maintaining genetic purity in Australian chickpea varieties after their release.

Key findings from chickpea seed purity research:

- DNA evidence has identified genetic contamination in commercial chickpea crops going back to at least 2011.
- Crop inspections have revealed obvious differences among plantings believed by growers to be the one variety.
- Minimise the risk of contamination of your 2014 planting seed by obtaining seed from a registered seed merchant.
- When retaining your own seed, put in place a quality control system to avoid accidental contamination.

The extent of purity contamination is not yet determined however, testing results from 36 seed lots suggest that the seed purity problem is far bigger than currently thought. Although the problem first surfaced in 2011, pathologists say it appears to be getting worse (Figure 4).



Figure 4: As the issue of seed purity increases, growers should treat crops from suspect seed as a susceptible variety.

Photo: Rachel Bowman, Seedbed Media

Accurate identification of chickpea variety is essential for:

- implementing appropriate disease-management strategies
- minimising the risk to resistance genes in moderately resistant varieties from increased inoculum generated on contaminant plants or 'mix up' crops of susceptible varieties
- maximising marketing opportunities by producing pure seed of one variety
- supporting grower's legal rights (e.g. if the seed you purchased is not what you paid for)
- assessing compliance with plant breeder's rights legislation, thus ensuring breeding programs receive the appropriate royalties
- prolonging the commercial life of new varieties
- providing confidence in the chickpea seed industry
- providing technical support to research programs (e.g. knowing the genotype of a plant from which an isolate is obtained is critical to the current GRDC project on the variability of the Australian population of the chickpea *Ascochyta* blight pathogen).¹³

¹³ K Moore, K Hobson, A Rehman, J Thelander (2014) Chickpea varietal purity and implications for disease management. GRDC Update Papers 5 March 2014, <http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Chickpea-varietal-purity-and-implications-for-disease-management>

WATCH: [Chickpea seed quality – Kevin Moore, 2013.](#)



2.3.5 Seed storage

Storing pulses successfully requires a balance between ideal harvest and storage conditions. Harvesting at 14% moisture content captures grain quality and reduces mechanical damage to the seed but requires careful management to avoid deterioration during storage.

Tips for storing pulses:

- Pulses stored at >12% moisture content require aeration cooling to maintain quality.
- Meticulous hygiene and aeration cooling are the first lines of defence against pest incursion.
- Fumigation is the only option available to control pests in stored pulses, and requires gas-tight, sealable storage.
- Avoiding mechanical damage to pulse seeds will maintain market quality, seed viability and be less attractive to insect pests.¹⁴

Most pulse seed should only be stored for 12 months, although longer storage periods are possible with high quality seed provided both grain moisture and temperature within the silo can be controlled. Rapid deterioration of grain quality occurs under conditions of high temperature/moisture and with poor seed quality including weathered, cracked and diseased seed.

Ideally, chickpea needs to be stored at 13% moisture content and at temperatures below 30°C. Storage at very low moisture contents (< 10%) may make chickpeas (particularly kabuli types) more susceptible to damage during subsequent handling, as the seed shrinks away from the seed coat.

Like other grain, chickpea seed quality deteriorates in storage. Most rapid deterioration occurs under conditions of high temperature and moisture. Crops grown from seed that has been stored under such conditions may have poor germination and emergence.

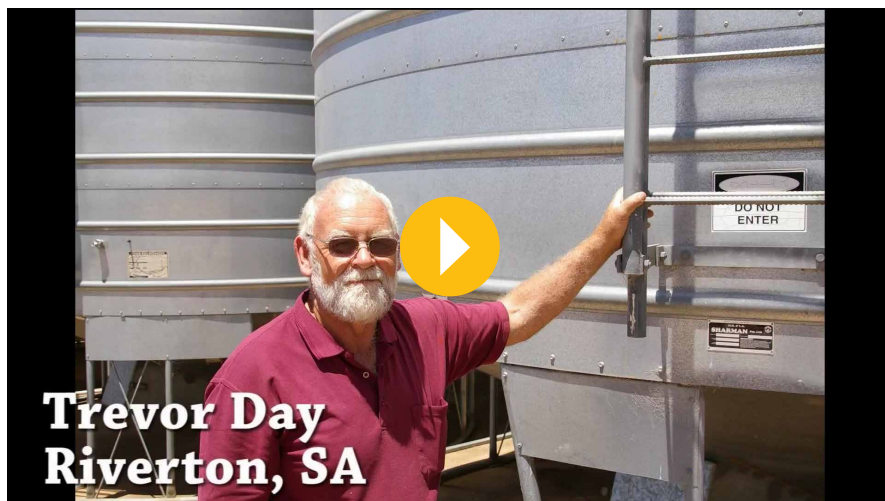
Reducing temperature in storage facilities (to below 30°C) is the easiest method of increasing seed longevity. Temperatures can be reduced in grain silos by painting the outside of the silo white (temperatures reduced by 4–5°C), and/or aerating silos with dry, ambient air.

¹⁴ GRDC (2012) Storing pulses. GRDC Grain Storage Fact Sheet July 2014, <http://grdc.com.au/Resources/Factsheets/2014/07/Grain-Storage-Fact-Sheet-Storing-Pulses>

Reducing 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 safe storage life of grains.
- Aerate silos with dry, ambient air. This option is more expensive, but in addition to reducing storage temperatures, is also effective in reducing moisture of seed harvested at high moisture content.
- Heat drying of chickpea sowing seed should be limited to temperatures $\leq 40^{\circ}\text{C}$.¹⁵

WATCH: Over the Fence: [Ensure seed viability with aerated storage.](#)



Insect pests in storage

Insects are generally not considered to be a major problem in stored chickpea seed. However, where a prior infestation exists in the storage structure (most commonly as a result of cereal grain residue) then the infestation can develop and spread in the chickpeas. Ensure all handling equipment and storages are cleaned of old cereal grain before they are used to handle chickpeas. Good hygiene, combined with aeration cooling, should prevent infestations developing. If insect pests are found in stored chickpeas, the only registered treatment is phosphine fumigation.

For more information, see Section 13: Storage.

2.3.6 Safe rates of fertiliser sown with the seed

All pulses can be affected by fertiliser toxicity. Higher rates of phosphorus (P) fertiliser can be toxic to establishment and nodulation if drilled in direct contact with the seed at sowing. Practices involving drilling 10 kg/ha of P with the seed at 18-cm row spacing through 10 cm points rarely caused any problems. However, with the changes in sowing techniques to narrow sowing points, minimal soil disturbance, wider row spacing, and increased rates of fertiliser (all of which concentrate the fertiliser near the seed in the seeding furrow), the risk of toxicity is higher. Agronomists, however, can present anecdotal reports where toxicity has not been a problem.

The effects are also increased in highly acidic soils, sandy soils, and where moisture conditions at sowing are marginal. Drilling concentrated fertilisers to reduce the product rate per hectare does not reduce the risk.

The use of starter nitrogen (N), such as DAP, banded with the seed when sowing pulse crops has the potential to reduce establishment and nodulation if higher rates are used. On sands, up to 10 kg/ha of N at 18-cm row spacing can be safely used. On clay soils, do not exceed 20 kg/ha of N at 18-cm row spacing.¹⁶

i MORE INFORMATION

[Storing pulses](#)

¹⁵ L Jenkins, K Moore, G Cumming. Pulse Australia. Chickpea: High Quality seed. <http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/high-quality-seed>

¹⁶ GRDC (2008) Grain Legume Handbook update 7 Feb 2008. Grain Legume Handbook Committee, supported by the Grains Research and Development Corporation (GRDC), <https://grdc.com.au/uploads/documents/3%20Seeding.pdf>

Banded potassium has been shown to be twice as accessible to the crop as top-dressed potassium. This is thought to be related to improved availability for the emerging crop, and decreased availability for weeds. Growers should not band high rates (i.e. >15 kg/ha) particularly with sensitive crops (e.g. chickpea, lupins) and should try to place potassium fertilisers away from the seed. Furthermore, growers should be aware that nutrient auditing requires fertiliser applications to cover potassium export during harvest, and are encouraged to account for variations in yield where possible. If a paddock is severely deficient then potassium needs to be applied early in the season to maximise response to the application. At seeding or up to 4 weeks after will optimise the benefits of potassium application.¹⁷

2.4 Future breeding directions

The current PBA program continues to focus on regional adaptation, higher grain yields and greater levels of varietal resistance to the main two chickpea diseases of *Ascochyta* blight and *Phytophthora* root rot.

Additional valuable traits that the breeding program is working with include:

- resistance to *Botrytis* grey mould
- virus resistance
- improved resistance to root-lesion nematodes (*Pratylenchus thornei* and *P. neglectus*)
- improved tolerance to soil salt levels
- improved reproductive cold tolerance¹⁸

¹⁷ Quinlan R, Wherrett A. (2016). Potassium – Factsheet. Soilquality.org. <http://soilquality.org.au/factsheets/potassium>

¹⁸ G Cumming (2014) Chickpea varieties selecting horses for courses. GRDC Update Papers 5 March 2014 <http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Chickpea-varieties-selecting-horses-for-courses>