SOUTHERN
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LENTIL

SECTION 3

PRE-PLANTING

KEY POINTS | LENTIL TYPES | SELECTION OF VARIETIES | RED LENTIL VARIETIES | GREEN LENTIL VARIETIES | SEED | PBR AND ROYALTIES

Pre-planting

Key points

- Lentil varieties differ physiologically by seed size, seed coat colour, kernel (cotyledon), colour and time to maturity.
- Red lentil is split or de-hulled for human consumption.
- Contamination of 'off-type' lentil varieties can lead to marketing concerns.
- Green lentil is predominantly used whole for cooking.
- Seed coat colour can be influenced by environmental conditions before harvest, post-harvest handling, time in storage and storage method.
- A variety's seed size is influenced by rainfall, soil type and seasonal conditions.
- Disease management is still a primary concern when growing lentil.
- Herbicide-tolerant (XT) lentil varieties are available to assist in weedy situations.
- High-intensity cropping can change the disease resistance ratings of varieties.
- Seed quality is very important in producing high grain yields.
- Quality seed has good germination and vigour.

FEEDBACK

MORE INFORMATION

For more information on variety cross-contamination, see: http://pulseaus.com.au/growing-pulses/bmp/lentil/variety-cross-contamination

3.1 Lentil types

Lentil varieties grown in Australia are divided into two main types. The red lentil types have red cotyledons and the green lentil types have yellow cotyledons.

It is critical that there is not contamination of other variety types in lentils delivered to markets.Variety contamination is restricted to 1% at delivery,and includes lentils of differing seed coat colour or size (even if the seed colour is the same) or type (red vs green).

Table 1: Australian lentil varieties.

Seed coat colour	Seed size and type				
	Small red	Medium red	Large red	Medium green	Large green
Grey	Nipper(b)[1] PBA Bounty(b)[1] PBA Herald XT(b)[2] PBA Hurricane XT(b)[1]	Nugget[3] PBA Ace(b)[3] PBA Blitz(b)[3] PBA Bolt(b)[3] Digger[3]	PBA Jumbo(b)[4] PBA Jumbo2(b)[4]		
Tan	Northfield[1]	–	–	–	–
White – green	–	PBA Flash(b)[3] Cobber[3]	Aldinga[4]	Matilda[5] PBA Greenfield(b)[5]	Boomer[6] PBA Giant(b)[6]

1 SRP = small red (premium round) 2 SRS = small red (split) 3 MRD = medium red (dual purpose) 4 LRS = large red (split)
5 MG = medium green 6 LG = large green

Source: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

3.1.1 Red lentil

Red lentil, sometimes known as small or Persian lentil, is the most commonly grown in Australia and is split or de-hulled for human consumption.[1]

Red lentil is so named because of their red kernel (cotyledon) that is exposed when the seed coat is removed and the seed split.

The cotyledon (kernel) colour required for international trade is red, but seed coat colour can vary from light grey, black to brown or red and may be speckled. The predominant seed coat colour targeted in Australia is grey and this, to a large extent, is genetically determined and highly heritable.[2]

Seed coat colour can be influenced by environmental conditions before harvest, post-harvest handling, time in storage and storage method.

Seed size can vary according to the variety (Table 1) and is influenced by rainfall, soil type and seasonal conditions.

1 Grains Research and Development Corporation (2016) Lentils: The Ute Guide. Grains Research and Development Corporation, https://grdc.com.au/resources-and-publications/all-publications/publications/2008/11/lentils-the-ute-guide

2 Pulse Australia (2016) Southern Lentil: Best Management Practices Training Course. Pulse Australia

FEEDBACK

Photo 1: *Whole red lentils.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

Photo 2: *Split red lentils.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

3.1.2 Green lentil

Green lentil, also known as large or Chilean lentil, is predominantly used whole in cooking.[3]

The seed coat is green to brown and the kernel colour is yellow. Seed size can vary from 6 to 10 mm in diameter. French green lentil, another green type, is a very small, dark-coloured lentil with a green kernel.

The cotyledon (kernel) colour required for international trade is yellow with a green-white seed coat that is unblemished. Colour is genetically determined and highly heritable, but blemishing is weather dependent.

Seed coat colour can be influenced by environmental conditions before harvest, post-harvest handling, time in storage and storage method. Canada sets the market standard for seed size by supplying large (Laird types), medium (Eston types) and small (Richlea types) green lentils.[4]

3 Grains Research and Development Corporation (2016) Lentils: The Ute Guide. Grains Research and Development Corporation, https://grdc.com.au/resources-and-publications/all-publications/publications/2008/11/lentils-the-ute-guide

4 Pulse Australia (2016) Southern Lentil: Best Management Practices Training Course. Pulse Australia.

FEEDBACK

Seed size and market category of current Australian varieties vary between the large and medium grades. There is currently no Australian variety in the small green lentil grade. However, there are breeding lines that could meet this market grade in the future.[5]

A variety's seed size is influenced by rainfall, soil type and seasonal conditions.

Photo 3: *Green lentils.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

3.2 Selection of varieties

MORE INFORMATION

For more information on variety choice in weedy situations see Section 8: Weed control

IN FOCUS

When choosing a variety both marketability and agronomic traits must be considered.

Marketability includes colour, size, shape and texture. Price paid can differ between varieties and premiums or discounts can be based on colour, type, size, and supply and demand.

Lentil varieties differ in their agronomic traits including disease tolerance, yield and time to maturity. Growing more than one variety might be an option for spreading risk.

Disease management is still a primary concern when growing lentil. Varieties must have the desired trait to manage disease for the location grown.

Herbicide-tolerant (XT) varieties may also drive variety choice in weedy situations.

5 Pulse Australia (2016) Southern Lentil: Best Management Practices Training Course. Pulse Australia.

FEEDBACK

MORE INFORMATION

For more information on the development of herbicide tolerance in lentil go to the GRDC website:

Lentil research in progress including herbicide tolerance in the pipeline. https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2015/08/lentil-research-in-progress-including-herbicide-tolerance-in-the-pipeline

Developing improved herbicide tolerance in pulse crops. https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2016/02/developing-improved-herbicide-tolerance-in-pulse-crops

3.2.1 Area of adaptation

Lentil varieties are bred for, and selected in, a range of different environments. Hence, individual varieties have specific areas of adaptation for maximising yield and reliability. Specific adaptation of a variety depends on rainfall, geography, temperature, disease pressure and soil types.

Pulse Breeding Australia has defined five regions in Australia for growing pulses (Figure 4). The production area for lentil is confined to two regions based on rainfall and geographic location:

- Region 4 – medium to high rainfall (Mediterranean/temperate); and
- Region 5 – low to medium rainfall (Mediterranean/temperate).

These regions cross state borders and are target zones for breeding programs and variety evaluation.

Results from breeding and the National Variety Trial (NVT) program highlight specific adaptation of varieties within a region (see Table 2 to Table 9). Some varieties have been found to be better adapted to specific parts of regions.

Lentil varieties are targeted to Regions 4 and 5.

FEEDBACK

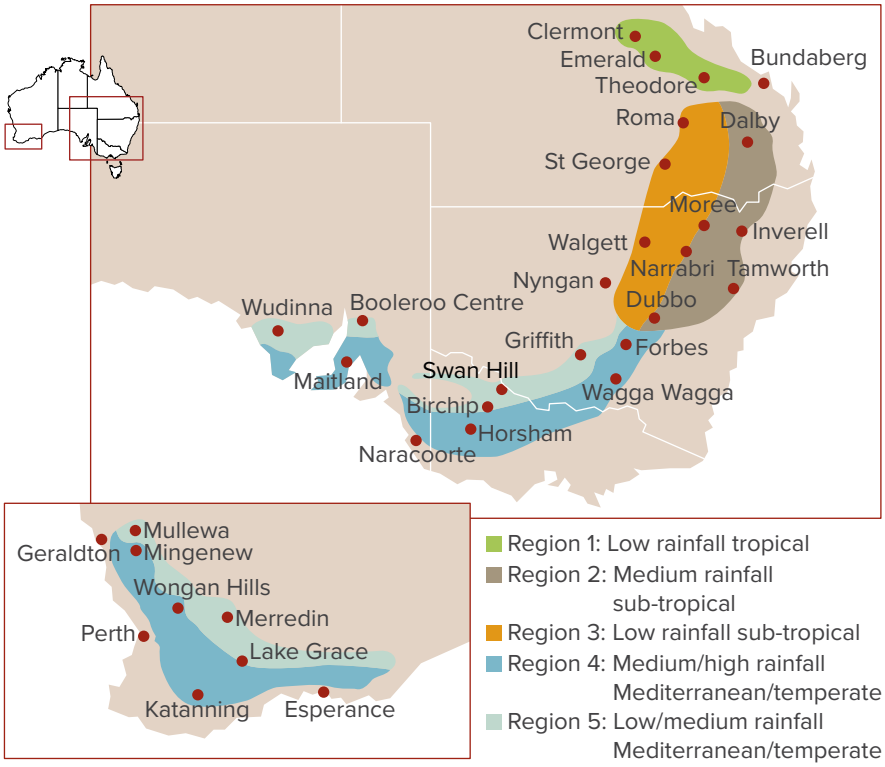

Figure 1: *Regions for growing pulses.*

Source: Pulse Breeding Australia via Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

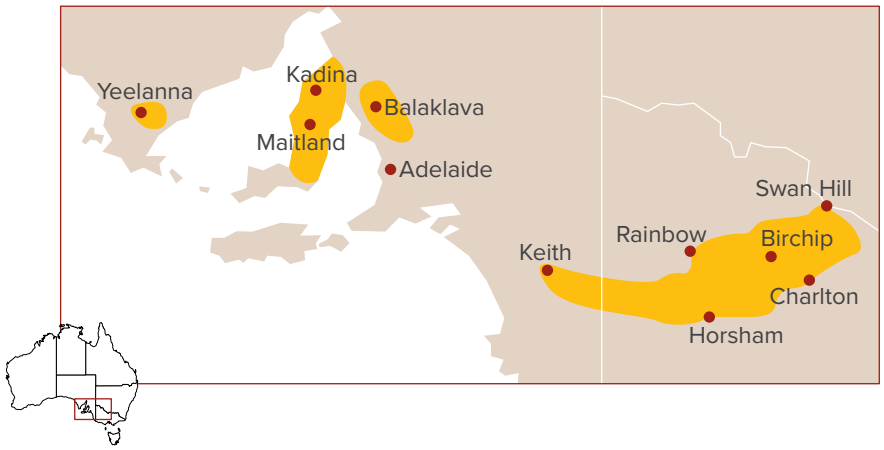

Figure 2: *The principal lentil-growing areas are in South Australia and Victoria.*

Source: Pulse Breeding Australia via Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

FEEDBACK

MORE INFORMATION

For more information see http://pulseaus.com.au/storage/app/media/crops/pulses/2016_Pulse-Variety-Charts-web.pdf

Victorian lentil variety information

For Victorian information on lentil, see the Victorian Winter Crop Summary 2017: http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

South Australian lentil variety information

For South Australian information on lentil, see the SA Sowing Guide 2017: http://www.pir.sa.gov.au/research/services/reports_and_newsletters/crop_performance

New South Wales lentil variety information

Limited research and trials have been conducted on lentil in New South Wales. Consequently, there are no local management guides or yield data for this region. Information should be sourced from South Australia and Victoria.

For specific information on lentil in NSW see:

'Agronomy and production of lentil in southern NSW 2016' by Richards *et al.* (2016): https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Agronomy-and-production-of-lentil-in-southern-NSW-2016

FEEDBACK

3.3 Red lentil varieties

3.3.1 Small red varieties

PBA Hurricane XT$^{\Phi}$

PBA Hurricane XT$^{\Phi}$ is a small, red-seeded lentil with mid flowering and maturity.

PBA Hurricane XT$^{\Phi}$ has tolerance to imazethapyr with an interim permit for pre or post-emergent application to 2017. It has improved tolerance to the herbicide flumetsulam plus reduced sensitivity to some sulfonylurea and imidazolinone herbicide residues.

Product label rates, plant-back periods and all label directions for chemical use must be adhered to when growing PBA Hurricane XT$^{\Phi}$.

PBA Hurricane XT$^{\Phi}$ is the highest yielding small red lentil available in Australia and has improved yields over PBA Herald XT$^{\Phi}$, Nipper$^{\Phi}$ and Nugget, but lower than PBA Ace$^{\Phi}$.[6]

It is moderately resistant (MR) to foliar Ascochyta, resistant (R) to seed Ascochyta and moderately resistant–moderately susceptible (MR-MS) to Botrytis grey mould.

PBA Hurricane XT$^{\Phi}$ was released in 2013 and is commercialised by PB Seeds. It has an End Point Royalty of $5.50 per tonne.

It is adapted to Regions 4 and 5.

MORE INFORMATION

Go to the GRDC website for the brochure on this PBA Hurricane XT$^{\Phi}$: https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

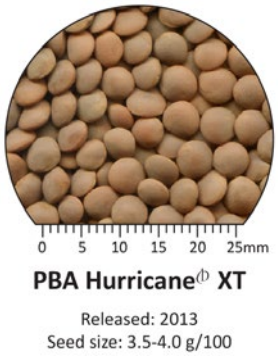

Photo 4: *PBA Hurricane XT$^{\Phi}$.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

6 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

PBA Herald XT$^{\Phi}$

PBA Herald XT$^{\Phi}$ is a small red-seeded lentil best adapted to longer growing seasons with medium to higher rainfall.

PBA Herald XT$^{\Phi}$ was the first lentil with improved tolerance to imazethapyr with an interim permit for pre or post-emergent application to 2017. It has improved tolerance to the herbicide flumetsulam plus reduced sensitivity to some sulfonylurea and imidazolinone herbicide residues.

Product label rates, plant back periods and all label directions for chemical use must be adhered to when growing PBA Hurricane XT$^{\Phi}$.

PBA Herald XT$^{\Phi}$ has been outclassed by the new PBA Hurricane XT$^{\Phi}$.

PBA Herald XT$^{\Phi}$ is R to foliar and seed ascochyta and Botrytis grey mould. Disease resistance assists this variety in achieving high grain quality.[7]

PBA Herald XT$^{\Phi}$ is commercialised by PB Seeds. It has an End Point Royalty of $5 per tonne.

Area of Adaptation: Regions 4 & 5

MORE INFORMATION

Go to the GRDC website for the brochure on PBA Herald XT$^{\Phi}$: https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

Photo 5: *PBA Herald XT$^{\Phi}$.*

Photo: Southern Lentil Best Management Practices Training Course (2016), Pulse Australia

7 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

Nipper(Ф)

Nipper(Ф) is similar to Northfield in many characteristics, including relatively short height and seed shape, but it has a grey seed coat.

Nipper(Ф) is MR-MS foliar Ascochyta blight, MR to seed Ascochyta and resistant to Botrytis grey mould. It is also resistant to the exotic disease Fusarium wilt.[8]

Nipper(Ф) has improved salinity tolerance and generally lodges less than other varieties.

Nipper(Ф) is well established in markets, and has attracted a premium price in some years.

Nipper(Ф) is commercialised by Seednet and has an End Point Royalty of $5.50 per tonne.

It is adapted to Regions 4 & 5.

MORE INFORMATION

For more information on Nipper(Ф) see: http://www.pulseaus.com.au/storage/app/media/crops/2011_VMP-RIentil-Nipper.pdf

Photo 6: *Nipper(Ф).*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

8 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

3.3.2 Medium red varieties

Nugget

Nugget is a mid-season variety with a medium-sized seed and a grey seed coat. It became the market 'standard' for medium-sized lentils with a grey seed coat

Nugget is MR-MS to foliar Ascochyta blight, moderately resistant to seed Ascochyta and resistant to Botrytis grey mould.

Nugget has now been superseded by PBA Jumbo2$^{\Phi}$ (although Jumbo2$^{\Phi}$ is a large-seeded lentil), PBA Ace$^{\Phi}$ and PBA Bolt$^{\Phi}$.

It is adapted to Regions 4 and 5.

MORE INFORMATION

For more information on Nugget see: http://www.pulseaus.com.au/storage/app/media/crops/2011_VMP-RIentil-Nugget.pdf

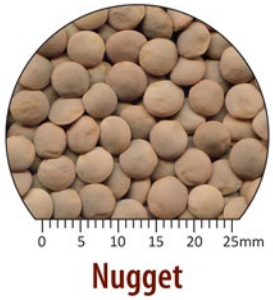

Photo 7: *Nugget.*

Photo: Southern Lentil Best Management Practices Training Course (2016), Pulse Australia

PBA Ace$^{\Phi}$

PBA Ace$^{\Phi}$ is a medium-sized red lentil with grey seed.

Its maturity is mid-season. PBA Ace$^{\Phi}$ has been one of the highest-yielding varieties across all areas, especially in Victoria and New South Wales. It can be lower yielding in short, dry seasons.[9]

PBA Ace$^{\Phi}$ is best suited to longer-season areas replacing Nugget and PBA Jumbo$^{\Phi}$.

PBA Ace$^{\Phi}$ is R to Ascochyta and MR-MS to Botrytis grey mould. It is intolerant to salinity and boron.

PBA Ace$^{\Phi}$ has a high milling quality.

PBA Ace$^{\Phi}$ was released in 2012 and is commercialised by PB Seeds and has an End Point Royalty of $5.50 per tonne.

It is adapted to regions 4 and 5.

Photo 8: *PBA Ace$^{\Phi}$.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

9 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

PBA Blitz$^{\phi}$

PBA Blitz$^{\phi}$ is a medium-sized red lentil with a grey seed coat.

It is an early flowering variety suited to the short growing seasons of South Australia. It is not recommended for Victorian growers.

PBA Blitz$^{\phi}$ has improved early vigour and an erect growth habit which is suited to no-till and inter-row sowing.[10]

PBA Blitz$^{\phi}$ is MR to foliar Ascochyta, MR-MS to seed Ascochyta and MR to Botrytis grey mould.

This variety is intolerant of soil boron and salinity.

It has demonstrated similar but generally improved milling characteristics compared to Nugget.

PBA Blitz$^{\phi}$ was released in 2010 and is commercialised by PB Seeds. It has an End Point Royalty of $5.50 per tonne.

It is adapted to Regions 4 and 5.

Photo 9: *PBA Blitz$^{\phi}$.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

MORE INFORMATION

Go to the GRDC website for the brochure on PBA Blitz$^{\phi}$: https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

10 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

PBA Bolt$^{\phi}$

PBA Bolt$^{\phi}$ is a medium-sized red lentil with grey seed.

It is adapted to the Mallee and northern Wimmera regions of Victoria and the low to medium rainfall zones of South Australia.

While similar to PBA Flash$^{\phi}$ with early to mid maturity and salinity tolerance, it performs better in the southern Mallee as it is MR to foliar Ascochyta blight and R to seed Ascochyta blight. Its susceptibility to Botrytis grey mould makes it less suited to medium to high rainfall areas in wetter years and with early sowing.[11]

Like PBA Flash$^{\phi}$, PBA Bolt$^{\phi}$ is a good variety for timely crop-topping to control weeds.

An erect habit and good lodging resistance make it easier to harvest in dry conditions.

PBA Bolt$^{\phi}$ was released in 2012, is commercialised by PB Seeds and has an End Point Royalty of $5.50 per tonne.

It is adapted to Regions 4 and 5.

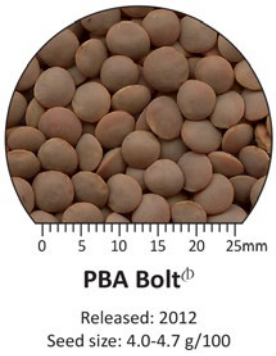

Photo 10: *PBA Bolt$^{\phi}$*.

Photo: Southern Lentil Best Practices Management Training Couse (20160, Pulse Australia

MORE INFORMATION

Go to the GRDC website for the brochure on PBA Bolt$^{\phi}$: https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

11 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

PBA Flash(Φ)

PBA Flash(Φ) is an early-maturing, high-yielding red lentil with a medium seed size. It has a green/white seed coat but is smaller than Aldinga.

It is suited to all current lentil-growing areas; in particular, shorter season growing areas.

PBA Flash(Φ) has improved tolerance to boron and salinity compared to Nugget, which along with its height and erectness, has contributed to its popularity in the Mallee.

It is MS to foliar and seed Ascochyta blight, and MR-MS to Botrytis grey mould. The disease susceptibility of PBA Flash(Φ) means that it is no longer a recommended lentil variety and has now been superseded by PBA Bolt(Φ)

PBA Flash(Φ) has improved standing ability at maturity relative to other lentil varieties, which may make it more prone to pod drop in windy environments, timely harvest is required.[12]

It is well suited to medium red-lentil grain markets, particularly for splitting.

PBA Flash(Φ) was released in 2009 and is commercialised by PB Seeds. It has an End Point Royalty of $5.50 per tonne.

It is adapted to Regions 4 and 5.

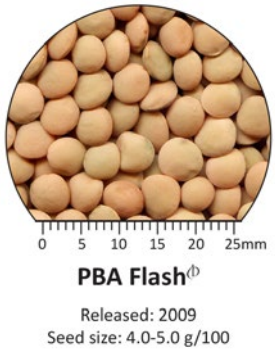

Photo 11: *PBA Flash(Φ).*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

MORE INFORMATION

Go to the GRDC website for the brochure on PBA Flash(Φ): https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

12 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

3.3.3 Large red varieties

PBA Jumbo2Φ

PBA Jumbo2Φ is direct replacement for PBA JumboΦ and Aldinga.

PBA Jumbo2Φ is the highest-yielding large-seeded red lentil, approximately 10% higher than PBA JumboΦ.[13]

PBA Jumbo2Φ is suited to medium to high rainfall regions where it produces uniform larger seed size well suited to premium large red split markets.

It is mid flowering and has a maturity similar to PBA JumboΦ.

PBA Jumbo2Φ has a similar seed size to PBA JumboΦ and Aldinga with a grey seed coat.

It is well suited to no-till inter-row sowing into standing stubble.

PBA Jumbo2Φ is R to Ascochyta and Botrytis grey mould. Its tolerance to soil boron is similar to PBA FlashΦ.

PBA Jumbo2Φ was released in 2014 and is commercialised by PB Seeds with an End Point Royalty of $5.50 per tonne.

It is adapted to Regions 4 and 5.

Photo 12: *PBA Jumbo2Φ.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

MORE INFORMATION

Go to the GRDC website for the brochure on PBA Jumbo2Φ: https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

13 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

PBA Jumbo^{Φ}

PBA Jumbo^{Φ} is suited to medium to high rainfall regions where it produces uniform larger seed size for the premium large red split markets.

PBA Jumbo^{Φ} is a high-yielding, large-seeded red lentil with a grey seed coat.

It is mid-flowering with a maturity similar to Nugget. This variety is suited to no-till inter-row sowing into standing stubble.[14]

PBA Jumbo^{Φ} is MR-MS to foliar Ascochyta blight and S to seed Ascochyta and MS to Botrytis grey mould. The disease susceptibility of PBA Jumbo^{Φ} means that it is no longer a recommended lentil variety and has now been replaced by PBA Jumbo2^{Φ}.

Tolerance to soil boron is similar to PBA Flash^{Φ}.

PBA Jumbo^{Φ} was released in 2010, is commercialised by PB Seeds and has an End Point Royalty of $5.5 per tonne.

It is adapted to Regions 4 and 5.

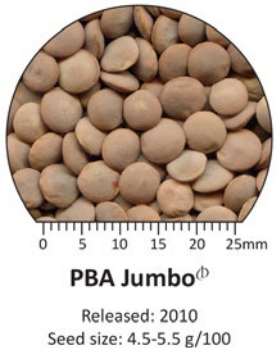

Photo 13: *PBA Jumbo^{Φ}.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

3.3.4 Superseded red lentil varieties

Red lentil varieties that have been superseded by new, improved varieties include:

- Northfield;
- PBA Bounty^{Φ};
- Cassab;
- Cumra;
- Cobber;
- Digger; and
- Aldinga.

Digger and Cobber pioneered the lentil industry in Victoria, while in South Australia, Northfield and Aldinga kicked-started the industry.

More recently, Nugget has been superseded. It was the industry medium-sized standard for some years.

MORE INFORMATION

Go to the GRDC website for the brochure on PBA Jumbo^{Φ}: https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

14 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

3.3.5 Trial data of red lentil varieties

Table 2: Long-term red lentil yields as a percentage of Nugget (2007–2013).

Variety	South Australia					Victoria		New South Wales	
	Yorke Peninsula	Mid North	Lower Eyre Peninsula	Mallee	South East	Wimmera	Mallee	South East	South West
Small red lentil									
Nipper(Φ)	97	96	100	94	96	95	87	85	90
Northfield	88	92	90	91	95	93	92	88	89
PBA Bounty(Φ)	102	102	105	105	92	99	103	109	101
PBA Herald XT(Φ)	90	92	92	102	98	96	93	89	91
PBA Hurricane XT(Φ)	105	107	107*	119	114	110	111	111	104
Medium red lentil									
Nugget	100	100	100	100	100	100	100	100	100
PBA Ace(Φ)	107	111	105	112	99	102	96	124	115
PBA Blitz(Φ)	106	106	115	112	99	102	96	101	93
PBA Bolt(Φ)	101	109	108	126	120	114	119	119	101
PBA Flash(Φ)	105	109	114	116	114	109	103	105	94
Large red lentil									
Aldinga	96	98	99	100	95	97	101	102	97
PBA Jumbo(Φ)	110	108	112	107	103	105	102	106	103
PBA Jumbo2(Φ)	119	117	118*	129*	117*	118	121	126*	117*
Yield of Nugget (t/ha)	**2.78**	**2.28**	**1.40**	**1.22**	**1.59**	**1.51**	**1.13**	**1.15**	**1.31**

* Variety has had limited evaluation in this region so treat results with caution.

Source: NVT, PBA, SARDI, Victoria DPI, NSW DPI

Table 3: Red lentil agronomic traits.

Variety	Seed coat colour	Seed size (as % of Nugget)	Crop vigour	Height	Flowering time	Maturity	Pod drop	Shattering	Boron	Salt
Small red lentil										
Nipper(Φ)	Grey	75–80	Poor/Mod	Short	Mid/Late	Mid	MR	MR	I	MT
Northfield	Tan	80	Poor/Mod	Short	Mid	Mid	MR	MR	I	I
PBA Bounty(Φ)	Grey	90	Moderate	Med/short	Mid/Late	Mid	R	R	I	MI
PBA Herald(Φ) XT	Grey	75	Poor/Mod	Short	Mid/Late	Mid/Late	MR	R	I	I
PBA Hurricane(Φ) XT	Grey	85	Moderate	Medium	Mid	Mid	MR	R	I	I
Medium red lentil										
Nugget	Grey	100	Moderate	Medium	Mid	Mid/Late	MR	R	I	I
PBA Ace(Φ)	Grey	100	Good	Medium	Mid	Mid	R	MR-MS	I	I
PBA Blitz(Φ)	Grey	115–120	Mod/Good	Med/Tall	Early	Early	MR	MR	I	I
PBA Bolt(Φ)	Grey	100	Mod/Good	Medium	Early/Mid	Early/Mid	R	R	MI	MI
PBA Flash(Φ)	Green	100–110	Moderate	Medium	Early/Mid	Early/Mid	MR	MR	MI	MI
Large red lentil										
Aldinga	Green	120	Moderate	Medium	Mid	Mid	MR	MR	I	MI
PBA Jumbo(Φ)	Grey	120	Moderate	Medium	Early/Mid	Mid	MR	MR	MI	I
PBA Jumbo2(Φ)	Grey	120	Mod/Good	Medium	Mid	Mid	MR	R	MI	I

VS = Very Susceptible; S = Susceptible; MS = Moderately Susceptible; MR = Moderately Resistant; R = Resistant. I = Intolerant; MI = moderately Intolerant, MT = Moderately Tolerant.

Source: Pulse Breeding Australia

FEEDBACK

MORE INFORMATION

For detailed disease information go to Section 10: Disease

Table 4: Red lentil disease traits.

Variety	Botrytis grey mould	Ascochyta blight	
		Foliar	Seed
Small red lentil			
Nipper$^{\Phi}$	R	MR-MS	MR
Northfield	S	MR-MS	MR
PBA Bounty$^{\Phi}$	MS	MR-MS	MS
PBA Herald$^{\Phi}$ XT	R	R	R
PBA Hurricane$^{\Phi}$ XT	MR-MS	MR	R
Medium red lentil			
Nugget	MR-MS	MR-MS	MR-MS
PBA Ace$^{\Phi}$	MR-MS	R	R
PBA Blitz$^{\Phi}$	MR	MR	MR-MS
PBA Bolt$^{\Phi}$	S	MR	R
PBA Flash$^{\Phi}$	MR-MS	MS	MS
Large red lentil			
Aldinga	MS	MR-MS	MS
PBA Jumbo$^{\Phi}$	MS	MR-MS	S
PBA Jumbo2$^{\Phi}$	R	R	R

VS = Very Susceptible; S = Susceptible; MS = Moderately Susceptible; MR = Moderately Resistant; R = Resistant

Source: Pulse Breeding Australia

Due to the high intensity of lentil cropping on the Yorke Peninsula and in the Lower Mid North of South Australia changes have occurred in the virulence of Ascochyta blight pathogens. This has resulted in increased levels of infection of Ascochyta blight in PBA Flash$^{\Phi}$ and Nipper$^{\Phi}$, and, to a lesser extent, PBA Jumbo$^{\Phi}$.[15]

Vegetative and podding sprays for Ascochyta blight are now recommended for these varieties in disease-prone areas. Note there are changes to the disease rating (Table 4).

15 Pulse Australia (2016) Southern Lentil: Best Management Practices Training Course. Pulse Australia.

FEEDBACK

Table 5: Availability of red lentil varieties.

Variety	PBR	Licensee or agency	Commercial partner	Seed-supplying agents	Telephone	EPR ($/t incl GST) & market restriction
Small red lentil						
Nipper[Φ]	PBR	Victorian DPI	Seednet	Seednet	1800 007 333	$5.50
Northfield	Terminated	SARDI	AFCA	None	–	None
PBA Bounty[Φ]	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50
PBA Herald XT[Φ]	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50
PBA Hurricane XT[Φ]	PBR	PBA	PB seeds	PB seeds	03 5383 2213	TBA
Medium red lentil						
Nugget	None	Victorian DPI	Seedmark	Heritage	1800 007 333	$5.50
PBA Ace[Φ]	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50
PBA Blitz[Φ]	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50
PBA Bolt[Φ]	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50
PBA Flash[Φ]	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50
Large red lentil						
Aldinga	None	–	–	–	–	None
PBA Jumbo[Φ]	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50
PBA Jumbo2[Φ]	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50

Source: Pulse Breeding Australia

MORE INFORMATION

For further variety information go to the Variety Central website: www.varietycentral.com.au

FEEDBACK

3.4 Green lentil varieties

3.4.1 Medium green varieties

PBA Greenfield$^{\phi}$

PBA Greenfield$^{\phi}$ is a medium-sized green lentil. It has broad adaptation, being best-suited to the medium-rainfall lentil-growing regions.

PBA Greenfield$^{\phi}$ is the highest yielding green lentil variety, with yields similar to PBA Ace$^{\phi}$.[16]

PBA Greenfield$^{\phi}$ has improved tolerance to salinity.

It is resistant to shattering, although timely harvest is still required.

PBA Greenfield$^{\phi}$ is moderately resistant–moderately susceptible (MR-MS) to foliar and seed Ascochyta and moderately resistant (MR) to Botrytis grey mould.

PBA Greenfield$^{\phi}$ was released 2014 and is licensed to PB Seeds. It has an End Point Royalty of $5.50 per tonne.

It is adapted to Region 4.

Photo 14: *PBA Greenfield$^{\phi}$.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

MORE INFORMATION

Go to the GRDC website for the brochure on Greenfield$^{\phi}$: https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

16 Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

3.4.2 Large green lentil varieties

Boomer

Boomer is a large-seeded green lentil. It is tall, bulky and vigorous but can lodge when growing conditions are favourable.

Sowing early can increase lodging and result in smaller seed.

Early harvest is important to prevent shattering and produce good coloured seed.

Boomer was released 2008 and is licensed to Seednet with a $5.50 per tonne End Point Royalty.

Boomer is expected to be superseded by PBA Giant$^{\Phi}$.

It is adapted to Region 4.

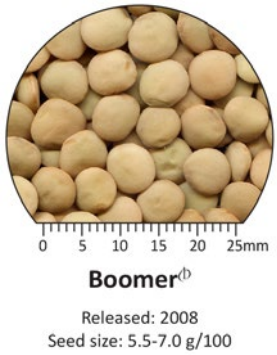

Photo 15: *Boomer.*

Photo: Southern Lentil: Best Management Practices Training Course (2016), Pulse Australia

MORE INFORMATION

Go to the GRDC website for the brochure on Boomer: https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

FEEDBACK

MORE INFORMATION

Variety contamination can be an issue for marketing lentils, although it is less so now that red lentil varieties are grey-seeded types.

That said, it is an agronomic issue when it comes to paddock management, variety selection/change-over and marketing. A 1% maximum visual contamination applies at delivery. So admixture of reds and greens, reds of differing seed coat colour or different seed size within the same seed coat colour must be considered and avoided.

Please see the following for more information: http://pulseaus.com.au/growing-pulses/bmp/lentil/variety-cross-contamination

MORE INFORMATION

Go to the GRDC website for the brochure on PBA Giant$^{\Phi}$: https://grdc.com.au/Research-and-Development/Major-Initiatives/PBA/PBA-Varieties-and-Brochures

PBA Giant$^{\Phi}$

PBA Giant$^{\Phi}$ is the largest seeded green lentil in Australia with an average seed diameter of 5.8 mm (approximately 7 g/100 seeds).[17]

PBA Giant$^{\Phi}$ is broadly adapted but best suited to the medium-rainfall lentil-growing regions.

It has similar yield and improved shattering resistance to Boomer, although timely harvest is still required to minimise shattering.

PBA Giant$^{\Phi}$ is more resistant to lodging at maturity than Boomer.

It is MR to foliar Ascochyta, and MS to seed Ascochyta and Botrytis grey mould.

PBA Giant$^{\Phi}$ was released 2014 and is licensed to PB Seeds with a $5.50 per tonne End Point Royalty.

It is adapted to Region 4.

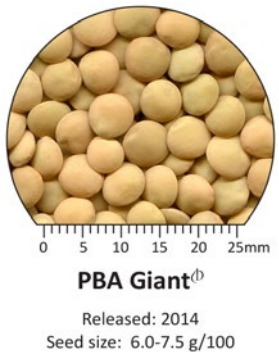

Photo 16: *PBA Giant$^{\Phi}$*.

Photo: Southern Lentil Best Management Practices Training Course (2016), Pulse Australia

3.4.3 Superseded green lentil varieties

The only green lentil variety that has been superseded by new, improved varieties is Matilda.

3.4.4 Trial data of green lentil varieties

Table 6: Long-term green lentil yields as a percentage of Nugget (2007–2013).

Variety	South Australia					Victoria		New South Wales	
	Yorke Peninsula	Mid North	Lower Eyre Peninsula	Mallee	South East	Wimmera	Mallee	South East	South West
Medium green lentil									
PBA Greenfield$^{\Phi}$	111	111	–	114*	113*	112	114	116*	110*
Large green lentil									
Boomer	102	102	101	97	103	102	102	102	102
PBA Giant$^{\Phi}$	98*	103*	–	–	–	106*	112*	112*	103*
Yield of Nugget (t/ha)	**2.78**	**2.28**	**1.40**	**1.22**	**1.59**	**1.51**	**1.13**	**1.15**	**1.31**

* Variety has had limited evaluation in this region so treat results with caution.

Source: NVT, PBA, SARDI, Victorian DPI, NSW DPI

17 J Couchman, K Hollaway (2016) Victorian Winter Crop Summary 2016. Department of Economic Development, Jobs, Transport and Resources, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/victorian-winter-crop-summary

FEEDBACK

Table 7: Green lentil agronomic traits.

Variety	Seed coat colour	Seed size (as % of Nugget)	Crop vigour	Height	Flowering time	Maturity	Pod drop	Shattering	Boron	Salt
Medium green lentil										
PBA Greenfield$^{\Phi}$	Green	130	Good	Tall	Mid	Mid/Late	R	MR	I	MI
Large green lentil										
Boomer	Green	140–160	Good	Tall	Mid	Mid/Late	MR	S	MI	I
PBA Giant$^{\Phi}$	Green	170	Good	Tall	Mid	Mid/Late	R	MR-MS	MI	I

VS = Very Susceptible; S = Susceptible; MS = Moderately Susceptible; MR = Moderately Resistant; R = Resistant. I = Intolerant; MI = moderately Intolerant, MT = Moderately Tolerant. Source: Pulse Breeding Australia

Table 8: Green lentil disease traits.

Variety	Botrytis grey mould	Ascochyta blight	
		Foliar	Seed
Medium green lentil			
PBA Greenfield$^{\Phi}$	MR	MR-MS	MR-MS
Large green lentil			
Boomer	MR-MS	MR	MR-MS
PBA Giant$^{\Phi}$	MS	MR	MS

VS = Very Susceptible; S = Susceptible; MS = Moderately Susceptible; MR = Moderately Resistant; R = Resistant
Source: Pulse Breeding Australia

MORE INFORMATION

For detailed disease information go to Section 10: Disease

Table 9: Availability of green lentil varieties.

Variety	PBR	Licensee or agency	Commercial partner	Seed-supplying agents	Telephone	EPR ($/t incl GST) & market restriction
Medium green lentil						
PBA Greenfield$^{\Phi}$	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50
Large green lentil						
Boomer	PBR	DPI Vic	Seednet	Seednet	03 5389 0150	$5.50
PBA Giant$^{\Phi}$	PBR	PBA	PB seeds	PB seeds	03 5383 2213	$5.50

Source: Pulse Breeding Australia

MORE INFORMATION

For further variety information go to the Variety Central website: www.varietycentral.com.au

FEEDBACK

3.5 Seed

3.5.1 Seed quality

Seed quality is very important in producing high grain yields.

High yields are produced by achieving optimum plant populations. Optimum plant populations are achieved with quality seed. Quality seed has good germination and vigour. Good germination and vigour allows for sowing rates to be calculated accurately resulting in optimum plant populations.[18]

Factors affecting seed quality include:

- variations in seed size (due to seasonal conditions);
- poor germination percentage (can result in inaccurate calculation of sowing rates);
- harvest and post-harvest seed damage (produces abnormal seedlings without vigour); and
- seed-borne diseases (cause reduced germination).

Grower-retained seed, if not tested, might have reduced germination and vigour, as well as being infected with seed-borne pathogens. Infected seed has the potential to introduce and/or spread disease onto the property.

The only way to accurately measure seed germination rate, vigour and disease is to have it tested.

Key parameters for ensuring high seed quality include:

- All seed should be tested for quality including germination and vigour.
- If grower-retained seed is of low quality, consider purchasing registered or certified seed from a commercial supplier.
- Always check the germination report of purchased seed.
- Seed should be treated with a thiram-based fungicide for the prevention of seed-borne diseases.
- Careful attention should be paid to the harvest, storage and handling of seed intended for sowing.
- Calculate sowing rates in accordance with seed quality (germination, vigour and seed size).
- **All seed over 12 months old all should be retested for germination and vigour.**[19]

It is important to know the germination requirement when calculating sowing rates.

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

19 Pulse Australia (2016) Southern Lentil: Best Management Practices Training Course. Pulse Australia.

FEEDBACK

3.5.2 Seed testing

Germination tests are conducted by seed-testing laboratories. The sample required for seed testing lentil is 1 kg for each 10 tonnes of seed.

Failure to obtain a true sample will result in inaccurate test results that could then lead to poor establishment in the paddock.

The sample should be random and consist of numerous sub-samples.

Sub-samples can be taken when seed is being moved:

- out of the harvester;
- into or out of the truck;
- into or out of the silo; and
- into or out of the seed cleaner.

Seed testing is best done as soon as possible after harvest:

- if there is a suspected quality issue;
- prior to grading and seed treatment; and
- to provide more time to source replacement seed if needed.

Seed testing in Australia

The Australian Seeds Authority (ASA) is responsible for controlling seed certification in Australia and oversees two certification schemes:

- the Organisation for Economic Co-operation and Development (OECD) Schemes for the Varietal Certification or the Control of Seed Moving in International Trade; and
- the Australian Seed Certification Scheme.

Other seed tests

There are numerous other seed tests available for:

- vigour;
- accelerated ageing vigour;
- conductivity vigour;
- cool germination and cold;
- tetrazolium (TZ) vigour;
- weed contamination;
- disease; and
- major pathogens.

MORE INFORMATION

The Australian Seeds Authority provides a listing of the laboratories in Australia that test and certify seed for both international and domestic purposes. They can be found on the ASA website: http://aseeds.com.au/testing

3.5.3 Grower-retained seed

Poor quality grower-retained seed

Seed quality issues can occur when a crop is harvested in less than ideal moisture conditions or poor seasonal conditions. A sharp seasonal finish where maturity is achieved suddenly, a wet harvest or a delayed harvest can all have a significant impact on seed quality.

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

The fragile nature of pulse seed, particularly faba and broad bean, lupin, kabuli chickpea and lentil seeds, makes them more vulnerable to mechanical damage during harvest and handling. This damage is not always visually apparent. Damage can be minimised by reducing the harvester thresher speed and opening the concave, or by reducing auger speed and lowering the flight angle and fall of grain.

FEEDBACK

Rotary harvesters and belt conveyers are ideally suited to pulse grain. Both reduce seed damage that often results in abnormal seedlings which germinate but do not develop further due to poor vigour.

Establishment of weak seedlings can be caused by low temperature, disease, insects, sowing depth, soil crusting and compaction. Seedlings that do emerge are unlikely to survive for long, or produce less biomass, and make little or no contribution to final yield.

Achieving high quality grower-retained seed

Achieving high quality grower-retained seed requires the best area of a paddock being selected prior to harvest. Best areas have a low weed burden, an absence of diseases, and a crop that is vigorous and healthy and likely to mature evenly with good grain size.

Seed should be harvested first (prior to grain) and ideally in conditions with 11–12% moisture. Harvesting seed at low moisture deems it susceptible to cracking.

When desiccating a paddock for seed, careful attention must be paid to the herbicide used.

DO NOT use glyphosate to desiccate or crop-top lentil if the seed is to be retained for sowing.

Glyphosate can have a significant impact on germination, normal seed count and vigour.

Growers should also ensure that seed varieties are properly labelled in storage and that different varieties are not accidentally mixed and sown together. Sowing varieties with different disease susceptibility will compromise disease management.

3.5.4 On-farm seed testing

A simple preliminary on-farm test can be conducted to assess germination and vigour. Ideally this should be followed up with a laboratory test from which sowing rates can be calculated.

On-farm seed-testing process:

1. Use a flat, shallow tray about 5 cm deep.
2. Place a sheet of newspaper in the base to cover drainage holes.
3. Fill with clean sand, potting mix, or a freely draining soil.
4. Temperature must be less than 20°C, so the test may need to be conducted indoors.
5. Randomly count out 100 seeds, including any damaged seeds.
6. Sow 10 rows of 10 seeds in a grid at the correct sowing depth.
7. Place the seed on the levelled soil surface and gently push each in with a pencil marked to the required depth. Cover seed holes with a little more soil and water gently.
8. Keep the soil moist, but not wet (overwatering will result in fungal growth and possible rotting.
9. After seven to 14 days most viable seeds will have emerged.
10. Only count normal, healthy vigorous seedlings at seven and 14 days. This number is the germination percentage.

MORE INFORMATION

See Section 11: Pre-harvest treatments and Section 13: Storage and handling

GRDC Videos on retained seed and aerated storage are at: https://youtu.be/5lq9T6_f6Tg

Ensure seed viability with aerated storage: https://youtu.be/8HFilsCnka0

FEEDBACK

Figure 3: *On-farm seed testing.*

Photo: Emma Leonard

3.5.5 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 should be handled carefully to ensure good germination.

To prevent seed damage, forward planning is required to minimise grain handling between harvest and sowing.

Auguring from the harvester should be treated with as much care as later during handling and storage because it has the same potential for seed damage.

Augers with steel flighting can damage pulses, even small-seeded types like lentil. This problem can be partly overcome by reducing auger speed.

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 working at a steeper angle than tubulators. However, cup elevators generally have lower capacities.

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

3.5.6 Safe storage of seed

Most grower-retained seed will need to be stored for a period of 180 days or more.

Seed needs to be stored correctly to ensure its quality is maintained. Ideal storage conditions for pulses are at around 20°C and at a maximum of 12.5% moisture content.

Lentil seed quality can deteriorate in storage (like other grain). Deterioration occurs most rapidly under conditions of high temperature and moisture. These conditions may result in poor seed germination and emergence.

Reducing moisture and temperature increases the longevity of the seed. Conversely, moisture at very low levels (>10%) may render lentil more vulnerable to mechanical damage during subsequent handling (see Table 10 for an example involving chickpea).

FEEDBACK

Table 10: Effect of moisture content and temperature on storage life of chickpea seed.

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

Source: R Ellis, K Osei-Bonsu, E Roberts (1982) The Influence of Genotype, Temperature and Moisture on Seed Longevity in Chickpea, Cowpea and Soya bean. Annals of Botany (1982) 50 (1): 69-82, http://aob.oxfordjournals.org/content/50/1/69

Under Australian conditions, storage of seed above 13% moisture is not recommended.

Reducing temperature in storage is the easiest method of increasing seed longevity. It will also reduce the potential for insect damage.

Options for reducing seed temperature in silos include painting the outside of the silo with white paint and aeration. Painting can reduce temperature by as much as 4–5°C and can double storage life. Aeration results in dry, ambient air which, as well as reducing storage temperature, also reduces the moisture of seed harvested at high moisture.

Heat drying of lentil seed should be limited to temperatures below 40°C.

MORE INFORMATION

For detailed information refer to
Section 13: Storage and handling

FEEDBACK

3.6 PBR and royalties

Plant Breeder's Rights and End Point Royalties provide an incentive to companies and individuals to invest in plant breeding. This value adding to the grains industry, by producing superior varieties, has numerous benefits:

- increased productivity with higher yields;
- improved price received for grain due to improved quality;
- protection from productivity losses caused by diseases and environmental stresses; and
- improving the profitability of grain growing.[20]

3.6.1 Plant Breeder's Rights

Plant Breeder's Rights (PBR) relate to legislation covered in the *Plant Breeders Rights Act (1994)*.

PBR is a copyright that protects the plant breeder's intellectual property rights for new and uniquely different plant varieties.

PBR provides the legal mechanism by which a breeder can license a variety to a grower and impose an End Point Royalty (EPR). The EPR aids in recovering the costs of breeding and allows re-investment into future variety development.

PBR allows the breeder/owner of the variety to place restrictions on what the grower and others in the supply chain can do with the protected variety.

The grower enters into a contract with the breeder/owner at the point of seed purchase of a PBR variety.

The contract between the grower and breeder/owner may place restrictions on what the grower can do with the grain produced from the seed when planted as a crop.

PBR restrictions can differ between varieties and breeders/owners.

The PBR legislation allows the variety breeder/owner to prevent growers from selling seed to other growers and any other third parties including traders and end-users.

The PBR legislation allows the grower to save seed on-farm for use in the sowing/planting of the following year's crop.

3.6.2 End Point Royalties

An End Point Royalty (EPR) is a fee paid by growers for every tonne of grain produced and sold as grain for each variety.

The EPR amount is set by the variety owner (breeder) when the variety is released. This may vary between varieties.

The EPR represents a performance based equitable return to the breeder/owner for successful crop breeding. Breeding a new cultivar is expensive, taking from eight to 12 years with an estimated cost of at least $2 million per variety[23].

An EPR shares the risk between the breeder and the grower, whereas a seed royalty places all the risk on the grower.

For example, with EPR if the grower has a failed crop, the breeder receives no royalty. With a seed royalty, the grower pays a fee regardless of whether the crop is a success or failure.

20 Australian Grain Technologies (2016) PBR and EPR Information. Australian Grain Technologies, http://www.agtbreeding.com.au/sourcing-seed/pbr-and-epr