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Winter crop variety sowing guide 2016

NSW DPI MANAGEMENT GUIDE

Peter Matthews, Don McCaffery and Leigh Jenkins

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Introduction

The complexities of modern technology, fluctuating markets and the vagaries of weather all contribute to the winter crop producer's need for careful planning and management to optimise production and profitability.

Profitable winter crop growing demands higher production per unit area at lower cost per unit of production. This can only be achieved by increasing grain yields through economic adoption of new or improved technology. The aim is not higher total production, but greater productivity from the resources invested in crop production, along with total sustainability of the farm business.

Profit depends on choosing the most suitable variety for each paddock and sowing time and matching this to available markets. This guide helps to select the most suitable variety and contains updated technical information from the latest research, extension and industry programs. It aims to assist growers to make better cropping decisions and higher profits. Consult your local agronomist or farm adviser for more specific advice.

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Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (March 2016). However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of NSW Department of Industry, Skills and Regional Development or the user's independent adviser.

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Wheat Quality Australia, GrainCorp, Grain Trade Australia, Pulse Australia and Barley Australia provide valuable assistance on the subjects of grain quality assessment, receival standards and marketing.

This publication is a companion to *Weed control in winter crops* and *Insect and mite control in field crops*, both publications are available on the NSW DPI website at **www.dpi.nsw.gov.au**

Front cover main photo: faba bean crop, north-western plain NSW. Smaller photos, left to right: faba bean crop, early vegetative stage, Luke Gaynor; faba bean flowers; faba bean whole and split seed, Don McCaffery. All NSW DPI.

Plant Breeder's Rights

Throughout this guide, varieties protected under Plant Breeder's Rights (PBR) legislation are signified by the symbol ⁽ᵠ⁾

Plant Breeder's Rights are exclusive commercial rights to a registered variety. In relation to propagating material of the registered variety, the breeder has exclusive rights to:

a. produce or reproduce the material;
b. condition the material for the purpose of propagation (conditioning includes cleaning, coating, sorting, packaging and grading);
c. offer the material for sale;
d. sell the material;
e. import the material;
f. export the material; and
g. stock the material for any of the purposes described in (a) to (f).

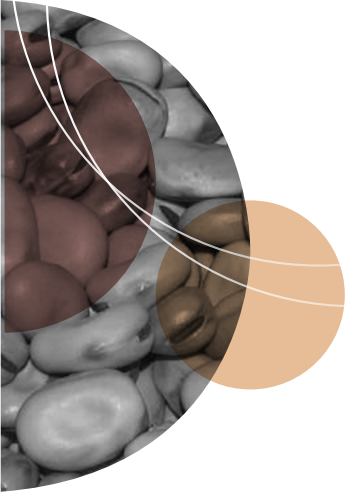
In most instances the breeder will licence these rights to a selected seed company (the licensee).

Exceptions to breeder's rights are the rights of farmers to save seed for sowing future commercial crops. However harvested material derived from farm saved seed will be subject to the End Point Royalty (EPR) applying to that variety.

Where EPRs apply, growers will be required to enter into arrangements with the breeder or licensee whereby royalties are paid on delivery of the grain. Some varieties may have a Seed Royalty (SR) paid on purchase of seed rather than an EPR.

Royalties collected are used to support ongoing research and the breeding of new and improved varieties.

Peter Matthews, Don McCaffery and Leigh Jenkins



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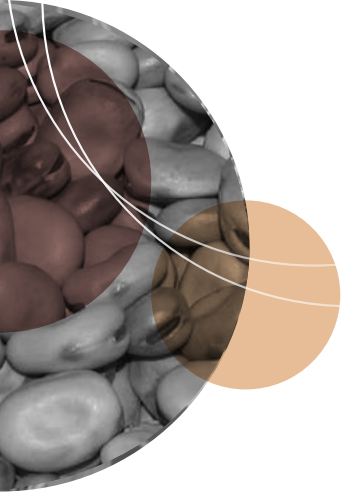


Highlights/changes 2016

Cereal diseases

Barley yellow dwarf virus (BYDV): BYDV was present in most regions last season, with plant symptoms being observed and confirmed in a large number of early-sown crops. Consider using a insecticidal seed dressing on all early-sown cereals. Disease management relies on growing a tolerant variety or controlling aphids to prevent the virus from spreading.

Wheat stripe rust: Stripe rust was again present across NSW last year, with seasonal conditions dictating the level of disease in each region. Growers need to remain proactive with stripe rust management plans for 2016, as without adequate fungicide protection, many varieties can suffer yield loss.

Wheat stem rust: Stem rust was detected in all regions of NSW in 2015. Only use varieties that have the best available stem rust resistance and are adapted to your area. Avoid relying on fungicides to manage this disease.

Wheat leaf rust: With the presence of the new leaf rust pathotype in NSW, growers should check the new variety ratings as many have been downgraded and now might be susceptible to leaf rust. Be vigilant, and if you see any unexpected leaf rust development in a variety, speak to your local agronomist, and collect and send a sample for identification.

Crown rot: Crown rot was widespread through NSW in 2015, with a higher incidence in the central and northern regions. Be aware of the presence of crown rot in your farming systems and adjust farm rotations to lower the risk of yield losses. Consider using the PreDicta B test if you are uncertain of the crown rot risk in your paddock.

Yellow leaf spot: Yellow leaf spot was an issue early in the season in many of the more susceptible varieties. Select a more tolerant variety where possible, or budget for fungicide sprays through the season if wheat residues are present from two seasons ago, even when following break crops.

Wheat streak mosaic virus (WSMV): There were only isolated reports of WSMV in 2015. If you are sowing wheat for grazing, consider replacing early grazing wheat with oats, triticale or barley where perennial pastures or roadsides adjoin the paddock.

Barley leaf rust: A new pathotype of barley leaf rust was present in northern NSW and southern Queensland in 2015. Some varieties are more susceptible to this pathotype. Growers should be vigilant and if you see any unexpected development of leaf rust in a variety, speak to your local agronomist, collect and send a sample for identification.

Smuts in cereals: Despite conditions through late spring being drier than average, smut was still detected throughout NSW. Review your seed fungicide programs for 2016 and ensure at least seed blocks for the 2017 season have a protective fungicide applied. Both feed and malt barley have a 'Nil' tolerance for smut-contaminated grain.

New varieties with limited data available

Consult either the owners or commercial licensees of these varieties for further information.

Wheat classification

The variety characteristics and reactions to diseases table for wheat lists the maximum quality classification of varieties for the northern and south-eastern zones at the time of publishing. Some newer varieties might not have a final classification for all NSW regions pending further testing of samples. If a variety does not have a formal classification in a region, it is considered a 'feed' variety when delivered to bulk handlers.

Varietal changes

Wheat. New milling wheat varieties for the 2016 include Beckom, DS Darwin, DS Pascal, LongReach Flanker, Sunlamb and Suntime. One new durum wheat variety was released for NSW: DBA_Lillaroi. There is also a number of newly released wheat varieties yet to receive classification in NSW, including Buchanan, Cutlass and Scepter. Until they are classified, they are considered feed varieties only.

When considering a new variety, compare the yield, grain quality and disease resistances of the new variety with the currently grown varieties.

Barley. Two new barley varieties were released last year: Rosalind, a high yielding feed variety and Spartacus CL, a new Clearfield-tolerant barley. Both varieties have performed well across NSW. There is also a number of newer specialty malting barleys that can only be grown under contract including Admiral, Charger and SouthernStar.

Oats. No new grain-only oat varieties have been released for sowing this year. If growing milling oats, consider applying a fungicide to reduce the impact of rust on grain yield and grain quality. There are no changes to dual-purpose oat varieties.

Triticale. Three new triticale varieties will be available for the 2016 season. Astute and Bison are grain-only types and Cartwheel is a dual-purpose variety suitable for grazing and grain recovery.

Canola. There are 12 new releases for 2016.

There are no new conventional varieties available for 2016.

ATR-Mako$^{\Phi}$ is a new triazine tolerant (TT) open-pollinated (OP) variety. DG 560TT, Pioneer® 45T01 (TT) and SF Turbine TT are three new TT hybrids. Monola® 416TT is a new OP specialty variety. Monola® 605TT has been withdrawn.

Banker CL and Rimfire CL are new CLEARFIELD® hybrids. Pioneer® 44C79 (CL), Pioneer® 44Y84 (CL) and Hyola® 971CL have been withdrawn.

DG 460RR Hyola® 504RR and Nuseed GT-42 are new Roundup Ready® hybrids. Hyola® 400RR, Hyola® 500RR and Hyola® 505RR have been withdrawn. Victory® V5003 is a new specialty RR hybrid.

Bayer 3000TR is a new Dual herbicide tolerant (TT plus Roundup Ready®) hybrid.

Suggested sowing times have been changed for 2016 (**see Canola chapter**). Sowing times have been moved earlier to start in mid April for western and eastern zones of central and southern NSW. An early sowing decision needs to take into account the variety and its phenology, and crop management.

Chickpea. There are no new chickpea variety releases for the 2016 season.

Growers are reminded to follow the disease management strategies in this guide.

In 2015, Ascochyta blight occurred in a higher proportion of chickpea crops (60 of 243 crops inspected) than in 2014 (62 of 332 crops inspected, which was also higher than 2012 and 2013 combined). Most infected crops were PBA HatTrick$^{\Phi}$, mainly because it is the most commonly grown variety.

Inoculum for the 2015 Ascochyta infections carried over from the 2014 season. Wet conditions during June and July favoured infection and disease; in addition it is known that chickpea resistance to Ascochyta is compromised under waterlogged conditions. In many cases, the genetic purity of the variety could not be guaranteed, leading to individual susceptible plants acting as a source of inoculum for the entire crop.

Work is underway to determine if the unexpected number of 2014 and 2015 infections, especially on PBA HatTrick$^{\Phi}$, is related to changes in the Ascochyta fungus. Initial results show that the fungus varies both in its ability to cause disease (pathogenicity) and time to develop fruiting bodies (latent period). However, there is no evidence to date that it has changed in its particular response to the widespread cultivation of PBA HatTrick$^{\Phi}$.

Localities where Ascochyta was found on any variety in 2015 are considered high risk for 2016 crops. Growers are advised to apply a preventative fungicide before the first post-emergence rain event to all varieties, including PBA HatTrick$^{\Phi}$.

Varietal purity remains an issue and is likely to get worse unless the industry implements a plan to reduce contamination and accidental mix-ups in planting seed. Ensure the varietal purity of 2016 planting seed is known, as this could have implications for disease management, particularly if the seed lot is contaminated with lower disease resistance rated varieties.

Faba bean. Two new faba bean varieties have been released from Pulse Breeding Australia (PBA) for 2016. PBA Nasma$^{\Phi}$ was released in spring 2015 for northern NSW and southern Queensland. It is higher yielding than PBA Warda$^{\Phi}$, with larger and more uniform seed size suited to human consumption markets. PBA Zahra$^{\Phi}$ was released for the southern region. It is higher yielding than Farah and Fiesta VF, resistant to Ascochyta and less susceptible to chocolate spot. Plump seed makes PBA Zahra$^{\Phi}$ suitable for human consumption markets.

The 2015 growing season was characterised by good early season rain that allowed timely sowing in most regions, except the north-western region, which remained dry west of about 75 km of the Newell Highway. Little, if any, rain fell from late July onwards, reducing potential yield but reinforcing the value of stored soil water to successful production in the northern region. In the south, seasonal conditions were generally wetter than average through most of winter, but little rain fell after early September. Very hot, windy conditions in early October caused flower abortion, reducing yield potential.

Some small adjustments to Table 50 Suggested sowing times, have been made for 2016 (see Faba bean chapter).

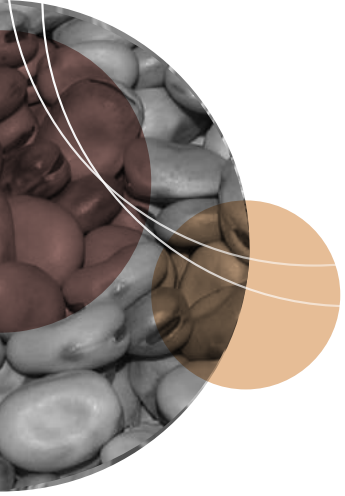
Field pea. There are no new field pea variety releases for the 2016 season. Of the three varieties that Pulse Breeding Australia recently released, PBA Wharton$^{\Phi}$ has shown outstanding yield potential across all regions of NSW. It has wide adaptability, high yield potential, early to midmaturity, and resistance to both powdery mildew and viruses. PBA Wharton$^{\Phi}$ is a Kaspa-type with semi-leafless erect growth, distinctive pink flowers, shatter resistant 'sugar' pods and spherical (non-dimpled) tan coloured seed. Its superior grain quality makes it highly suited to human consumption markets for dhal, flour and roasted snack foods.

The end of the 2015 growing season was not overly favourable for field peas, with below average rainfall in September limiting the flowering period, followed closely by heatwave conditions in early October. However, this also meant that crops were largely free of disease at harvest. Cool daytime temperatures and frequent rainfall events during winter were ideal for both black spot and downy mildew diseases to develop in field peas, but the drier spring kept disease levels low. There were isolated outbreaks of bacterial blight in central and southern NSW as a result of frost events in July and August. Drier seasons over the past four years have favoured pulse crops, largely through limiting disease and enabling early harvest of high quality seed.

Lupin. No new varieties are available for 2016; however, a decision on releasing a new narrow-leaf variety PBA Jurien$^{\Phi}$ will be made in March 2016.

In the main production areas of central and southern NSW, conditions were generally average to wetter than average through most of winter, but little rain fell after early September. Due to the wet winter, brown leaf spot was widespread in southern NSW last season. Also *Bean yellow mosaic virus*, spread by aphids, was observed in some crops in central NSW in spring 2015. Varietal resistance to the virus exists within yet-to-be-released breeding lines of the narrow-leaf lupin.

Very hot, windy and dry conditions in early October caused flower abortion in pulse crops including lupin, reducing yield potential.



Wheat

Crop management

Profitable yields result from good management, of which variety choice is only a minor part. To reach their full potential, varieties must be grown in a rotation that minimises the risks from diseases and weeds, and maximises soil fertility and soil moisture storage.

Variety choice

Varieties are tested across NSW before being included in the *Winter crop variety sowing guide*. However, varietal performance varies from year to year due to seasonal conditions and many other factors. Use varieties yielding consistently well over several years that offer the best combination of yield potential, grain quality and disease resistance.

Sow at least two different varieties each year. This spreads the risk of frost and disease damage. To ensure high yields select varieties by considering:

» grain quality to attract premium payments
» good disease resistance
» maturity suited to sowing time
» strong seedling vigour
» resistance to lodging and shattering
» tolerance to herbicides
» tolerance to soil acidity
» tolerance to preharvest sprouting
» good threshing ability
» tolerance to frost.

Varieties for each receival zone

Varieties are considered according to their suitability for the two receival zones in NSW: northern and south-eastern. The major purpose of this division is for the environmental growing season differences on grain quality, transport and marketing arrangements. This facilitates deliveries by quality grade, maximising grower returns.

To be included in the *Winter crop variety sowing guide*, varieties must have a quality classification and ideally two or more years of regional yield evaluation. There are now only two quality classification zones in NSW, with the central zone being amalgamated with the northern zone. Growers should check carefully the maximum quality classification of each variety in their delivery zone.

Growers are encouraged to try new varieties for which there is limited yield and agronomic data available. Information on these varieties should be obtained from either the owner or commercial partner.

Growers can grow the varieties of their choice and deliver them to selected clients. If a variety is to be accepted into its classification grade, it must be taken to a receival site where that grade is segregated. Certain quality standards must be met before the variety will be accepted.

Segregation is a separate issue from variety approvals. Varieties are commonly suited to a range of end uses such as pan bread, steam bread or noodles, whereas others have specific uses such as biscuits or pasta, depending on their quality.

Sow on time

Varieties differ in the time they take from sowing to flowering. Late sown (quicker maturing) varieties take fewer days to flower than early-sown (late maturing) varieties. This difference is more marked from early sowings (April) than from late sowings (July).

Avoid sowings that result in crops flowering in late winter. Frosts can cause damage resulting in reduced yield and can also affect grain quality. Some varieties sown too early will flower in late winter. Varieties sown too late have little chance of reaching their yield potential because flowering and grain filling occur under hot, dry, stressful conditions.

Sowing time is a management compromise between having the crop flowering soon after the last heavy frost, but early enough to allow adequate grain fill before the onset of moisture stress and heat in spring.

Yield drops 4–7% with each week of delay in sowing after the optimum time for a specific variety.

If varieties are sown within the optimum sowing period, they can produce their highest yields, but the best sowing date varies with topography and variety. Locally, sowing dates might need to be extended (earlier or later) depending upon local climatic conditions and soil types.

Sowing towards the earliest part of the recommended sowing window usually results in higher yields.

Conservation tillage techniques (no-till, minimum till) as well as using moisture-seeking sowing tynes can enable varieties to be sown on time.

Frost damage is a major consideration and the risk cannot be eliminated entirely; therefore the potential for higher yields from earlier sowings needs to be balanced against the risk of frost damage at flowering. There are two ways of doing this:

1. In areas where the risk of frost is high, sow later than the suggested optimum sowing period. As a rule of thumb, three days difference at planting makes one day difference at heading.

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2. Change varieties. Use maturity differences to have the crop flowering at a time when frost risk is acceptable.

Since rain for sowing is often erratic, varieties must be chosen carefully to achieve this balance.

Sowing rates and plant populations

High yields are possible from a wide range of sowing rates because wheat compensates by changing the number of tillers and the size of the head – the number of grains per head in response to the prevailing environment, including weather, fertility and plant competition.

Aim to establish a target number of plants. To achieve this, target a population for the environment and the seasonal conditions. Adjust sowing rates to compensate for:

» sowing date – higher with later sowings
» seed germination
» seed size
» seedling vigour differences
» seedbed conditions
» conservation tillage techniques (no-till, minimum till)
» double cropping
» soil fertility
» soil type
» field losses – see the following explanation.

Field losses. Under normal conditions, expect to lose up to 20% of seed sown in addition to germination losses. Adjust sowing rates to suit sowing conditions.

Press wheels improve establishment under dry or marginal moisture conditions.

Where herbicide resistance is suspected, higher sowing rates can assist with competition against weeds.

Calculating sowing rates

The following formula can be used to calculate sowing rates, taking into account:

» target plant density
» germination percentage (90% = 90 in the formula)
» seed size
» establishment – usually 80%, unless sowing into adverse conditions (80% = 80 in the formula).

Tip – 1000 seed weight:

» count out 200 seeds
» weigh to at least one decimal point of a gram
» multiply weight in grams by five.

Example

1000 seed weight # (grams)		target plant population		establishment percentage × germination percentage
.....35.....	×	.....140.....	× 100 ÷	(80 × 90)

= your sowing rate .....68..... kg/ha

Your calculation

1000 seed weight # (grams)		target plant population		establishment percentage × germination percentage
.....	×	.....	× 100 ÷	..... × .....

= your sowing rate ..... kg/ha

Nutrition

A balance of nutrients is essential for profitable yields. Fertiliser is commonly needed to add phosphorus and nitrogen, which are essential nutrients. The lack of other essential plant nutrients can also limit production in some situations.

Knowing a crop's nutrient demand is essential in determining nutrient requirements. Soil testing and nutrient audits help to match nutrient supply to crop demand.

Weed management in winter crops

Herbicide resistance in weeds is a problem that continues to become more widespread through NSW, and of which growers need to be aware. It is the biggest threat to cropping system sustainability. However, this problem can be managed by having good crop and pasture rotations, by rotating herbicide groups and by combining both chemical and non-chemical methods of weed control.

Variety selection

Locate your farm on the map for either of the delivery regions – northern or south-eastern – and check the classification of varieties for each classification zone.

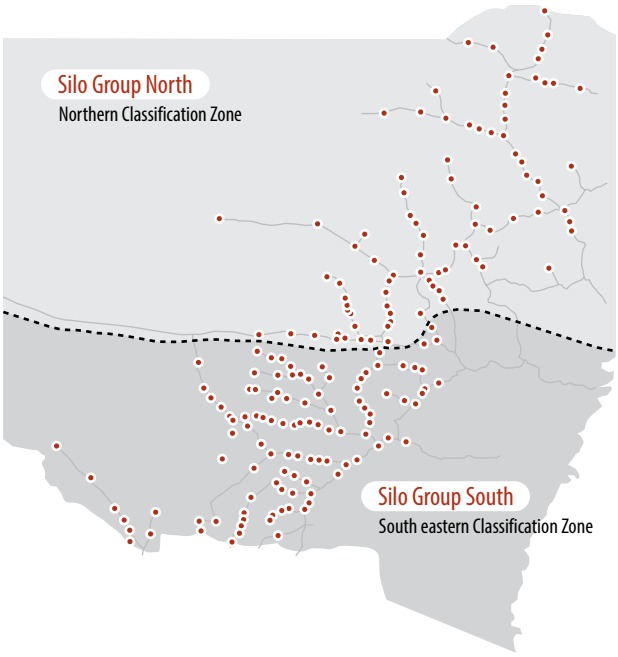

Figure 1. Map of NSW showing wheat silo groups

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Northern NSW – Varieties

Yield performance experiments from 2011–2015.

Yield results presented are NVT 'Production Value' MET values on a regional mean basis for NSW from 2011–2015. The number of experimental results are listed; the more trials, the greater the reliability.

Table 1. Long season varieties: Compared with EGA_Wedgetail = 100%

Variety	East EGA_Wedgetail = 3.32 t/ha	Number of trials
EGA_Wedgetail■	**100**	**10**
Einstein■	89	4
Mackellar■	96	10
Manning■	77	5
Mansfield	85	8
Naparoo■	92	10
Rudd■	91	10
SF Adagio■	102	5
SF Ovalo■	98	3
SF Scenario■	88	5
SQP Revenue■	96	10
Sunlamb	106	6
Tennant■	87	10
Wylah■	104	10

■Winter wheat

Table 2. Early season variety trial results (sown before 15 May): Compared with EGA_Gregory = 100%

Variety	East EGA_Gregory = 3.98 t/ha	Number of trials	West EGA_Gregory = 3.38 t/ha	Number of trials
Bolac	97	5	94	7
EGA_Bounty	96	25	96	32
EGA_Gregory	**100**	**25**	**100**	**32**
EGA_Wedgetail■	84	25	85	32
Flanker	103	10	105	12
Forrest	83	15	–	–
Gascoigne	101	25	101	25
Gauntlet	103	25	100	32
Gazelle*	88	25	91	32
Kiora	104	20	99	13
Lancer	103	25	98	32
Mitch	103	25	103	32
Sentinel3R	102	10	100	14
Strzelecki	82	25	88	32
Sunbri	87	25	87	32
Sunlamb	90	8	87	6
Suntime	99	20	96	25
Sunvale	97	25	94	32
Sunvex	94	5	93	9
Sunzell	92	25	90	32
Viking	104	20	102	25
Feed wheats				
Naparoo■	70	3	–	–

■Winter wheat. *Soft/biscuit wheat variety.

Table 3. Main season variety trial results (sown after 14 May): Compared with EGA_Gregory = 100%

Variety	East EGA_Gregory = 3.86 t/ha	Number of trials	West EGA_Gregory = 3.09 t/ha	Number of trials
Baxter	90	30	91	36
Beckom	103	6	104	6
Buchanan	100	6	–	–
CLF Janz	96	12	93	16
Condo	103	18	103	28
Crusader	95	30	92	36
Dart	99	30	93	36
EGA_Gregory	**100**	**30**	**100**	**36**
EGA_Wylie	92	30	92	36
Ellison	88	18	85	23
Elmore CL PLUS	100	30	97	36
Emu Rock	–	–	99	8
Flanker	104	12	106	13
Gascoigne	99	30	97	28
Gauntlet	97	30	97	36
Impala*	104	30	100	36
Janz	95	24	91	22
Livingston	100	30	98	36
Merinda	96	12	91	16
Merlin	100	12	94	16
Mitch	105	12	104	13
Orion*	94	18	95	23
QAL2000 *	95	8	–	–
QALBIS *	93	8	–	–
Spitfire	99	30	95	36
Sunco	93	12	92	16
Sunguard	97	24	96	28
Sunlin	94	6	88	8
Sunmate	104	24	102	28
Suntop	104	30	103	36
Sunvale	94	30	91	36
Sunvex	94	6	90	8
Ventura	101	30	99	36
Viking	98	12	100	13
Wallup	101	30	98	36
Feed wheats				
B53	100	18	100	21

*Soft/biscuit wheat variety.

Suggested sowing times

Aim to sow grain-only crops in the earlier part of the optimum period. The actual date is influenced by location, soil fertility and the likelihood of frost at flowering in a particular paddock. Sowing windows for specific varieties varies across the regions and the tables are provided as a guide. Sowing decisions should be made according to the relative maturity of each variety.

Table 4. Suggested sowing times

Variety / Weeks	March				April				May				June				July		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Slopes																			
Brennan ■, Mackellar ■, SF Adagio ■, SF Ovalo ■, SF Scenario ■, Tennant ■	>	★	★	★	★	★	★	★	<	<									
EGA_Wedgetail ■, Manning ■, Naparoo ■, Rudd ■, SQP Revenue ■		>	>	★	★	★	★	★	★	★	<								
Sunlamb				>	★	★	★	★	★	<									
EGA_Eaglehawk, Sunbrook,					>	★	★	★	<	<									
Kiora, Lancer, Sunbri, Suntime, Sunzell						>	★	★	★	★	<								
EGA_Gregory, Flanker, Gazelle, Giles, Mitch, Sentinel3R, Strzelecki, Sunlin,							>	★	★	★	<								
Beckom, EGA_Bounty, EGA_Burke, EGA_Wylie, Gauntlet, Sunvale, Sunvex, Viking								>	★	★	★	<							
Ellison, Elmore CL PLUS, Impala, Janz, Merinda, Orion, Sunco, Sunguard, Suntop, Wallup									>	★	★	★	★	<					
Baxter, Petrel										>	★	★	★	★	<	<			
B53, Crusader, Kennedy, Livingston, Merlin, Spitfire, Sunmate, Ventura											>	★	★	★	★	<	<		
Axe, Condo, Dart												>	★	★	★	★	<	<	
Plains																			
EGA_Wedgetail ■, Sunlamb, Naparoo ■				>	★	★	★	★	★	<									
EGA_Eaglehawk, Sunbrook					>	★	★	★	<	<									
Kiora, Sunbri, Suntime, Sunzell,						>	>	★	★	★	★	<	<						
EGA_Gregory, Flanker, Gazelle, Giles, Lancer, Mitch, Sentinel3R, Strzelecki, Sunlin								>	★	★	★	<							
Beckom, EGA_Bounty, EGA_Burke, EGA_Wylie, Sunvale, Sunvex, Viking									>	★	★	★	<						
Ellison, Elmore CL PLUS, Impala, Janz, Merinda, Orion, Sunco, Sunguard, Suntop, Wallup									>	★	★	★	★	<	<				
Baxter, Petrel										>	★	★	★	★	<	<			
B53, Crusader, Emu Rock, Kennedy, Livingston, Merlin, Spitfire, Sunmate, Ventura											>	★	★	★	★	<			
Axe, Condo, Dart												>	★	★	★	★	<		

> Earlier than ideal, but acceptable. ★Optimum sowing time. < Later than ideal, but acceptable. ■Winter wheat. Petrel sown in late May for hay/chaff production. Can be sown earlier if grazed. Note: For durum suggested sowing times see Durum section, page 28.

Southern NSW – Varieties

Yield performance experiments from 2011–2015.

Yield results presented are NVT 'Production Value' MET values on a regional mean basis for NSW from 2011–2015. The number of experimental results are listed; the more trials, the greater the reliability.

Table 5. Long season varieties: Compared with EGA_Wedgetail = 100%

Variety	East EGA_Wedgetail = 4.18 t/ha	Number of trials
EGA_Wedgetail■	**100**	**18**
Einstein■	99	10
Mackellar■	104	18
Manning■	110	12
Mansfield	95	13
Naparoo■	90	18
Rudd■	98	18
SF Adagio■	108	12
SF Ovalo■	91	5
SF Scenario■	107	12
SQP Revenu■	103	18
Sunlamb	97	13
Tennant■	92	18
Wylah■	95	18

■Winter wheat

Table 6. Early season variety trial results (sown before 15 May): Compared with EGA_Gregory = 100%

Variety	East EGA_Gregory = 4.42 t/ha	Number of trials	West EGA_Gregory = 3.79 t/ha	Number of trials
Bolac	95	29	98	35
Cutlass	106	6	106	7
DS Darwin	98	17	98	21
DS Pascal	93	11	99	9
EGA_Bounty	95	29	94	35
EGA_Eaglehawk	90	6	91	6
EGA_Gregory	**100**	**29**	**100**	**35**
EGA_Wedgetail■	91	29	91	35
Estoc	98	23	101	35
Flanker	106	11	105	14
Forrest	89	17	93	21
Gascoigne	98	23	100	28
Gauntlet	97	29	98	35
Gazelle*	93	29	99	35
Kiora	100	23	103	28
Lancer	96	29	97	35
Mitch	103	23	104	28
Phantom	102	6	104	7
Sentinel3R	99	12	101	14
Strzelecki	90	29	91	34
Sunlamb	90	12	89	7
Suntime	95	23	96	28
Sunvale	93	29	95	35
Sunvex	90	12	93	14
Sunzell	91	29	90	35
Trojan	109	17	110	21
Viking	102	23	102	28
Feed wheats				
Naparoo■	85	6	–	–
Preston	101	29	–	–

■Winter wheat. *Soft/biscuit wheat variety.

Table 7. Main season variety trial results (sown after 14 May): Compared with EGA_Gregory = 100%

Variety	East EGA_Gregory = 4.22 t/ha	Number of trials	West EGA_Gregory = 3.40 t/ha	Number of trials
Axe	96	18	100	24
Barham*	90	30	96	34
Beckom	109	18	113	23
Bolac	95	12	98	7
Buchanan	96	6	–	–
CLF Janz	90	12	95	15
Cobra	104	18	107	31
Condo	104	18	107	29
Corack	103	18	109	38
Crusader	91	30	93	34
Cutlass	104	6	107	8
Dart	93	30	99	36
DS Darwin	95	12	101	9
EGA_Gregory	**100**	**30**	**100**	**34**
Ellison	88	30	91	22
Elmore CL PLUS	97	30	100	37
Emu Rock	99	30	102	38
Espada	101	18	105	21
Estoc	97	6	101	11
Flanker	101	12	103	14
Forrest	87	6	–	–
Gascoigne	98	30	102	27
Gauntlet	97	30	99	35
Gladius	96	18	100	24
Grenade CL PLUS	92	30	99	38
Impala*	98	30	104	34
Janz	94	24	98	27
Justica CL PLUS	94	30	99	38
Kord CL PLUS	97	24	101	30
Lincoln	95	30	99	35
Livingston	95	30	100	34
Mace	102	18	107	31
Merinda	92	12	100	16
Merlin	92	30	99	35
Orion*	94	18	98	20
Phantom	98	18	104	24
QAL2000*	95	15	102	9
QALBIS*	88	15	92	9
Scepter	106	6	113	8
Scout	99	18	107	26
Shield	94	6	100	11
Spitfire	92	30	98	35
Sunguard	95	24	97	27
Sunmate	98	24	105	27
Suntop	101	30	107	34
Sunvale	92	30	94	34
Sunvex	88	9	93	7
Trojan	105	18	110	24
Ventura	96	30	98	34
Viking	102	12	105	14
Waagan	102	6	107	7
Wallup	98	30	101	35
Yenda*	85	15	92	9
Yitpi	94	24	99	30
Feed wheats				
B53	98	18	98	21

*Soft/biscuit wheat variety.

Suggested sowing times

Aim to sow grain-only crops in the earlier part of the optimum period. The actual date is influenced by location, soil fertility and the likelihood of frost at flowering in a particular paddock. Sowing windows for specific varieties varies across the regions and the tables are provided as a guide. Sowing decisions should be made according to the relative maturity of each variety.

Table 8. Suggested sowing times

Variety / Weeks	March				April				May				June				July		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Slopes																			
Brennan■, Mackellar■, SF Adagio■, SF Ovalo■, SF Scenario■, Tennant■	>	★	★	★	★	★	★	★	<	<									
EGA_Wedgetail■, Manning■, Naparoo■, Rosella■, Rudd■, SQP Revenue■		>	>	★	★	★	★	★	★	★	<								
Sunlamb				>	★	★	★	★	★	★	<								
Bolac, DS_Pascal, EGA_Eaglehawk, Forrest, Kiora, Sunzell , Suntime, Yenda						>	★	★	★	★	<								
EGA_Gregory, Flanker, Gazelle, Lancer, Preston, Sentinel3R, Strzelecki							>	★	★	★	★	<							
Beckom, Correll, DS_Darwin, EGA_Bounty, Ellison, Estoc, Gauntlet, Gladius, Phantom, Sunguard, Suntop, Sunvale, Sunvex, Trojan, Viking								>	★	★	★	<							
Barham, Cobra, Corack, Elmore CL PLUS, Espada, Grenade CL PLUS, Impala, Janz, Justica CL PLUS, Kord CL PLUS, Lincoln, Merinda, Orion, Petrel, QALBis, QAL2000, Scout, Shield, Wallup									>	★	★	★	★	<					
B53, Crusader, Emu Rock, Merlin, Livingston, Peake, Spitfire, Sunmate, Ventura										>	★	★	★	★	<				
Axe, Condo, Dart, Waagan											>	★	★	★	★	<			
Plains																			
EGA_Wedgetail■, Sunlamb, Rosella■				>	★	★	★	★	<	<									
Bolac, DS_Pascal, EGA_Eaglehawk, Kiora, Suntime, Yenda						>	★	★	★	★	<								
EGA_Gregory, Flanker, Gazelle, Lancer, Preston, Sentinel3R, Strzelecki, Sunzell							>	★	★	★	★	<							
Beckom, DS_Darwin, EGA_Bounty, Ellison, Estoc, Phantom, Sunguard, Suntop, Sunvale, Sunvex, Trojan, Viking								>	★	★	★	<							
Barham, Corack, Elmore CL PLUS, Espada, Grenade CL PLUS, Impala, Janz, Justica CL PLUS, Kord CL PLUS, Lincoln, Livingston, Mace, Merinda, Orion, Petrel, QALBis, QAL2000, Scout, Shield, Wallup									>	★	★	★	<	<					
B53, Crusader, Emu Rock, Gladius, Merlin, Peake, Spitfire, Sunmate, Ventura, Wallup									>	>	★	★	★	★	<				
Axe, Condo, Dart, Waagan										>	>	★	★	★	★	<			

> Earlier than ideal, but acceptable. ★Optimum sowing time. < Later than ideal, but acceptable. ■Winter wheat.
Petrel sown in late May for hay/chaff production. Can be sown earlier if grazed. Note: For durum suggested sowing times see Durum section, page 36.

Table 9. Varietal characteristics and reaction to diseases

Variety	Maximum quality classification		Resistances and tolerances																Origin	Year of release
	Northern zone	South-eastern zone	Crown rot	Common root rot	Flag smut	Leaf rust	Stem rust	Stripe Rust WA Yr 17–27 pathotype	Septoria tritici blotch	Yellow leaf spot	RLN *P. thornei* resistance*	RLN *P. thornei* tolerance**	RLN *P. neglectus* resistance*	RLN *P. neglectus* tolerance**	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance		
Bread wheat																					
Axe	APW	APW	S	MS–S [$]	S	S–VS	MS	R–MR	S–VS	S	MS	MT–MI	MS–S	MI ▲	S	S	S–VS	MR	I	AGT	2007
Baxter	APH	APH	MS	MS [N]	R	S	MR–MS	MS–S	S	S	MS–S	MT	MS–S	MI–I	–	MS [N]	S	MS–S	MT	DAFF Qld	1998
Beckom	AH	AH	S	MS–S [$]	MR	S	MR	MR–MS	S	MS–S	MS ▲	MT ▲	MS–S ▲	MT ▲	R	MS	MS–S	MR–MS	T–MT	AGT	2015
Bolac	APW	APH	S	MS [$]	R–MR	S	MR–MS	R–MR	MS	S	MR–MS	MT–MI ▲	MS–S	MI ▲	S	MS–S	S	MR	MI	Viterra	2006
Buchan	NYC	NYC	–	–	–	MR	S	R–MR	MS	MR▲	–	–	–	–	–	–	–	–	–	Austgrains	2015
Chara	APH	APH	S ▲	S [$]	MS	S	MR–MS	MS–S	MS–S	MS–S	MR–MS	MT–MI	S–VS	–	R	MS	S	MR	I	DELWP Victoria	1998
CLF Janz	APH	AH	S ▲	MS–S	R	S▲	MR	MS–S	S	MS–S	S	MI–I ▲	S	–	S	S	S	MS	–	BASF/Ag WA	2001
Cobra	APW	AH	S	MS–S [$]	S	MR	R–MR	MS–S	MS–S	MR–MS	MS–S ▲	MI ▲	MS–S ▲	MI ▲	MS	MS	S	MR	MT	LongReach	2011
Condo	AH	AH	S	–	S	S	R–MR	MS–S	S	MS	MR–MS	T–MT ▲	S	MT ▲	MR	–	–	–	MT	AGT	2014
Corack	APW	APW	S	MS [$]	S	S–VS	MR	MS	S–VS	MR▲	S	MI	MS–S	MT ▲	R–MR	S	MS–S	MR	T–MT	AGT	2011
Correll	APW	AH	S	MS [$]	R	MS–S	MR–MS	MR–MS	MS–S	S–VS	S	MI–I	MS–S	MT–MI ▲	MR	MS	S–VS	MS	–	AGT	2007
Crusader	APH	APH	S	MR–MS	MR	MS–S	R–MR	MS	S	MS	MS–S	MI	S	MI ▲	MS	R–MR [N]	S	R–MR	MT	LongReach	2007
Cunningham	APH	APH	MS	MS	R	–	R–MR	MS	S	MS	S–VS	MI–I	S	MT–MI	–	MS	MS–S	MS–S	I	DAFF Qld	1991
Cutlass	NYC	NYC	–	–	–	R–MR	R	MS▲	MS–S	MS–S	–	–	–	–	–	MS	S	MR–MS	MT	AGT	2015
Dart	APH	APH	MS–S	MS–S	MS	S–VS	MR	MR	S–VS	MS	MS	MI	MS–S	MI ▲	S	MR–MS▲	S	R–MR	MT	LongReach	2012
Derrimut	APW	APW	MS	S [$]	R–MR	MS–S	MR	MS–S	S	S	S	MI–I	MS–S	MI ▲	R	S	S	MR–MS	–	Nugrain	2007
Diamondbird	AH	AH	–	–	R	–	MS	MS	MS	MS–S	MS	MI ▲	MS–S	MI–I ▲	–	MR–MS	S	MS	T–MT	NSW DPI Wagga	1997
Drysdale	AH	AH	–	–	R	–	MR	MS	MS	MS	MS	MT	S	T–MT ▲	–	–	S	MS	T–MT	Graingene/NSW DPI	2001
DS Darwin	FEED	AH	S	MS–S	MR	S–VS	MR	MR	S–VS	S	S	MI ▲	MS–S	MI–I ▲	MS–S	MR	–	–	–	Dow Seeds	2015
DS Pascal	FEED	APW	MS–S	MS	S–VS	MS	MS–S	MR	MS–S	MR–MS	S ▲	I–VI ▲	MS–S ▲	MI ▲	S	–	–	–	–	Dow Seeds	2015
EGA_Bounty	AH	AH	S	S [N]	–	MSP	MR	MR	MS–S	MS	MS	MT	MS–S	MT–MI ▲	–	MS–S [N]	S	MR–MS	–	EGA	2008
EGA_Burke	APH	AH	S	MS–S [N]	MR	MS	MR	MS–S	S	MS–S	MS	MT	MS–S	MT–MI ▲	–	R–MR [N]	MS–S	S–VS	–	EGA	2006
EGA_Eaglehawk	AH	APH	–	–	MS	–	R–MR	MR–MS	MS	MS–S	MS	MT	MS	MI ▲	–	MR–MS [N]	S	MS	T	EGA	2008
EGA_Gregory	APH	AH	S	MR–MS [N]	MS–S	MR	MR	MR [†]	MS	S	MS–S	T–MT	MS–S	MT	S	MS [N]	S	MS	T	EGA	2004
EGA_Wedgetail	AH	APH	S	–	MR	MS	MR–MS	MS	MS–S	MS–S	S	MI–I ▲	S	MI–I ▲	S	–	S	MR	T–MT	EGA	2002
EGA_Wentworth	AH	AH	MS–S	MR–MS	–	–	R–MR	MS	–	MS–S	MS–S	MI–I	S	MT ▲	–	R–MR	S	MS	–	EGA	2004
EGA_Wills	AH	APW	S	MR–MS [N]	–	–	R–MR	MR–MS [†]	–	MS	MS	MT	MS–S	MT ▲	–	MS [N]	S	MS	–	EGA	2007
EGA_Wylie	AH	AH	MR–MS	MS [N]	MS–S	MS	R	MS	MS–S	MS–S	MS–S	T–MT	MS–S	MI	–	MR [N]	S	MS	–	EGA	2004
Ellison	APH	APH	S–VS	S [N]	R–MR	–	MR	MS	MS–S	MR–MS	MS–S	I–VI	MS–S	MI	–	MS [N]	MR	MR	I	Uni Sydney	2003
Elmore CL PLUS	AH	AH	S	MS [$]	S	R–MR	MR	MR–MS	MS–S	S	S	MI–I	S	MT ▲	S	MS [N]	MS–S	MR–MS	I	AGT	2011
Emu Rock	APW	AH	MS	MS–S [$]	MS	S	MR–MS	MR–MS	S–VS	MR–MS	S	I–VI	MS–S	MI ▲	S	MS	–	MR	–	InterGrain	2011
Espada	ASW	AH	S	MS–S [$]	MR–MS	R	MR	MR–MS	S	MS	S	I–VI p	S	MT–MI ▲	MS	S	S–VS	MR–MS	MT	AGT	2007
Estoc	ASW	ASW	MS	MR–MS [$]	MR–MS	MS–S	MR	MR–MS	S–VS	MS–S	S	I ▲	S ▲	MT ▲	MR	MS	MS	MR	MT	AGT	2010
Flanker	APH	APH	S ▲	–	R	MR–MS	R–MR	R–MR	MS	MS–S	MS ▲	T–MT ▲	MS–S ▲	–	S	MS	S	MS	–	LongReach	2015

Table 9. Varietal characteristics and reaction to diseases (continued)

Variety	Maximum quality classification		Resistances and tolerances																Origin	Year of release
	Northern zone	South-eastern zone	Crown rot	Common root rot	Flag smut	Leaf rust	Stem rust	Stripe Rust WA Yr 17–27 pathotype	Septoria tritici blotch	Yellow leaf spot	RLN *P. thornei* resistance*	RLN *P. thornei* tolerance**	RLN *P. neglectus* resistance*	RLN *P. neglectus* tolerance**	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance		
Forrest	ASW	APW	S–VS	MS $	MR	MS	R–MR	R–MR	MS–S	MR–MS	S–VS	I–VI ▲	S	MI ▲	S	MR	S	MR–MS	–	Advantage Wheat	2011
Gauntlet	APH	AH	MS	MS–S	MS	MS	R–MR	MR–MS	MS–S	MS	MR	MT	S	MT–MI ▲	MR–MS	MR–MS N	MS–S	MR–MS	MT	LongReach	2011
Giles	APH	AH	S	MS–S N	–	R	R–MR	MS	MR–MS	MS–S	MS–S	MI	S	MT	–	MR–MS N	MS–S	MR–MS	MT	DAFF Qld	1999
Gladius	APW	AH	S	MS $	MR	MS	MR	MR–MS	MS–S	MS	S	I–VI	MS	MT–MI ▲	MS	MS	S–VS	MR–MS	MT	AGT	2007
Grenade CL PLUS	APW	APW	S	MR–MS $	MR	S	MR	MR–MS	MS–S	S	S ▲	I–VI ▲	MS–S ▲	–	R	MS	MS	MR–MS	MT	AGT	2012
Janz	APH	APH	S	MR–MS	MR	MR–MS	R–MR	MS	MS–S	S	S	I	S	MT–MI	S	S	S	MS	I	DAFF Qld	1989
Justica CL PLUS	ASW	APW	S	MS $	R–MR	S	MR	MS	S	S	S	I–VI	S	MI ▲	MS	S	S	MR	MT	AGT	2011
Kennedy	APH	FEED	S	MS N	VS	MR	MR	MS	S	MS–S	S	MT–MI	S	MT–MI	–	R N	S	MR–MS	MT	DAFF Qld	1998
Kiora	APH	APH	S	MS	MR–MS	MR–MS	R–MR	R–MR	MS–S	MS–S	MR–MS	T–MT ▲	MS–S	MT–MI p	MS	MS	S	MR	I	AGT	2014
Kord CL PLUS	APW	APW	S	MR–MS $	MR	MS	MR	MR–MS	MS–S	MS–S	MS	I ▲	MS–S	MT–MI p	MR	MR–MS	S	–	MT	AGT	2011
Lancer	APH	APH	MS–S	S	MS–S	R–MR	R	MR	MS	MS	MS	T–MT	S	MT–MI p	S	MR–MS	–	MR	–	LongReach	2013
Lang	APH	APH	MS–S	MR–MS N	–	MS	R	MS	MS–S	MS–S	MS–S	MI–I	S	MI	–	R–MR N	MS–S	S	I	DAFF Qld	2000
Lincoln	AH	AH	S–VS	MS $	R–MR	S	MR	R–MR	S	MS–S	S–VS	I–VI	MS–S	MI ▲	S	MR–MS	S–VS	MS	MT–MI	LongReach	2007
Livingston	AH	AH	S	S N	R	MS–S	MR–MS	MR–MS	S	MS	MS	MT	S	MI ▲	S	MR–MS N	–	MR–MS	I	AGT	2007
Mace	AH	AH	S	MS $	S	MS–S	MR	S–VS	S	MR–MS	MS	MT ▲	MS	VI ▲	MR–MS	MR–MS	MS–S	MR–MS	MT	AGT	2007
Marombi	ASW	ASW	MS–S	–	R	–	MS	MS	MS	MS	MS	–	MS–S	–	–	R–MR	–	–	–	Uni Sydney	2001
Merinda	AH	AH	S–VS	S N	–	R	R–MR	MR–MS	MS–S	MS–S	MS–S	MT	S	MT–MI ▲	S	MR	–	MR	–	AGT	2007
Merlin	AH	AH	MS–S	S	MR–MS	MS	MR	MR	S	S	MS	MT–MI	MS	MT–MI ▲	MS	S	MS	MS	MT–MI	LongReach	2012
Mitch	AH	APW	MS	–	S	S–VS	MR–MS	MR–MS	S	MS	MS	MT	MS–S	T ▲	S	MR	–	MR–MSP	MT–MI	AGT	2014
Peake	APW	AH	S	S $	MR–MS	MS–S ▲	MR	MS	S–VS	S	MS	MI–I ▲	MS–S	MI–I ▲	R–MR	MS–S	MS–S	MS	MT	Nugrain	2008
Phantom	APW	APW	MS–S	MS–S $	MR–MS	S	MS	MR	MS	S–VS	S	MI	S	MT ▲	MS	MR–MS ▲	MS–S	MS–S	MT–MI	LongReach	2012
Scepter	NYC	NYC	–	–	–	MS–S	MR	MS–S	MS–S	MR–MS	–	–	–	–	–	MS	MS–S	MR	MT	AGT	2015
Scout	ASW	APW	S	S $	MR	MS	MR	MS	MS–S	S–VS	MS	MT–MI ▲	S	MI ▲	R	S–VS	MS–S	MS	MT–MI	LongReach	2009
Sentinel3R	ASW	ASW	MS–S	S $	MS–S	R	R–MR	R–MR	MR–MS	MS	MS–S	MI–I ▲	S	MT ▲	S	MS–S	S	MR	T–MT	LongReach	2005
Shield	APW	APW	S	MR–MS $	S	R	R–MR	MR	MS–S	MS–S	MS–S	I–VI p	MS ▲	–	MR–MS	MS	S	MR	MT	AGT	2012
Spitfire	APH	APH	MS	MS N	MS–S	S	MR	MR	MS–S	MS–S	MS	MT–MI	MS–S	MT–MI ▲	MS	S	MS	MS	MT–MI	LongReach	2010
Strzelecki	APH	AH	S	MR N	–	R	MR–MS	MR	MS	MS	S–VS	I	S	MT	–	MS N	MS–S	MS	–	DAFF Qld	2000
Sunbri	APH	APH	MS	MR–MS	R–MR	–	R	MR	MS	MS	MS–S	MI	MS–S	MT–MI	–	R–MR	MS–S	MS–S	I	Uni Sydney	1990
Sunbrook	APH	AH	MR–MS	R	MS–MS	–	MR–MS	MR–MS	MR–MS	S	MS	MT–MI	MS–S	MT–MI ▲	–	–	S	MS–S	T–MT	Uni Sydney	1995
Sunco	APH	APH	MS	MR–MS N	MR–MS	MR	R	MR–MS	MS	MS–S	S	I	S	MI	–	R–MR N	MS–S	S	I	Uni Sydney	1986
Sunguard	AH	AH	MS	MR–MS	S–VS	MR	R	MR	MS	MS–S	MS–S	MT	S	MT–MI ▲	–	MR N	MS–S	MS	I	AGT	2011
Sunlamb	ASW	ASW	S ▲	–	S–VS	MR–MS	R	MR–MS	MR–MS	MR–MS	MS ▲	MI ▲	MS ▲	I ▲	R–MR	–	–	MR–MS	MI	AGT	2015
Sunlin	APH	APH	MS–S	R–MR N	–	–	MR–MS	MR	MR–MS	MS	S	I	S–VS	MI	–	S N	R	R–MR	I	Uni Sydney	1996
Sunmate	APH	AH	MS–S	–	MR	MS	MR–MS	MR–MS	MS–S	MS–S	MR	T–MT ▲	S	MT–MI ▲	MR–MS	MR	S	MRP	MT–MI	AGT	2014
Sunstate	APH	APH	S	MR–MS N	–	–	MR	MS	–	MS–S	MS–S	MT–MI	MS–S	MT–MI	–	MR–MS N	S	MS–S	T–MT	Uni Sydney	1992
Suntime	APH	APH	MS	–	S	MS	R	R–MR	MS	MS–S	MR–MS	T–MT ▲	MS–S	MI ▲	MR–MS	–	–	MR–MS	MT–T	AGT	2015
Suntop	APH	APH	MS–S	MS	R	MR–MS	MR	MR–MS	S	MS–S	MR	T–MT	MS–S	MT ▲	S	MR	S	MR–MS	MT	AGT	2012

Table 9. Varietal characteristics and reaction to diseases (continued)

Variety	Maximum quality classification		Resistances and tolerances																Origin	Year of release
	Northern zone	South-eastern zone	Crown rot	Common root rot	Flag smut	Leaf rust	Stem rust	Stripe Rust WA Yr 17–27 pathotype	Septoria tritici blotch	Yellow leaf spot	RLN *P. thornei* resistance*	RLN *P. thornei* tolerance**	RLN *P. neglectus* resistance*	RLN *P. neglectus* tolerance**	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance	
Sunvale	APH	APH	MS–S	MS [N]	–	S	R–MR	MR [†]	MS	MS–S	MS–S	MT–MI	MS–S	MI	–	R–MR [N]	S	S–VS	I	Uni Sydney	1995
Sunvex	APH	AH	S	VS [N]	MS–S	MR	R	MR	MR–MS	MR–MS	MS–S	I	MS–S	MT–MI ▲	–	MS [N]	S	MS–S	I	AGT	2008
Sunzell	AH	APH	MS–S	MS–S	MS–S	MS	MR	MS	MS–S	MS–S	MS	MT	MS	MI ▲	–	S [N]	–	MR–MS	T–MT	AGT	2006
Trojan	ASW	APW	MS	MS [$]	S–VS	MR–MS	MR–MS	MR	MS	MS–S	MS	MI	MS–S	MT ▲	MS	MR–MS	–	MR–MSP	–	LongReach	2013
Ventura	AH	AH	MS–S	MR–MS [N]	R	MS–S	R–MR	MS–S	MS–S	S	MR–MS	MT	MS–S	MT–MI	–	MR–MS ▲	S	MS–S	T	Uni Sydney	2004
Viking	APH	APH	MS–S	MR–MS ▲	MS–S	MS–S	MR–MS	R–MR	S	MS–S	MS ▲	T–MT ▲	S ▲	I–VI ▲	MR	MR–MS [N]	S	MS	–	LongReach	2014
Waagan	AGP	ASW	S	–	MS	S	MS–S	S	S	MS–S	MS–S	MT–MI	S	MT–MI ▲	–	MS [N]	–	MS	MI	AGT	2009
Wallup	APH	APH	S	MS [$]	S–VS	S–VS	MR–MS	MR–MS	S	MS–S	MR–MS	MT	MR–MS	T–MT ▲	MR	MR	–	MR	I	AGT	2011
Whistler	ASW	ASW	–	–	MR	–	MR	MS–S	MR–MS	–	MS–S	–	MS–S	–	–	–	S	R	T–MT	NSW DPI Temora	1998
Wylah	AH	AH	–	–	R	–	MR	MS	MR–MS	MS	S	I ▲	S	–	–	–	S	MS–S	MI–I	NSW DPI Temora	1999
Feed wheat																					
Amarok	FEED	FEED	–	–	–	–	S	MR–MS	–	–	MR	–	S	–	–	–	–	–	–	–	2003
B53	FEED	FEED	MS	–	MR	S	MS	MR	S	MS–S	MS ▲	T ▲	MS–S	MT–MI ▲	S	–	–	–	–	Elders	2015
Brennan	FEED	FEED	S	–	–	–	MS	R–MR	MR	MS	S–VS	–	S	–	–	–	–	MR	–	CSIRO	1998
Mackellar	FEED	FEED	–	–	–	S–VS ▲	MR	R–MR	R–MR	MR–MS	MS	–	MS–S	MT ▲	–	S	–	–	–	CSIRO	2001
Manning	FEED	FEED	VS	S–VS	R	MR–MS	MR	R–MR	R	MR–MS	S	–	MS–S	–	S	–	–	–	–	CSIRO	2013
Mansfield	FEED	FEED	MS	–	R	MS	S–VS	R–MR	R–MR	MS	S	–	MS	–	S	–	–	R–MR	–	Advantage Wheat	2010
Naparoo	FEED	FEED	S	–	VS	S	R–MR	R	MR–MS	MS	S–VS	MI ▲	S–VS	–	–	–	–	–	–	AGT	2007
Preston	FEED	FEED	S	MS [$]	S	S–VS	S–VS	R–MR	MS–S	MS–S	MS–S	MI ▲	MS–S	–	S	MR–MS	–	MR	–	Advantage Wheat	2009
Rudd	FEED	FEED	–	–	–	–	S	R	MR–MS	MR–MS	S–VS	–	S	–	–	–	–	–	–	CSIRO	2001
SF Adagio	FEED	FEED	S–VS	MS	MS	MS–S	S–VS	R–MR	R–MR	MR–MS	MS ▲	–	MS ▲	–	S	–	–	R–MR	–	Seedforce	2014
SF Ovalo	FEED	FEED	S–VS	–	MR–MS	MS–S	S	R–MR	R	MR	MS	–	MS–S	–	S	–	–	R–MR	–	Seedforce	2014
SF Scenario	FEED	FEED	S–VS	–	R–MR	MS–S	MS–S	R–MR	R–MR	MS	MS ▲	–	MS–S ▲	–	S	–	–	R–MR	–	Seedforce/RAGT	2014
SQP Revenue	FEED	FEED	S	S–VS [$]	S	S–VS	R–MR	R	MR	MS	MS–S	–	MS–S	–	S	MS	–	–	–	Ausgrainz	2009
Tennant	FEED	FEED	–	–	–	–	R & S	R–MR	MR	MR	S	–	MR–MS	–	–	–	–	–	–	CSIRO	1998
Durum																					
Caparoi	ADR	ADR	VS	MS [$]	R	R–MR	R	MR	MR	MR	MR	T–MT	MS–S	MI ▲	MR	MS	MR	MR–MS	VI	NSW DPI Tamworth	2008
DBA Aurora	ADR	ADR	VS ▲	MR–MS [$]	R	R	R ▲	R–MR	MR–MS	MR–MS	R–MR	MT ▲	MS	–	MS–S	MS	–	–	–	Durum Breeding Australia	2015
DBA Lillaroi	ADR	ADR	S–VS	–	R	R	R–MR	R–MR	MR–MS	MR–MS	R–MR	MT–MI ▲	MR–MS	–	S	–	–	–	–	Durum Breeding Australia	2014
EGA_Bellaroi	ADR	ADR	VS	MR [N]	R	R–MR	MR	MR	MR–MS	MR	MR	MT–MI	MS	MI–I	–	R–MR [N]	MS–S	MR	VI	NSW DPI Tamworth	2002
Hyperno	ADR	FEED	S–VS	MS [$]	R	R	R–MR	MR	MR–MS	MR–MS	R–MR	T–MT	MS	MT ▲	MS	MS	R	S–VS	VI	AGT	2008
Jandaroi	ADR	FEED	VS	MR [N]	R	R–MR	MR	MR [†]	R–MR	MR–MS	MR–MS	MT–MI	MS	MI ▲	MS	R–MR [N]	MR	MS–S	VI	NSW DPI Tamworth	2007
Wollaroi	ADR	ADR	VS	R–MR [N]	R	–	MR	MR	R	MS	MR–MS	MT–MI	MS–S	I	–	R–MR [N]	MR–MS	R	VI	NSW DPI Tamworth	1993
Yallaroi	ADR	ADR	VS	R–MR [N]	R	–	R–MR	MR	R	MR–MS	MR	MT	MR–MS	MT–MI	–	MR [N]	MS	R	VI	NSW DPI Tamworth	1987
ASW Soft/Noodle																					
Lorikeet	ANW	ANW	–	–	VS	MS	MS	MS–S	R–MR	S	S–VS ▲	–	MS–S ▲	–	–	–	S	–	I	NSW DPI Temora	2001

Table 9. Varietal characteristics and reaction to diseases (continued)

Variety	Maximum quality classification		Resistances and tolerances																	Origin	Year of release
	Northern zone	South-eastern zone	Crown rot	Common root rot	Flag smut	Leaf rust	Stem rust	Stripe Rust WA Yr 17–27 pathotype	Septoria tritici blotch	Yellow leaf spot	RLN *P. thornei* resistance*	RLN *P. thornei* tolerance**	RLN *P. neglectus* resistance*	RLN *P. neglectus* tolerance**	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance		
Rosella	ANW	ANW	MS–S	–	VS	–	MR–MS	MR–MS	MR–MS	S	S	–	S	–	–	S	MS–S	MR–MS	I	NSW DPI Temora	1985
Sunsoft 98	ANW	ANW	S–VS	S–VS[N]	VS	–	R–MR	MS–S	MR–MS	MS	S	I	MS	MI–I	–	–	S	–	I	Uni Sydney	1998
Soft domestic																					
Barham	AGP	ASF1	S	MS–S[$]	MR–MS[$]	MR–MS	MR–MS	S	S	MS–S	MS–S	MI▲	MR	T–MT▲	MS	MS	–	MS	I	AGT	2006
Bowie	ASF1	ASF1	S	S	–	–	S	S	MS	S	MS–S	MI	MS	–	MR–MS	MR–MS	–	MS–S	I	Roseworthy	1996
Gazelle	ASF1	ASF1	S	MS–S	S	MR	MR	R–MR	MR–MS	MS–S	S	MI–I	S	MT▲	MS–S	MS–S	S	MR	–	LongReach	2012
Impala	ASF1	ASF1	MS–S	MS–S[$]	S	S–VS	R–MR	MR	S	MS–S	S	MI–I	S	MT–MI▲	MS–S	MR–MS	MS–S	MR–MS	MT–MI	LongReach	2011
Orion	ASF1	ASF1	MS–S	MS–S[$]	S	R	MR	MS–S	MS–S	MS–S	MS–S	MT–MI	MS	MT–MI▲	MS	S	–	S	–	LongReach	2009
QAL2000	ASF1	ASF1	S–VS	MR[N]	–	R	R–MR	VS	MR–MS	MS–S	MR–MS	MT–MI	S	MI▲	–	–	–	–	–	VAWCRC	2000
QALBis	ASF1	ASF1	S	R–MR	MR–MS	–	R–MR	S–VS	–	MS–S	MS–S	I–VI	S	MI	–	S[N]	–	–	–	VAWCRC	2002
Yenda	AGP	ASF1	S	MS–S	MR	–	R	S	MS	MR–MS	MS–S	MI–I	MR	MT–MI▲	MS	MR	–	R–MR	I	AGT	2006

Scoring: – = Insufficient data. NYC = No grain quality classification in NSW currently. † Varieties expected to respond to control measures if stripe rust begins early.

▲ Provisional rating. N = North. $ = South. Crown rot and common root rot ratings come from screening in SARDI, SA($) and DAF Qld (N). SARDI = South Australian Research and Development Institute; DAFWA = Department of Agriculture and Food Western Australia; NSW DPI = NSW Department of Primary Industries; DAF Qld = Department of Agriculture and Fisheries, DELWP Victoria = Department of Environment, Land, Water and Planning Victoria.

esistance ratings – The root-lesion nematode (Pratylenchus thornei & P. neglectus) rating systems were revised during 2014 and some cultivars might have different ratings to previous years.

* = RLN Resistance - The root-lesion nematode (*P. thornei* & P. neglectus) resistance ratings that appear in this planting guide are national consensus ratings based on glasshouse and field data collected in the northern and south-eastern grain regions.

Tolerance ratings – The root-lesion nematode (*P. thornei* & P. neglectus) rating systems were revised during 2014 and some cultivars might have different ratings to previous years.

** = RLN Tolerance - The root-lesion nematode (*P. thornei* & P. neglectus) tolerance ratings that appear in this planting guide are based on field data collected in the northern grain region rather than national consensus ratings. P RLN data relating to these varieties is based on less than four years of testing and is to be considered provisional information.

Resistances

R (Resistant) indicates a high level of resistance and grain yield is unlikely to be reduced.

R–MR (Resistant–Moderately resistant) indicates a high level of resistance and grain yield is unlikely to be reduced.

MR (Moderately resistant) indicates disease can develop in favourable conditions, some yield loss could occur. Early disease control can be important in some varieties.

MR–MS (Moderately resistant–Moderately susceptible) indicates disease can develop in favourable conditions, some yield loss could occur. Early disease control can be important in some varieties.

MS (Moderately susceptible) indicates disease might be conspicuous in favourable situations with moderate yield losses. Early disease control is important.

MS–S (Moderately susceptible–Susceptible) indicates disease might be conspicuous in favourable situations with moderate yield losses. Early disease control is important.

S (Susceptible) indicates high levels of disease can occur with substantial yield losses. Early disease control is essential.

S–VS (Susceptible–Very susceptible) indicates high levels of disease can occur with substantial yield losses. Early disease control is essential.

VS (Very susceptible) indicates high levels of disease can occur with substantial yield losses.

Tolerances

T (Tolerant) indicates a high level of tolerance and grain yield is unlikely to be reduced.

T–MT (Tolerant–Moderately tolerant) high level of tolerance and grain yield is unlikely to be reduced.

MT (Moderately tolerant) indicates disease can develop in favourable conditions, some yield loss could occur.

MT–MI (Moderately tolerant–Moderately intolerant) indicates disease can develop in favourable conditions, some yield loss could occur.

MI (Moderately intolerant) indicates disease might be conspicuous in favourable situations with moderate yield losses.

MI–I (Moderately intolerant–Intolerant) indicates disease might be conspicuous in favourable situations with moderate yield losses.

I (Intolerant) indicates high levels of disease can occur with substantial yield losses.

VI (Very intolerant) indicates high levels of disease can occur with substantial yield losses.

Acknowledgments for Table 9. Variety characteristics and reaction to diseases

CCN ratings are largely from the southern region screening coordinated by Hugh Wallwork, SARDI. RLN ratings are from the Queensland screening program coordinated by Jason Sheedy, Toowoomba, DAF Qld.

Note: RLN or CCN tolerance indicates the ability of the variety to grow and yield in the presence of nematodes. Resistance refers to the ability of the variety to reduce nematode carryover.

Disease scores courtesy of the various NVT screening projects throughout Australia. Lodging scores are combined ratings from the southern irrigated wheat project and Allan Peake's, CSIRO (northern irrigated wheat project).

Contributing authors: Robert Park, Harbans Bariana, William Cuddy (NSW DPI), The University of Sydney, Cobbitty; John Thompson, Graeme Wildermuth (formerly DAF Qld); Peter Williamson, Phillip Banks, John Sheppard, DAF Qld;

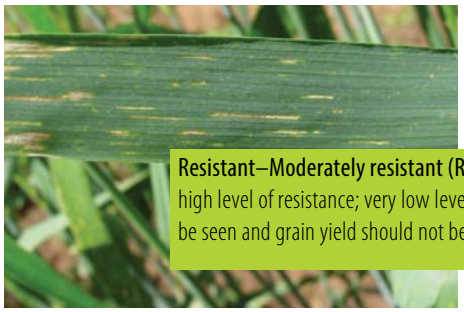
Andrew Milgate, and Steven Simpfendorfer, NSW DPI; Peter Martin and Ray Hare (formerly NSW DPI); Daryl Mares, University of Adelaide; Hugh Wallwork, SARDI; Grant Holloway, DELWP Victoria.

Stripe rust ratings – what do they mean?

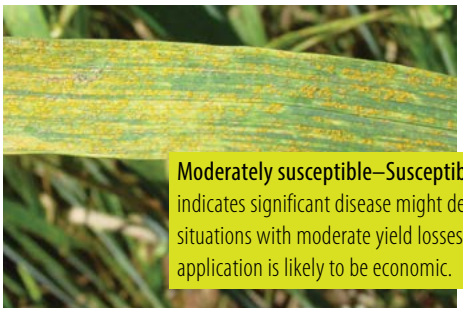
The pictures below show the varying levels of adult plant reaction to stripe rust.

Resistant (R) – indicates a high level of resistance; disease should not be normally seen and grain yield should not be affected.

Moderately susceptible (MS) – indicates moderate levels of disease can develop in favourable situations with moderate yield losses. Fungicide application is likely to be economic.



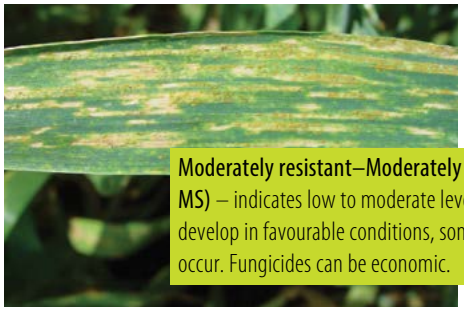
Resistant–Moderately resistant (R–MR) – indicates a high level of resistance; very low levels of disease might be seen and grain yield should not be reduced.



Moderately susceptible–Susceptible (MS–S) – indicates significant disease might develop in favourable situations with moderate yield losses. Fungicide application is likely to be economic.

Moderately resistant (MR) – indicates low levels of disease might develop in favourable conditions, some yield loss can occur but fungicide control is unlikely to be economic.

Susceptible (S) – indicates high levels of disease could occur with substantial yield losses. Fungicide applications should be budgeted and are most likely economic to apply.



Moderately resistant–Moderately susceptible (MR–MS) – indicates low to moderate levels of disease might develop in favourable conditions, some yield loss may occur. Fungicides can be economic.

Susceptible–Very susceptible (S–VS) – indicates high levels of disease could occur with substantial yield losses. Disease might require close monitoring and proactive fungicide control.

Adult plant resistance – what does it mean?

Response to stripe rust is determined by the interaction of genes for resistance in a variety and genes for virulence in the pathogen population. The reaction of a wheat variety to stripe rust depends on two forms of resistance.

1. **Seedling genes,** effective from seedling emergence through to maturity, provided the matching virulence gene in the pathogen population is absent.
2. **Adult plant resistance (APR) genes,** which become effective at various growth stages, ranging from the fourth leaf stage through to full head emergence. APR will also be effective provided that matching virulence is not present in the pathogen.

Both seedling and APR genes, and combinations of both, provide varying levels of crop protection which can be influenced by environment (temperature, crop nutrition, management) and disease pressure.

Growers need to be aware that varieties which predominantly rely on APR for stripe rust protection might be more susceptible to stripe rust infection earlier in the season until the APR provides protection. Wheat varieties with APR can benefit from early stripe rust control by fertiliser, seed or foliar fungicides. If unsure speak to your local agronomist.

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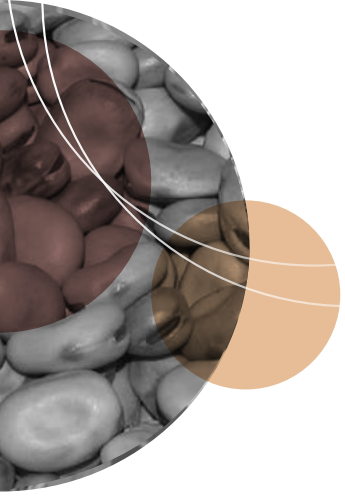

Coleoptile length of wheat varieties

Coleoptile length of wheat varieties is an important characteristic when selecting a variety to sow into difficult seedbed conditions. Coleoptile length will affect how deep you can sow a variety before plant emergence is reduced. Coleoptile length has been found to be influenced by several factors including variety, seed size, temperature, low soil moisture and certain seed fungicide dressings. Following are the results of wheat variety screening for coleoptile length from samples collected from the National Variety Testing program, which is funded by GRDC.

Table 10. Predicted mean coleoptile length for durum wheat varieties at 18 NVT sites across Australia from 2010 to 2014

Variety	Predicted mean coleoptile length (cm)
Caparoi	7.5
DBA_Aurora	7.5
DBA_Lillaroi	7.6
EGA_Bellaroi	7.7
Hyperno	7.8
Jandaroi	7.0
Kalka	7.4
Saintly	7.2
Tamaroi	7.9
Tjilkuri	7.6
WID802	7.7
Wollaroi	7.2
Yawa	7.6
Check varieties	
Federation (long)	9.3
Whistler (short)	6.0

Table 11. Predicted mean coleoptile length for early and long season wheat varieties at 17 NVT sites across Australia from 2008 to 2014

Variety	Predicted mean coleoptile length (cm)
Amarok	6.3
Beaufort	8.1
Bolac	5.6
Currawong	6.6
EGA Bounty	6.3
EGA Burke	6.1
EGA Eaglehawk	6.4
EGA Gregory	6.3
EGA Wedgetail	5.8
Einstein	6.1
Estoc	7.0
Flanker	6.2
Forrest	6.0
Frelon	7.2
Gascoigne	6.2
Gauntlet	6.7
Gazelle	5.7
Kiora	6.4
Lancer	6.7
Mackellar	6.1
Manning	5.6
Mansfield	6.2

Variety	Predicted mean coleoptile length (cm)
Mitch	6.9
Naparoo	6.3
Phantom	6.6
Rosella	6.8
Rudd	5.8
Sentinel	6.3
SF Adagio	6.1
SF Ovalo	9.1
SF Scenario	6.6
SQP Revenue	6.4
Strzelecki	6.4
Sunbri	6.8
Sunlamb	6.4
Sunsoft 98	5.9
Suntime	6.2
Sunzell	6.4
Tennant	7.2
Thornbill	5.8
Trojan	6.9
Wylah	6.1
Yenda	6.9
Check varieties	
Federation (long)	9.4
Whistler (short)	5.6

Table 12. Predicted mean coleoptile length for main season wheat varieties at 46 NVT sites from 2008–2014

Variety	Predicted mean coleoptile length (cm)
Axe	6.0
B53	6.3
Barham	6.8
Baxter	7.0
Beckom	6.4
Chara	6.3
Clearfield Janz	6.4
Cobra	6.6
Condo	6.5
Corack	6.8
Correll	7.7
Crusader	6.6

Variety	Predicted mean coleoptile length (cm)
Cunningham	6.7
Dart	7.1
Diamondbird	6.5
Drysdale	6.4
DS Darwin	5.5
EGA_Gregory	6.3
EGA Hume	6.7
EGA_Wills	6.8
EGA_Wylie	6.8
Ellison	6.9
Elmore CL PLus	7.1
Emu Rock	6.4

Variety	Predicted mean coleoptile length (cm)
Espada	6.7
Gladius	6.5
Grenade CL Plus	6.6
Impala	5.6
Janz	7.0
Justica CL Plus	6.7
Kennedy	5.9
Kord CL Plus	6.7
Lang	7.1
Lincoln	6.1
Livingston	6.6
Mace	6.9

Variety	Predicted mean coleoptile length (cm)
Merinda	6.4
Merlin	7.1
QAL2000	7.2
QALBIS	6.8
Scout	7.3
Shield	6.6
Spitfire	7.1
Sunco	7.0
Sunguard	6.9
Sunlin	6.7
Sunmate	6.9
Sunstate	6.4

Variety	Predicted mean coleoptile length (cm)
Suntop	7.0
Sunvale	6.9
Sunvex	7.4
Ventura	6.6
Viking	6.4
Waagan	6.7
Wallup	6.3
Yitpi	7.8
Check varieties	
Federation (long)	9.5
Whistler (short)	5.8

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Varietal characteristics

* NB: Quality classifications are preliminary and subject to final review.

Aim to spread the overall risk by planning to sow at least one variety at each sowing opportunity. This depends upon suitable sowing rains. Disease reactions and ratings are in Table 9. Variety characteristics and reaction to diseases on page 12.

Refer to the chapter on Durum (page 36) for notes on durum varieties.

Axe.Φ Australian Premium White classification in NSW. Very early maturity, similar to, slightly earlier than H45. Intolerant of high aluminium acidic soils. Produces very large grain with low screenings. AGT.

Barham.Φ Awnless. Biscuit wheat. Australian soft quality in southern NSW. Improved rust resistance, grain yield and quality over Bowie. Mid-season maturity, similar to Bowie. Seednet.

Baxter.Φ Australian Prime Hard quality. Combines high tolerance to root lesion nematode (*P. thornei*) and moderate susceptibility to crown rot. Maturity similar to Cunningham. High protein achiever. Heritage Seeds.

Bolac.Φ Australian Prime Hard quality in southern NSW and Australian Premium White northern NSW. Later maturing than Chara. Adapted to mildly acidic, neutral and alkaline soils. Small grain size. Seednet.

Condo.Φ Australian Hard quality in NSW. Early maturity, adapted to low–medium rainfall areas of NSW. Maturity similar to Livingston. Condo has a tall plant type with medium straw strength. Moderately tolerant of acid soils. Released in 2014. AGT.

Corack.Φ Australian Premium White quality in NSW. An early maturing Wyalkatchem derivative that has yielded well in low and medium rainfall environments and/or tight finishes to the growing season. It has high straw strength, good resistance to cereal cyst nematode and yellow leaf spot. Could be suitable for a wheat on wheat situation, low rainfall environments or late sowings. Highly tolerant to acid soils. AGT.

EGA_Bounty.Φ Australian Hard quality. Suitable for early to mid-season sowings. Nuseed.

EGA_Burke.Φ Australian Prime Hard quality in northern NSW and Australian Hard in southern NSW. Suitable for early to mid-season sowings. Medium to medium–slow maturity, similar to Giles. Pacific Seeds.

EGA_Eaglehawk.Φ Australian Prime Hard quality in southern NSW and Australian Hard in northern NSW. Late maturing spring type, similar to Sunbrook. Heritage Seeds.

EGA_Gregory.Φ Australian Prime Hard quality in northern NSW and Australian Hard in southern NSW. Similar maturity, straw strength and height to Batavia and Strzelecki. Pacific Seeds.

EGA_Wedgetail.Φ Winter wheat– **see note page 32**. Australian Prime Hard quality in southern NSW and Australian Hard quality in northern NSW. Acid soils-tolerant, early sowing variety. Large grain size. Similar maturity and height to Rosella. Adapted to higher rainfall regions in southern and central NSW and the eastern part of the northern wheat belt. Seednet.

EGA_Wylie.Φ Australian Hard quality. Suited to northern NSW. A sister line to Baxter with improved disease and lodging resistance. Medium maturity, slightly longer maturity than Baxter. Pacific Seeds.

Elmore CL PLUS.Φ Australian Hard quality classification in NSW. A mid maturing variety with Clearfield® Plus technology, which provides tolerance to label rates of Intervix® herbicide. Has an adaptation pattern similar to Janz, providing an alternative strategy for in-crop weed control. AGT.

Emu Rock.Φ Australian Hard quality classification for southern NSW. Early season variety with broad adaptation. Produces large grain with good test weight and has a low susceptibility to screenings. Bred by InterGrain and marketed by Nuseed.

Estoc.Φ Australian Standard White quality in southern NSW. Mid to late season variety, 1–3 days earlier than Yitpi. AGT.

Forrest.Φ Australian Premium White quality southern NSW and Australian Standard White quality in northern NSW. Forrest is a long season spring wheat best suited to mid–high rainfall areas of southern NSW. Forrest is currently the only released wheat variety with tolerance to *Wheat streak mosaic virus*. Released by Dow Seeds and marketed by Seednet.

Grenade CL PLUS.Φ Australian Premium White quality in NSW. An early to mid maturing line, carrying Clearfield Plus® technology, which provides tolerance to label rates of Intervix herbicide. Grenade CL PLUS combines the flexibility of improved weed management options through using Intervix® with high yield and cereal cyst nematode resistance. AGT.

Janz. Australian Prime Hard quality. Widely adapted main season variety. Moderate seedling vigour. Medium to strong straw strength,with good lodging and shattering resistance. Good milling quality.

Justica CL PLUS.Φ Australian Premium White classification in southern NSW. A mid maturing variety, possessing Clearfield® Plus technology, which provides tolerance to label rates of Intervix® herbicide. Justica CL PLUS is most suited to the mid to high yielding environments of southern NSW. AGT.

Kiora.Φ Australian Hard quality in southern NSW and Australian Prime Hard in northern NSW. Medium to late maturity suited to early to mid-season sowings in medium–high rainfall areas. A possible replacement for Bolac in medium–high rainfall environments. Released in 2014. AGT.

Kord CL PLUS.Φ Australian Premium White classification in southern NSW. An early to mid maturing variety with CCN resistance and Clearfield® Plus technology, which provides tolerance to label rates of Intervix® herbicide. Kord CL Plus performance has been better at sites and in years that have experienced terminal drought stress. AGT.

Livingston.Φ Australian Hard quality. Early maturing variety, later than H45 but earlier than Ventura and Sunstate. Intolerant of acid soils. AGT.

LongReach Cobra.Φ Australian Hard quality in southern NSW. High yielding, early mid-season variety suited to

both acid and alkaline soil types. Compact plant height, moderately resistant to lodging and has performed particularly well on irrigation and in high-production areas. Pacific Seeds.

LongReach Crusader.Φ Australian Prime Hard quality. Quick maturity, similar to Ventura and H45. Strong straw with good lodging resistance. Pacific Seeds.

LongReach Dart.Φ Australian Prime Hard quality in NSW. Quick maturity suited to later plantings; slightly quicker than Ventura, LongReach Crusader and H45. Suited to Queensland, NSW and NE Victoria. Late plantings can be a useful tool in herbicide resistance management. Good physical grain, milling and baking quality package. Lower tillering variety, with a long coleoptile and good early seedling vigour. Pacific Seeds.

LongReach Gauntlet.Φ Australian Prime Hard in northern NSW and Australian Hard quality in southern NSW. Main season maturity, similar to Janz and Lang. Fully awned. Medium length coleoptile with good early seedling vigour, short–medium plant height at maturity. Performs well in acid soils. Seednet.

LongReach Gazelle.Φ Biscuit wheat. Australian Soft quality in NSW. Mid to late season maturity, similar to QAL2000 and slightly quicker than Yenda. Fully awned. Medium length coleoptile with good early seedling vigour, medium plant height at maturity and suited to high rainfall production areas and irrigation. Very susceptible to powdery mildew. Good soft wheat grain package with low screenings, low protein accumulation and good test weight. Pacific Seeds.

LongReach Impala.Φ Biscuit wheat. Australian Soft quality in NSW. Quick to main season maturity, similar to Lincoln and Ventura. Fully awned. Medium length coleoptile with good early seedling vigour, medium plant height at maturity. Good soft wheat grain package with low screenings, low protein accumulation and good test weight. Pacific Seeds.

LongReach Lancer.Φ Australian Prime Hard milling quality in NSW. A mid to late maturing variety, which is responsive to temperature, suited to early to mid-season planting. Shorter canopy height with good resistance to lodging. Medium coleoptile length and has a medium plant height at maturity; improved lodging resistance over EGA_Gregory. Stripe rust resistance based on adult plant resistance, rated moderately resistant. Pacific Seeds.

LongReach Lincoln.Φ Australian Hard quality. Medium maturity, slightly earlier than Janz. Erect, strong and upright canopy. Well suited to southern NSW. Very susceptible to pre-harvest sprouting. Pacific Seeds.

LongReach Merlin.Φ Australian Hard milling wheat, with early to mid-season maturity similar to Ventura, Baxter and Drysdale. Suited to NSW and NE Vic. A Drysdale type with similar growth habit. A sister line to LongReach Spitfire, with a similar grain quality package. Stripe rust resistance package based on adult plant resistance (APR), rated moderately resistant. Pacific Seeds.

LongReach Orion.Φ Awnless. Biscuit wheat. Australian Soft quality. Mid-season maturity, similar to Bowie and QALBis. Long coleoptile with good seedling vigour. Performs well in acid soils. Pacific Seeds.

LongReach Phantom.Φ Australian Premium White in NSW. A mid to late season variety with similar area of adaptation as Yitpi. Tolerates boron and acid soils. Sprouting tolerance similar to Yitpi with good black point tolerance. Pacific Seeds.

LongReach Scout.Φ Australian Premium White in southern NSW. Mid-season maturity, similar to Gladius. Good grain package with low screenings and high test weight. Medium–long coleoptile with good early vigour. Performs well in both alkaline and acid soils. Pacific Seeds.

LongReach Spitfire.Φ Australian Prime Hard quality in NSW. Early to mid-season maturity, similar to Ventura and Livingston. Good soil disease control against crown rot and root lesion nematode (*P. thornei*). Good grain package with low screenings and high test weights. Long coleoptile and medium plant height. Performs well in acid soils. Pacific Seeds.

LongReach Trojan.Φ Australian Premium White in southern NSW. Mid to long season maturity suited to the medium–high rain zone of southern Australia. Short–medium plant height at maturity with good straw strength. Moderately tolerant to boron. Pacific Seeds.

LongReach Viking.Φ Australian Prime Hard quality in NSW. Mid to late maturity, similar to EGA_Gregory, which suits early May plantings. Viking has a similar plant type and early growth habit to Chara, but is taller – comparable height to EGA_Gregory at maturity. Released in 2014. Pacific Seeds.

Mace.Φ Australian Hard quality in NSW. Has good foliar disease package apart from being susceptible–very susceptible to stripe rust and should only be grown where a full fungicide management program can be implemented. Has shown adaptation to south western NSW. AGT.

Merinda.Φ Australian Hard quality. Mid-season maturity, similar to Janz. Good straw strength. Moderately resistant to black point. AGT.

Mitch.Φ Australian Hard quality in northern NSW and Australian Premium White in southern NSW. Mid to late maturing variety, suited to late April early May sowing in northern NSW. Similar height to EGA_Gregory, but has improved straw strength. It is moderately resistant to black point. Released in 2014. AGT.

Petrel. Awnless. For hay/white chaff production. Aim to sow late May to early June, but adjust so the crop can be cut for hay in optimum weather. Can be grazed if sown early.

QALBis.Φ Biscuit wheat. Australian Soft quality for NSW. Similar maturity to Sunstate. Austgrains International.

QAL2000.Φ Biscuit wheat. Australian Soft quality. Similar maturity to Sunstate. Austgrains International.

Rosella. Winter wheat – **see note page 24**. Australian Standard White/Noodle quality. Widely adapted with good seedling vigour. A useful dual-purpose grazing wheat. Strong straw, but with early sowing and higher soil fertility it can lodge when not grazed. Mid-season maturity once cold requirement is met.

Sentinel3R.Φ Australian Standard White quality in NSW. Later maturing than Janz. Moderately susceptible–susceptible to black point, susceptible to pre-harvest sprouting and resistant to shattering. Short coleoptile. Seednet.

Shield.Φ Australian Premium White quality in southern NSW. An early to mid-maturing variety, with good disease resistance and competitive grain yield. Shield has achieved grain yield levels a little lower than Wyalkatchem across southern Australia. AGT.

Strzelecki.Φ Australian Prime Hard quality for northern NSW and Australian Hard quality in southern NSW. Heritage Seeds.

Sunbri. Australian Prime Hard quality. Early season sowing option. Does not have the seedling vigour of many other varieties. Avoid sowing deeper than 10 cm.

Sunbrook.Φ Australian Prime Hard quality for northern NSW and Australian Hard quality in southern NSW. A long season spring wheat, not suited to very early sowing. Good seedling vigour. Strong straw. Prone to shattering. AGT.

Sunco. Australian Prime Hard quality. Moderate straw strength. Moderately susceptible to crown rot. In crown rot-free paddocks, lower yielding than other varieties with similar maturity.

Sunguard.Φ Australian Hard quality classification in NSW. A main season Janz derivative; similar crown rot tolerance level to EGA_Wylie with higher yield potential. AGT.

Sunlin. Awnless. Australian Prime Hard quality. Excellent sprouting tolerance and grain retention in the head at harvest. Susceptible to black point. Some frost tolerance. AGT.

Sunmate.Φ Australian Prime Hard quality in northern NSW and Australian Hard quality in southern NSW. An early maturing variety similar to Spitfire. Moderately tolerant–moderately intolerant of acid soils. Released in 2014. AGT.

Suntop.Φ Australian Prime Hard quality in NSW. A main season line that is well adapted to NSW, showing high and stable yields from low to high yield potential areas. Suntop is quicker maturing than EGA_Gregory, similar in maturity to Janz. AGT.

Sunvale.Φ Australian Prime Hard quality. Main season maturity. Medium straw strength. Moderately susceptible to common root rot. AGT.

Sunvex.Φ Australian Prime Hard quality for northern NSW and Australian Hard in southern NSW. A Sunvale derivative. Mid to late maturing line with similar maturity to Sunvale. Moderately susceptible to black point. AGT.

Sunzell.Φ Australian Prime Hard quality for southern NSW and Australian Hard in northern NSW. Acid soils tolerant early sowing variety. Slightly longer season than Strzelecki. AGT.

Ventura.Φ Australian Hard quality. Main season semi-dwarf spring wheat. Sunstate maturity. Good straw strength. Tolerates black point and acid soils. AGT.

Waagan.Φ Australian Standard White quality for southern NSW. A widely adapted, very early maturing spring wheat, similar to H45. High yield potential in medium to low rainfall environments. Moderately intolerant of acid soils. AGT.

Wallup.Φ Australian Prime Hard quality classification in NSW. A wheat that has very good grain processing quality characteristics and high straw strength. Moderate coleoptile length. Best suited to medium yield potential environments, but has not performed as well in Mallee environments. It does not tolerate toxic levels of soil boron or acid soils. Intermediate resistance to pre-harvest sprouting and black point and expresses low levels of screenings. AGT.

Yenda.Φ Biscuit wheat. Australian Soft quality in southern NSW. Short stiff-strawed variety suitable for irrigation and high rainfall areas. Seednet.

The following are more recently released varieties with limited data available in NSW.

Beckom.Φ Australian Hard quality in northern and southern NSW. Tested as V06008-14. Mid maturity similar to Suntop. Best yield performance from sowing in the first three weeks of May. Broadly adapted variety throughout NSW. Short plant height with good lodging resistance. Moderate grain size, aluminium and boron tolerant. Released in 2015. AGT.

Buchanan. No formal grain quality classification in NSW. Mid late season variety, targeted for northern NSW and southern Queensland. Very limited yield data available of performance in NSW. Grown under production risk closed loop contract. Commercialised by Austrgrains Pty Ltd.

Cutlass.Φ No current formal grain quality classification for NSW. Replacement variety in south western NSW for Yitpi. Similar maturity to Yitpi, with a flexible sowing window of mid April through to mid May. Improved disease resistance over Yitpi. AGT

DS Darwin.Φ Australian Hard quality in southern NSW. Tested as ADV03.0056. DS Darwin is an early to mid-season wheat variety suited to early–mid May sowing. It has a compact plant type, with good straw strength and lodging resistance. It performs well under both irrigated and dryland conditions. It is susceptible to *Septoria tritici* and needs to be managed accordingly where Septoria is a problem. Moderately resistant to black point. DS Darwin has a good grain package and exhibits low screenings, a large seed size and good test weight. Released in 2015. Dow Seeds.

DS Pascal.Φ Australian Premium White quality in southern NSW. Tested as ADV08.0062. DS Pascal is an early season line, being 1–2 days quicker than Bolac, making it suitable for mid April through to early May sowing. Medium plant height, with good standability and high yield potential under irrigation. Exhibits pre-harvest sprouting tolerance. Released in 2015. Dow Seeds.

LongReach Flanker.Φ Australian Prime Hard milling quality in NSW. Tested as LPB10-2555. High yielding EGA_Gregory type adapted to NSW where EGA_Gregroy is grown and has shown a 4–8% yield increase. Mid-late in maturity and has demonstrated a similar plasticity in maturity to EGA_Gregory. Reliable grain package with good test weights and sound for screenings. Pacific Seeds.

Scepter.Φ No current formal grain quality classification in NSW. Potential Mace replacement, with the limited yield data indicating improved yield over Mace. Early mid-season variety, which is slightly later than Mace. Scepter has improved stripe rust resistance over Mace. AGT

Sunlamb.Φ Australian Standard White quality in NSW. Tested as SUN521C. An awnless, long season spring wheat suited to early April plantings. Suited to grazing and grain recovery across NSW. Similar flowering time to EGA_Wedgetail, and a few days earlier than Naparoo. Moderately intolerant of acid soils. Released in 2015. AGT.

Suntime.Φ Australian Prime Hard quality in northern and southern NSW. Tested as SUN663A. Mid to late maturity variety, about 4–6 days quicker in flowering then Sunzell and 5–10 days slower than EGA_Gregory. Suited to northern NSW and an alternative to Sunzell, Lancer and EGA_Gregory. Moderately tolerant to acid soils. Released in 2015. AGT.

Feed wheats

Note – Winter wheats

Winter wheats have the major advantage of adaptability to a wide range of sowing times. Winter habit delays maturity in early sowings, thus reducing the risk of frost damage. Maturity varies once cold requirement has been met. Winter wheats can be sown from February to early April for grazing depending on vernalisation (cold) requirement. **See Managing grazing cereals, page 61**.

Amarok.Φ Winter wheat. Red grained feed wheat. Maturity between Brennan and Chara. Short straw with excellent standability. GrainSearch.

Brennan.Φ Winter wheat. Awnless. White grained feed wheat. Suitable for sowing after second week of February for grazing. Seednet.

EGA_Stampede.Φ Early to mid-maturing, similar to Hartog. Nuseed.

Mackellar.Φ Awnless. Winter wheat. Red grained, dual-purpose feed wheat. Tolerant to pre-harvest sprouting. Average coleoptile length. Resistant to *Barley yellow dwarf virus*. Seednet.

Manning.Φ Winter wheat. White grained feed wheat. Long season dual purpose grazing and grain variety with a maturity similar to SQP Revenue. Resistance to *Barley yellow dwarf virus*. Bred by CSIRO and commercialised by GrainSearch.

Mansfield.Φ White grained feed wheat, bred by Dow Seeds. Tennant maturity, potential dual-purpose variety. GrainSearch.

Naparoo.Φ Awnless. Winter wheat. Feed quality. Maturity similar to Marombi, slower than Whistler and EGA_Wedgetail. Medium height with good straw strength. Consistently produces higher levels of dry matter than Marombi, but lower grain recovery. AGT.

Preston.Φ Broadly adapted mid to long season variety. Has Australian Standard White quality grain but is only classified as feed because of late maturity alpha-amylase (LMA) expression. Moderately susceptible to common root rot. Exhibits some physiological flecking that does not affect yield. Seednet.

Rudd.Φ Awnless. Winter wheat. Red grained feed wheat. Suitable for sowing after the second week of February for early grazing opportunities. Seednet.

SF Adagio.Φ Red feed grain quality awned winter wheat, with potential for high yields. Medium to long season maturity suited high rainfall zones. Suitable for sowing late February to early March for early grazing. Bred by RAGT, commercialised by Seed Force.

SF Ovalo.Φ An awnless, long growing season winter wheat, with potential for high yields in the high rainfall zone. Bred by RAGT, commercialised by Seed Force.

SF Scenario.Φ Awnless Red winter wheat, feed grain quality, suited to the high rainfall zone. Suitable for sowing late February to early March for early grazing. Maturity similar to Frelon. Bred by RAGT, commercialised by Seed Force.

SQP Revenue.Φ Awnless. Winter wheat. Red grained feed wheat. Suitable for sowing late February–early March for early grazing opportunities. GrainSearch.

Tennant.Φ Awnless. Winter wheat. Red grained, dual-purpose feed wheat. Tall with good straw strength. Resistant or susceptible to stem rust depending on pathotype present. Sown February to March for grazing. Seednet.

The following are more recently released varieties with limited data available in NSW.

B53. White grained early maturing feed wheat variety with a high yield performance and very wide adaptation. Plant height is 2 cm less than EGA_Gregory with strong straw. Does not fit conventional classification profiles but has high dough strength and excellent sponge and dough baking performance. It is being marketed as "Feed" class but with "Specialty End Use" potential under contract. Intolerant to boron. Elders network and other partners.

Einstein. Awnless. Winter wheat. Red grained feed quality wheat. Late maturity variety best suited to high rainfall zones. Heritage Seeds.

Table 13. Disease and crop injury guide – wheat

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Foliar diseases				
Yellow spot *Pyrenophora tritici-repentis*	Tan coloured leaf lesions with a yellow border. Lesions eventually join, resulting in leaf death.	More severe in northern and central NSW, associated with retained wheat stubble. Can develop in all crops late in season after above average rainfall. Common in the south early in the growing season.	Primary infection from ascospores off wheat stubble, which are air-borne for a short distance. Secondary infection from conidia produced on infected leaves during season, which are air-borne for longer distances.	Wheat stubble removal, crop rotation (avoid wheat-on-wheat). Resistant varieties. Foliar fungicides applied before rain event as they have poor curative activity.
Septoria tritici blotch *Zymoseptoria tritici*	Leaf lesions with minute black spots; leaf death.	Once common in the south, in early-sown crops in wet springs; now rare. Can occur in high rainfall regions.	Initially air-borne spores, then rain-splashed spores within crop from infected leaves.	Resistant varieties. Seed and foliar fungicides. Fungicide resistance has developed in Victoria and Tasmania with some fungicides less effective.
Septoria nodorum blotch *Phaeosphaeria nodorum*	Leaf blotches with minute grey–brown spots; leaf death. Glumes darken to brown to grey.	Uncommon. Develops late in season with above average mid–late spring rainfall and warm temperatures.	Initially air-borne spores, rain-splashed spores within crop from infected leaves..	None required at present.
Ring spot *Drechslera campanulata*	Small (1–4 mm) spots with light centres and dark brown rims.	Southern and central areas; favoured by prolonged wet periods in late winter–early spring.	Spores spread from previously infected barley grass seed.	Reduce grass weeds in previous season. Minor disease. Control not warranted.
Physiological black chaff genetic disorder	Glumes, and sometimes stems just below the head, discoloured to brown–purple–black.	Throughout the state. Develops in wet, humid springs.	This is a genetic disorder associated with the stem rust resistance gene Sr2 in some wheat varieties.	None. Is not a disease.
Stripe (yellow) rust *Puccinia striiformis* f.sp. *tritici*	Yellow powdery pustules, often in stripes on leaves.	Can develop from mid-autumn onwards; favoured by cool (8–15 °C) moist weather. Plant infection can occur between 5–20 °C.	Air-borne spores from living plants.	Resistant varieties; seed fungicide or in-furrow fungicides on starter fertiliser at sowing and/or foliar fungicides applied in-crop; control volunteer wheat and barley grass over summer–autumn period.
Leaf rust *Puccinia triticina*	Small, orange–brown powdery pustules on leaf.	Can develop from early spring; favoured by mild (15– 22 °C) moist weather.	Air-borne spores from living plants.	Resistant varieties, foliar fungicides; control volunteer wheat over summer–autumn period.
Stem rust *Puccinia graminis* f.sp. *tritici*	Red-brown, powdery, oblong pustules with tattered edges on leaf (both sides) and stem.	Can develop from mid-spring to end of season, more severe in the north; favoured by warm (15–30 °C) humid weather.	Air-borne spores from living plants.	Resistant varieties; foliar fungicides; control volunteer wheat and barley over summer–autumn period.
Powdery mildew *Blumeria graminis* f.sp. *tritici*	White to grey cottony fungal growth on leaf and leaf sheath; black resting bodies developing during the season.	Generally more prevalent in irrigated crops and usually more evident in winter and early spring. High nitrogen levels within a crop can favour development.	Spores blown from infected trash and infected plants.	Resistant varieties, seed or in-furrow fungicides at sowing or foliar fungicides in-crop. Note: fungicide resistance in barley powdery mildew has been recorded in Western Australia.
Virus diseases				
Barley yellow dwarf *Barley yellow dwarf virus* (BYDV) and *Cereal yellow dwarf virus* (CYDV)	Yellowing, dwarfing of infected plants, reduced seed set.	Most common near perennial grass pastures and in early-sown crops.	Transmitted by aphids from infected grasses and cereals.	Resistant/tolerant varieties. Seed treatments to control early aphids in crop. In-crop aphid control.
Wheat streak mosaic *Wheat streak mosaic virus* (WSMV)	Light green streaks and blotches on leaves, stunted plants, reduced seed set.	Has occurred in wheat in southern irrigation areas, and in early-sown grazing wheat on the tablelands and slopes.	Transmitted by the wheat curl mite (WCM). Low level of seed transmission.	Generally no control required. In irrigation areas, spray out grasses in adjoining paddock 4 weeks before sowing wheat. Insecticides do not control WCM as they are protected within the curled leaf. Do not retain seed from infected crops for planting.
Root and crown rots				
Take-all *Gaeumannomyces graminis* var. *tritici*	Blackened roots, stem bases and crown; stunting; 'white heads' and pinched grain.	More common in the centre and south, favoured by a wet winter and early spring, followed by dry weather.	Soil-borne on grass and cereal residues, mostly roots and crowns.	Crop rotation for one year free of hosts; some seed and in-furrow fungicides provide a level of suppression.
Crown rot *Fusarium pseudograminearum*	Stem bases, crown and sometimes roots go brown;, 'white heads'; pinched grain.	More common in northern and western areas, favoured by moist early season and dry finish. Becoming common in the south.	Stubble-borne on grass and cereal residues.	Crop rotation, preferably for 18 months–2 years; grow more tolerant varieties; grass weed control; balance inputs to available soil water. Inter-row sowing and avoid delayed sowing to minimise losses. Only grow susceptible varieties (e.g. durum) in low risk paddocks.

Table 13. Disease and crop injury guide – wheat (continued)

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Common root rot *Bipolaris sorokiniana*	The root between the crown and seed (sub-crown internode) is always dark; roots and sometimes the stem base are brown; 'white heads', pinched grain.	Widespread through grain belt, often found in association with crown rot; scattered through the crop. Exacerbated by deep sowing.	As spores in soil, and on grass and cereal residues in soil.	Resistant varieties; crop rotation; optimise nutrition, be careful with sowing depth.
Rhizoctonia bare patch *Rhizoctonia solani*	Patches of spindly, stunted plants with yellow erect leaves; 'spear point' root rot; plant death. Later infection of crown roots just seen as wavy appearance across crop.	Associated with minimum or reduced tillage; often aggravated by Group B herbicides.	As fungal threads in soil; soil-borne on residues of many grass, cereal and broadleaf plants.	Crop rotation, soil disturbance to 5–10 cm below sowing depth at or within 2–4 weeks before sowing; avoid Group B herbicides building up, which can cause root pruning. Some seed treatments provide suppression only.
Eyespot *Tapesia yallundae*	Lodging, distinctive 'eyespot' with sharp bend in stem 3–5 cm above ground.	Southern and Central West Slopes, eastern Riverina; favoured by prolonged wet periods in late winter to mid spring.	Rain-splashed spores from crop or grass residue during winter.	Crop rotation (2-year break from cereals); fungicide at first node stage (Zadoks GS 31).
Root lesion nematode *Pratylenchus thornei* *Pratylenchus neglectus*	Lower leaves yellow, reduced tillering, general ill thrift, restricted root system.	*P. thornei* more common in north. Crops differentially host each species, e.g. canola hosts *P. neglectus* but not *P. thornei*. Lower soil fertility and delayed sowing can exacerbate impacts.	Survive within old roots or as dormant nematodes in the soil. Nematodes can be spread between paddocks and regions through the movement of soil on machinery or in flood water.	Crop rotation but note different crops, differentially host the two nematode species, tolerant or resistant varieties which again can differ for the two nematode species.
Smuts				
Flag smut *Urocystis agropyri*	Stunted plants with black, powdery streaks in leaves.	Most likely in early-sown crops (sown in warm soil).	Soil and seed-borne spores.	Resistant varieties, seed-applied fungicide.
Loose smut *Ustilago tritici*	Black powdery heads on diseased plants.	Statewide.	Air-borne spores infect developing seeds at flowering.	Seed-applied fungicide.
Bunt *Tilletia laevis*; *T. tritici*	Seed contains a black, foul-smelling mass of spores – affected grain is not accepted by buyers.	Now very rare, but present at low levels in many crops.	Spores on seed coat infect seedling before it emerges.	Seed-applied fungicide.
Grain conditions				
Head blight *Fusarium graminearum*; other fungi	Dying portions of head; white or pink, pinched grain; orange spore masses on head.	In wet springs; more common in north. Durum wheat very susceptible. Overhead irrigation during flowering can provide conditions favourable for infection.	Stubble-borne on wheat, maize, sorghum, other grasses; wind-borne and rain-splashed spores.	Crop rotation; avoid highly susceptible varieties especially durum; fungicides at flowering.
Black point genetic disorder	Dark coloured areas on grain, particularly at embryo end, reducing appearance of grain products.	Favours moist weather during late stages of grain filling and ripening..	This is a physiological condition affecting some varieties of bread wheat and durum.	Resistant varieties.
Frost injury				
	1. Dark or split nodes, kinked stem. 2. Whole or partial head death. 3. Absence of seeds.	After severe frost at stem elongation. After frost during booting. After frost from heading to flowering.		Avoid early sowing of short season varieties. Avoid short sowing windows to spread risk.

Scoring 'Herbicide injury' – Crops under climatic or disease stress can show symptoms of injury after they are sprayed with herbicide. **Refer to NSW DPI's *Weed control in winter crops*.**

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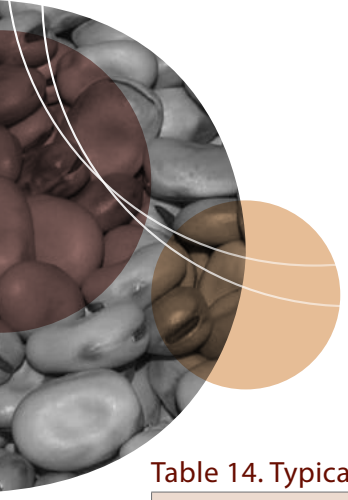


Handy hints

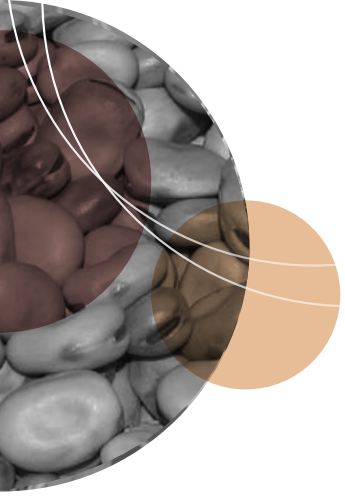
Table 14. Typical values for characteristics

Grain	Typical values for key grain characteristics				
	Seeds/kg	Volumetric grain weight (kg/hL)	Bulk densities		Angle of repose°
			kg/m³	t/m³	
Barley	53,200	62	620	0.62	28
Canary seed	143,000	70	700	0.70	–
Canola	250,000	70	700	0.70	22
Cereal rye	40,000	71	710	0.71	26
Chickpea – desi	4,500	75	750	0.75	–
Chickpea – kabuli	2,100	75	750	0.75	–
Cowpea	5,000	76	760	0.76	–
Faba bean	2,000	75	750	0.75	–
Field pea	5,000	75	750	0.75	–
Grain sorghum	45,000	72	720	0.72	28
Linseed	150,000	73	730	0.73	20
Lupin – narrow-leaf	6,000	75	750	0.75	–
Lupin – albus	3,000	75	750	0.75	–
Maize	3,000	72	720	0.72	28
Millet	250,000	62	620	0.62	–
Mungbean	15,000	75	750	0.75	–
Navy bean	5,000	75	750	0.75	–
Oats	34,400	45	450	0.45	28
Pigeon pea	6,600	75	750	0.75	–
Rice – medium grain	35,700	56	560	0.56	31
Rice – long grain	40,000	56	560	0.56	31
Safflower	24,000	53	530	0.53	28
Soybean	5,500	75	750	0.75	27
Sunflower	17,300	40	400	0.40	30
Triticale	23,000	65	650	0.65	–
Vetch	14,000	75	750	0.75	–
Wheat	34,800	75	750	0.75	27

Note: The number of seeds/kg will vary according to variety and growing conditions. The bulk density and angle of repose varies according to variety, moisture content, quality and trash content of the grain.

To check grain bulk density, weigh 1 L of grain. This weight in kilograms is its density in tonnes per cubic metre.

A**cknowledgment**: The information above was adapted from Agfact E3.9, *Storage capacity of circular silos and field bins*.



Durum

Durum wheat makes semolina upon milling which is used to make pasta and similar products.

Durum wheat produces high yields and often attracts a price premium over bread wheat, giving growers in Prime Hard wheat or similar areas a useful alternative. Durum varieties should only be grown in high fertility soils where grain of 13% protein or above is consistently produced, and preferably following a weed-free fallow, broadleaf or sorghum crop to minimise the risk of crown rot.

Varieties

See Table 9 – Variety characteristics and reaction to diseases on page 14 for additional information.

Caparoi.$^{\Phi}$ ADR quality. A mid season maturity durum, with a maturity between EGA_Bellaroi and Jandaroi. It is a semi-dwarf durum variety with good yield potential in all regions. The grain quality is better than Wollaroi, and similar to Jandaroi and EGA_Bellaroi. Caparoi has improved dough strength compared with EGA_Bellaroi, but is inferior to Jandaroi for this trait. Caparoi is superior to Jandaroi for semolina yellowness. Moderately susceptible to root lesion nematode (*Pratylenchus thornei*) and very susceptible to crown rot. Adequate resistance to common root rot. Good shedding resistance. Marketed by Seednet.

DBA_Aurora.$^{\Phi}$ ADR quality. A mid season maturity durum variety with high yield potential, released for the southern grains region. High yield potential, with yield levels similar to Hyperno in most NSW regions, so nitrogen management is important to obtain acceptable grain protein levels for delivery into durum quality grades, especially DR1. Higher levels of screenings can occur in some circumstances when compared with varieties such as Jandaroi and Caparoi. Avoid sowing DBA_Aurora later than the suggested sowing window for your region as grain quality and yield potential can be affected. It can lodge under irrigation or high yielding conditions. It is rated resistant–moderately resistant to root lesion nematodes (*P. thornei*) and susceptible–very susceptible to crown rot. Bred by the Southern Program of Durum Breeding Australia (University of Adelaide). Marketed by SA Durum Growers Association.

Table 15. Suggested sowing times

Variety Weeks	April				May				June				July		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Northern Slopes															
Caparoi, EGA_Bellaroi, Hyperno						>	★	★	★	★	★	<			
DBA Aurora*					>	★	★	<							
DBA_Lillaroi*							>	★	★	★	★	★	<		
Jandaroi							>	★	★	★	★	★	<		
Northern Plains (Moree, Narrabri)															
Caparoi, EGA_Bellaroi, Hyperno							>	★	★	★	★	<			
DBA_Aurora*					>	★	★	<							
DBA_Lillaroi*								>	★	★	★	★	<		
Jandaroi								>	★	★	★	★	<		
Liverpool Plains															
Caparoi, EGA_Bellaroi, Hyperno								>	★	★	★	<			
DBA_Aurora*					>	★	★	★	<						
DBA_Lillaroi*								>	★	★	★	★	★	<	
Jandaroi									>	★	★	★	★	<	
South Western Plains (Griffith, Hillston)															
Caparoi, EGA_Bellaroi,						>	★	★	<						
DBA_Aurora*					>	★	★	★	<						
DBA_Lillaroi*							>	★	★	★	<				

Suggested sowing times – Aim to sow crops in the earlier part of the optimum period.
The actual date is influenced by location, soil fertility and the likelihood of frost at flowering in a particular paddock.

> Earlier than ideal, but acceptable, some frost damage may occur. ★ Optimum sowing time. < Later than ideal, but acceptable, yield may be reduced.

*Note: new varieties – limited information available on the response to sowing time for these varieties.

DBA_Lillaroi.Φ ADR quality. An early–medium maturity variety, three days later flowering than Jandaroi, with a higher grain yield. Excellent durum quality with the large grain size of the commercial varieties, low screenings, high test milling yield, and the highest semolina colour compared with current varieties. Adapted to the rain-fed durum production regions of NSW and is also suited to sowing later in the season. DBA_Lillaroi is not recommended for high-input irrigated systems without the appropriate agronomic management. Rated moderately resistant to root lesion nematode (*P.thornei*) and susceptible–very susceptible to crown rot. Bred by the Northern Program of Durum Breeding Australia (NSW Department of Primary Industries). Marketed by Seednet.

EGA_Bellaroi.Φ ADR quality. A mid season maturity durum variety. The grain yield is typically better than Yallaroi or Wollaroi, but inferior to the newer-released varieties, Caparoi, DBA_Lillaroi and Jandaroi. The grain protein is consistently higher than other current commercial varieties. EGA_Bellaroi makes good quality pasta, but has poor dough strength. Moderately resistant to common root rot and very susceptible to crown rot. It can lodge under high yielding conditions, but is still the best variety for reduced crop lodging in irrigated durum production systems in southern NSW. Marketed by Seednet/Heritage Seeds.

Hyperno.Φ ADR quality for northern NSW. A mid season maturity durum with excellent yield potential. Maturity is earlier than EGA_Bellaroi. It is resistant to stem rust and resistant–moderately resistant to leaf rust; susceptible–very susceptible to crown rot. It has a good level of sprouting and black point tolerance. It can produce higher screenings than other durum varieties in some circumstances. It can lodge under irrigation or high yielding conditions. Marketed by AGT.

Jandaroi.Φ ADR quality for northern NSW. A quick maturity variety adapted to most durum producing regions and is suited to sowing later in the season. It has been shown to have improved weather tolerance at harvest compared with other varieties. Grain quality is superior to Caparoi, EGA_Bellaroi and Wollaroi, with much stronger dough properties but lower yellow pigment. An erect, semi-dwarf plant type. It is very prone to lodging under high yield conditions in southern NSW. It is moderately susceptible–susceptible to root lesion nematode, moderately resistant to black point and very susceptible to crown rot. Marketed by Seednet.

Crop management

Seed. Use sound, true-to-type seed that is free of weed seeds, cracked grain, bread wheat and barley. Durum seed is significantly larger than bread wheat seed. Thousand grain weight should be determined and used to calculate a sowing rate based on target plant population. Target plant populations are similar to bread wheats (see Calculating sowing rates on page 6). Germination percentage should exceed 90%.

Sowing time. Best yields are obtained from sowing in mid May to the end of June, depending on variety and region. Frost can damage earlier sowings at flowering.

Sowing. Adjustments might be necessary for the larger seed size; increase the sowing rate if using seed with a reduced germination percentage, or sowing later into cold conditions or higher yield potential situations. Short coleoptile length should be considered when moisture seeking. Ensure seeders are clean of bread wheat and barley in particular before starting sowing.

Nutrition. A balance of nutrients is essential for profitable yields. Fertiliser is commonly needed to add the essential nutrients nitrogen and phosphorus. A lack of other essential plant nutrients (e.g. sulfur and zinc) can also limit production in some situations. Soil test and consider paddock history to determine nutritional requirements. Complete a nitrogen budget and consider variety selection to ensure protein levels above 13% are achieved.

Table 16. Durum – Northern region – compared with Caparoi = 100%

Variety	East % Caparoi = 3.44 t/ha	Number of trials	West % Caparoi = 2.37 t/ha	Number of trials
Caparoi	**100**	**17**	**100**	**17**
DBA_Lillaroi	101	17	99	17
DBA_Aurora	109	17	110	17
EGA_Bellaroi	90	17	87	17
Hyperno	107	17	112	17
Jandaroi	97	17	96	17
Wollaroi	91	4	89	4

Yield results are a combined across sites analysis of NVT yield trials from 2011–2015.

The tables present NVT "Production Value" MET (multi environment trials) data on a regional mean basis.

Table 17. Durum – Southern region – compared with Caparoi = 100%

Variety	West#	Number of trials
	% Caparoi = 3.76 t/ha	
Caparoi	**100**	**13**
DBA_Lillaroi	99	13
DBA_Aurora	108	13
EGA_Bellaroi	93	13
Jandaroi	94	13

Includes irrigated and dryland variety trials.

Crops usually tolerate low zinc (Zn) levels when grown on heavy, self-mulching black earths (pH_{Ca} 8–8.5). When grown in very wet, high phosphate soils for several weeks, zinc deficiency symptoms can appear.

If the soil is known to be low in zinc (soil and plant tissue tests are available), a 1% aqueous solution of zinc sulfate heptahydrate applied as a foliar spray 2–4 weeks after emergence ameliorates the deficiency. A range of zinc-fortified starter fertilisers are also available.

Diseases. Durum varieties generally have useful levels of resistance to all pathotypes (including the new virulent strains) of the three rusts, but are very susceptible to crown rot. They are also susceptible to Fusarium head blight, which is common in very wet seasons and in areas where durum is grown in close proximity to maize stubble. This disease is not commonly observed under irrigation in southern NSW when grown in rotation with maize, however, growers must be aware of the risks. Rotations and paddock selection are therefore important. Avoid wheat on wheat/barley situations due to the high crown rot risk and low nutrition. Nutrient management also needs to be considered if following cotton, as incorporated cotton trash ties up and immobilises a large amount of nutrients. Ensure good grass weed control as many grass species also host crown rot. Current varieties have useful tolerance to yellow spot.

Weed control. Crops with good even plant stands usually compete well with weeds, but strong weed competition reduces yield.

Herbicide sensitivity trials suggest durum varieties can be sensitive to various Group B herbicides. Growers are advised to read product labels and **refer to the** *Weed control in winter crops* guide for the latest information on variety tolerances. Consider plant-back periods for rotations when using residual products. For additional information, check the reaction of varieties to herbicides on the relevant herbicide labels.

Harvesting. Concave adjustments might be necessary as durum can be slightly more difficult to thresh than most bread wheats. Take care when adjusting headers, because durum grain has a greater tendency to fracture than bread wheat grain.

Crops should be harvested as soon as the grain is ripe to avoid weather damage and black point development. Buyers consider grain appearance important and seek large, well-filled vitreous grain with a low percentage of mottled or bleached grains. Header cleaning is also critical to prevent contamination with barley or other cereals.

Grain storage and disposal. Durum must be strictly segregated so clean, on-farm storage is necessary if immediate delivery to buyer storage cannot be arranged. Check with end users or consult insecticide labels before applying any insecticide for grain insect management to durum in storage.

NSW Durum Wheat Growers Association. Growers are advised to join this association as the group provides a forum for growers and industry to exchange information such as variety performance, prevailing prices, market supply and demand. Refer to **Industry information, page 53**.

Further reading

Durum wheat production, 2002 John Kneipp, NSW DPI can be found on the NSW DPI website

Agronomy of the durum wheats Kamilaroi, Yallaroi, Wollaroi and EGA_Bellaroi, Primefact 140 2006 can be found on the NSW DPI website

Durum wheat chemistry and technology, 2012. 2nd edition. M. Sissons, J. Abecassis, B. Marchylo and M. Carcea eds. AACC International Press.

Contributing authors

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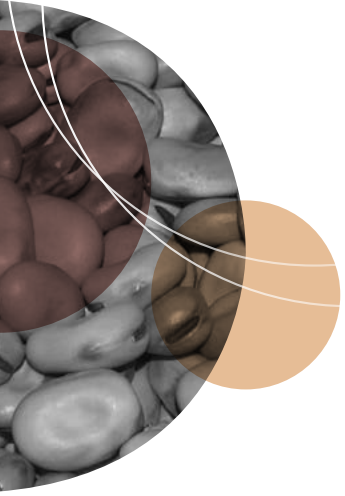

Barley

Paddock selection and nitrogen management are often the keys to producing malting quality barley.

Crop management

Sowing time

Sowing time determines the time a crop matures, and ideally flowering and grain fill should be in the cooler part of spring.

Sowing on time maximises the chances of achieving high yields and a malting grade. Sowing after mid-June usually limits yield potential and results in smaller grain and higher protein, rendering the grain less likely to be accepted as malting.

Nutrition

Soil fertility and fertiliser management, with attention to nitrogen and phosphorus, is essential to optimise yield.

Grain protein below 10.5%, in combination with low yields, usually indicates nitrogen deficiency. Where the level of protein is consistently less than 10%, at least 50 kg/ha of nitrogen can normally be applied at sowing or up to the 5-leaf stage to increase yields whilst maintaining malting quality. High fertility paddocks usually produce grain too high in protein for malting grade. High rates of nitrogen can optimise feed grain yields.

Sowing depth

Pay close attention to sowing depth, particularly where direct-drilling is practised and for varieties with a short coleoptile. The ideal depth is 3–6 cm, but seed should always be sown into moist soil. If dry sowing is being considered target a sowing depth of 3–4 cm, particularly on a hardsetting or slumping soil, to avoid problems with crop emergence.

Irrigation

Barley does not tolerate waterlogging, so good paddock drainage and management are essential for high grain yields.

Sowing rates

Select seed carefully for large size and high germination percentage. A germination test can be conducted if in doubt. See Calculating sowing rate on page 6 for the formula.

A suggested guide per hectare is:

» plains: 35–50 kg
» slopes: 45–60 kg
» tablelands and partial irrigation: 60–90 kg
» full irrigation: 70–110 kg
» grazing and grain: increase the above rates by 10–20 kg
» cover crops for pastures: 10–20 kg.

The lower rates should be used when there is limited subsoil moisture at sowing, and in drier areas. High sowing rates tend to decrease grain size and increase screenings.

Acid soils tolerance

Yambla and Tulla tolerate high soil aluminium up to 10–15%. Most varieties are very tolerant of high manganese levels.

Variety choice

When selecting a variety consider:

» Crop use. For grazing and grain recovery, feed grain, or malt grain production?
» Grazing value. When is feed most important? Dual-purpose varieties are most suitable.
» Grain:
  – For retention on farm?
  – For sale as feed grain?
  – For sale as human food?
  – For sale as a malting or food grade – for general delivery to malt segregations or under contract? Use only accredited malting or food grade varieties.
» Disease prevalence. Check variety response to common diseases in the area; see Table 20 Variety characteristics and reaction to diseases.
» Herbicide tolerance.

See variety details in Varietal characteristics on page 32.

Management to achieve malting barley

Paddock selection

» Nitrogen status appropriate for expected yield.
» Soil pH_{Ca} not less than 5.0 or soil aluminium not more than 5%.
» Avoid soils prone to waterlogging.
» Rotation: ideally sow after a root-disease break crop.
» Avoid barley on barley. Barley can be sown after wheat if disease or seed contamination is not a problem.
» Avoid varietal contamination.

Variety choice

» Appropriate for the environment.
» To suit the sowing time.
» Availability of segregation.

Sowing time

» Too early increases the risk of frost damage.
» Too late will increase protein and screenings.

Sowing rate

» Too high can reduce grain size and increase lodging, especially under irrigation.
» Too low will reduce yield potential.

Seed treatment

» Use appropriate seed dressings to control smuts and foliar diseases.
» Note the effect of seed treatments on short–medium coleoptile length varieties, particularly in deep-sown situations.

Phosphorus

» Too low will limit yield and increase protein.

Nitrogen

» Too low will reduce yield and quality.
» Excessive nitrogen fertiliser can increase screenings and protein levels.

Timely weed control

» Weeds compete for nutrients and moisture.
» Reduce contamination.

Care with harvest

» Avoid skinning.
» Try to minimise weather damage effects.
» Avoid varietal contamination.
» Only use grain protectants registered for malting barley.

Variety selection

Varietal characteristics

The following is a list of barley varieties, including new releases for 2016. The variety descriptions should be read in conjunction with Table 20 Variety characteristics and reaction to diseases.

Information has been collated from breeding companies. Refer to tables for suggested sowing times.

BARLEYmax. A specialty barley for the human food market. Early–mid season maturity. Dark coloured, semi hulless seed with a shrunken endosperm.

Bass.$^{\Phi}$ Malt. Baudin replacement with excellent grain plumpness and high test weight, suited to medium–higher rainfall districts. Similar maturity to Baudin. Moderately short variety with good straw strength and head retention. Improved disease resistance compared with Baudin. Undergoing market development. InterGrain.

Baudin.$^{\Phi}$ Malt. Excellent malting quality. A Gairdner replacement with earlier maturity (rated mid-season) and lower screenings. Adapted to medium rainfall areas. Short with excellent straw strength and head retention. Very susceptible to powdery mildew and leaf rust. Released by the Department of Agriculture and Food WA (DAFWA). Seednet.

Buloke.$^{\Phi}$ Malt. Excellent malting quality for export market. Tall, early to mid-season variety; flowering time similar to Schooner. Buloke has a better grain size than Gairdner, but smaller than the benchmark variety Schooner. Buloke exhibits sprouting tolerance, similar to Gairdner. Can lodge under conditions favouring high yield and is susceptible to head loss. Bred by VIC DEPI. Seednet.

Capstan.$^{\Phi}$ Feed. A very short variety with outstanding straw strength and head retention. Best suited to high input farming systems targeting very high yield. Offers advantages in stubble management. Modest, early vigour and potential for low test weights under drought stress should preclude it from drier districts. Bred by the University of Adelaide. Seednet.

Commander.$^{\Phi}$ Malt. A malting quality variety suitable for the domestic and Asian export markets. Mid-season variety, with a maturity between Schooner and Gairdner. Plump grain size compared with other malting varieties. High yield potential and lower grain protein than Schooner or Gairdner when grown under the same conditions. Can lodge when sown early. Developed by the University of Adelaide. Seednet.

Fairview.$^{\Phi}$ Malt. A mid–late season variety available only under contract to Malteurop. Better straw strength and grain size than Gairdner. Has performed particularly well under irrigation. Fairview has an export malt quality profile and must be marketed through Malteurop.

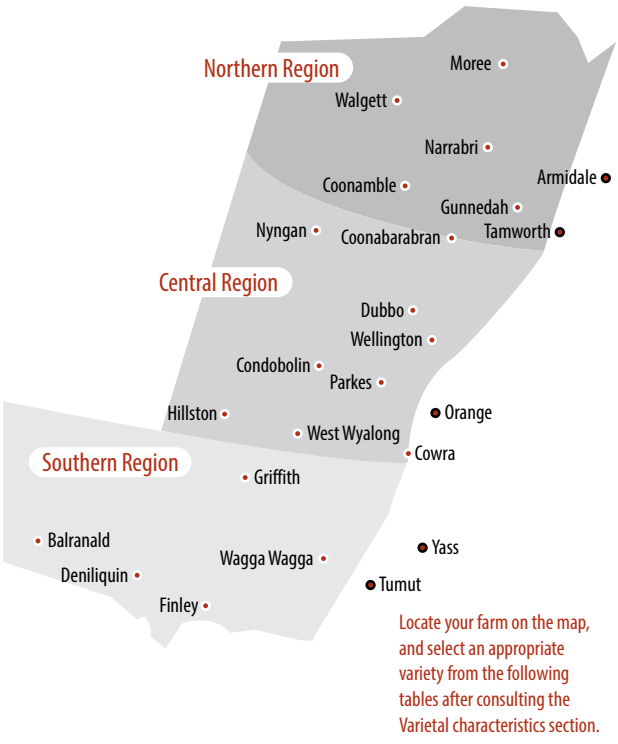

Figure 2. Map of NSW showing barley growing zones

Yield performance experiments from 2009–2015

Yield results presented are NVT 'Production Value' MET values on a regional mean basis for NSW from 2009–2015. The number of experimental results are listed; the more trials, the greater the reliability.

Table 18. Main season sown: Compared with Hindmarsh = 100%

Variety	North-east Hindmarsh = 3.62 t/ha	Number of trials	North-west Hindmarsh = 3.61 t/ha	Number of trials
Bass ◆	94	17	97	27
Baudin ◆	90	15	93	26
Buloke ◆	94	16	96	26
Capstan	97	20	101	5
Charger	98	10	–	–
Commander ◆	103	20	105	31
Compass	109	10	107	17
Fairview ◆	101	6	–	–
Fathom	108	16	108	26
Fitzroy ◆	93	20	97	31
Fleet	104	10	107	14
Flinders ◆	94	16	96	26
Gairdner ◆	87	20	88	31
GrangeR ◆	102	20	102	26
Grimmett ◆	87	18	87	26
Grout	97	20	97	31
Hindmarsh	**100**	**20**	**100**	**31**
LaTrobe ◆	100	13	100	21
Mackay	94	14	94	26
Navigator ◆	90	17	–	–
Oxford	97	20	101	31
Rosalind	108	4	107	9
Schooner ◆	89	16	89	31
Scope CL ◆	93	20	94	31
Shepherd	99	20	98	31
Spartacus CL	102	4	100	9
SY Rattler	95	16	95	4
Urambie	93	20	97	31
Westminster ◆	92	20	94	3

Note: ◆Accredited malt varieties.

For grazing consider Yambla and Urambie.

For grazing and grain recovery consider Urambie.

For malting production, consider Buloke, Commander, La Trobe and Scope CL. In more reliable rainfall regions also consider GrangeR and Navigator.

For food grade production, consider Hindmarsh.

For feed grain production only consider Compass, Grout, Mackay, Oxford, Rosalind, Shepherd and Spartacus CL.

Variety	South-east Hindmarsh = 3.82 t/ha	Number of trials	South-west Hindmarsh = 3.60 t/ha	Number of trials
Bass ◆	96	12	90	21
Baudin ◆	92	14	81	25
Buloke ◆	94	14	90	25
Capstan	101	6	–	–
Charger	101	12	–	–
Commander ◆	98	14	90	25
Compass	106	8	105	15
Fairview ◆	97	8	–	–
Fathom	100	12	98	23
Flagship ◆	89	6	87	10
Fleet	99	14	93	25
Flinders ◆	93	12	90	23
Gairdner ◆	89	14	84	25
GrangeR ◆	98	14	93	21
Hindmarsh	**100**	**14**	**100**	**25**
LaTrobe ◆	102	10	100	19
Navigator ◆	90	12	–	–
Oxford	99	14	88	25
Rosalind	110	4	109	8
Schooner ◆	84	14	81	25
Scope CL ◆	93	14	90	25
Shepherd	90	10	87	17
Spartacus CL	102	4	102	8
SY Rattler	93	14	–	–
Urambie	94	14	88	25
Westminster ◆	92	13	–	–

Note: ◆Accredited malt varieties.

Yambla and Urambie can be sown from mid–late March if grazed. For grazing and grain recovery consider Urambie.

For malting production consider Buloke, Commander, La Trobe and Scope CL. In more reliable rainfall regions also consider GrangeR.

For food grade production consider Hindmarsh.

For feed grain production only consider Compass, Oxford, Rosalind, Spartacus CL and Urambie. In western areas, also consider Fathom.

Suggested sowing times

Aim to sow in the earlier part of the indicated optimum time to achieve maximum potential yield, particularly in western parts of the region. Selection of the actual date should allow for soil fertility and frost damage risk in particular paddocks.

Table 19. Suggested sowing times

Variety / Weeks	March				April				May				June				July		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Northern region																			
Urambie■, Yambla■		>	★	★	★	★	★	★	★	★	<								
Capstan, Fairview▲, Gairdner, GrangeR, Navigator, Oxford, Westminster▲							>	★	★	★	★	<							
Bass▲, Baudin, Yarra								>	★	★	★	★	★	<					
Buloke, Commander, Fitzroy, Flagship, Fleet, Mackay, Scope CL									>	★	★	★	★	★	<				
Compass▲, Grimmett, Hindmarsh, La Trobe▲, Rosalind▲, Spartacus CL▲									>	>	★	★	★	★	<				
Fathom ▲, Grout, Shepherd										>	★	★	★	★	★	<			
Central region																			
Urambie■, Yambla■		>	★	★	★	★	★	★	★	★	★	<							
Bass▲, Capstan, Fairview▲, Gairdner, Oxford, Westminster▲							>	★	★	★	★	<							
Baudin, GrangeR, SY Rattler▲								>	★	★	★	★	<	<					
Buloke, Commander, Fitzroy, Flagship, Fleet, Mackay, Schooner, Scope CL, Tilga, Tulla									>	★	★	★	★	<	<				
Compass▲, Rosalind▲										>	★	★	★	<	<				
Fathom▲, Grout, La Trobe▲, Hindmarsh, Shepherd, Spartacus CL▲										>	★	★	★	★	<	<			
Southern region																			
Urambie■, Yambla■		>	★	★	★	★	★	★	★	★	<								
Admiral▲, Bass▲, Baudin, Capstan, Charger▲, Fairview▲, Flinders▲, Gairdner, GrangeR , Oxford, SY Rattler▲, Westminster▲							>	>	★	★	★	★	★	★	<	<			
Tilga, Tulla									>	★	★	★	★	★	★	<	<		
Buloke, Commander, Flagship, Fleet, Schooner, Scope CL, SouthernStar▲										>	★	★	★	★	★	★	<		
Compass▲, Fathom▲, Hindmarsh, La Trobe▲, Rosalind▲, Shepherd, Spartacus CL▲										>	>	★	★	★	★	★	★	<	

> Earlier than ideal, but acceptable. ★ Optimum sowing time. < Later than ideal, but acceptable.
■ Dual purpose varieties that can be grazed. Yambla and Urambie can be sown from mid–late March, if grazed.
▲ Limited information available on performance in NSW.

Table 20. Variety characteristics and reaction to diseases

Variety?	Straw strength	Leaf scald	Net Blotch net form	Net Blotch spot form	Powdery mildew	Leaf rust	BGYR (stripe) rust	Crown rot	Common root rot	Cereal cyst nematode resistance	RLN *P. thornei* Resistance	RLN *P. thornei* Tolerance	RLN *P. neglectus* Resistance	RLN *P. neglectus* Tolerance	Issued by	Year registered
Admiral◆	very good	S–VS	MS–S	S	MR & S–VS	MS	R	–	–	R	–	–	–	–	Cargill (Joe White Malting)/University of Adelaide	2014
Bass◆	good	S–VS	MS–S	S	S	S–VS	MR	S	MS	S	MR–MS▲	MT▲	MR–MS▲	I▲	InterGrain	2012
Baudin◆	good	S–VS	MR–MS & S	MS–S	VS	VS	MR	–	S	S	MS–S▲	–	MR–MS▲	MI–I▲	DAFWA	2002
Binalong	good	S–VS	VS	MS	R & S	S–VS	–	MS	MR	S	MR▲	I▲	MS▲	–	NSW DPI/DAFF Qld	2002
Buloke◆	medium	MS–S & S–VS	MR	S	R–MR	S	MR	S–VS▲	MS	S	MS▲	–	MR–MS▲	–	DELWP Victoria	2004
Capstan	very good	S–VS	MS–S	MR–MS	MS	MS–S	MR–MS	–	S–VS	R	MR▲	MT–MI▲	MR▲	VI▲	University of Adelaide	2002
Charger	good	VS	VS	S–VS	R	MR	R	S▲	MS	R	MR–MS▲	MT–MI▲	MR▲	T–MT▲	Carlsberg & University of Adelaide	2013
Commander◆	medium	VS	MR–MS & S	MS–S	MR–MS & S	S	R–MR	MS–S	MS	R	MR–MS	MT	MR–MS	MT▲	University of Adelaide	2008
Compass	medium	S–VS	MR–MS	MS–S	MR & S	VS	R–MR	S	MS	R	MR▲	T▲	MR–MS▲	T–MT▲	University of Adelaide	2013
Fairview◆	very good	VS	MS–S	S	R	S	R–MR	–	–	–	MR▲	–	MR–MS▲	–	Malteurop	2008
Fathom	good	MS	MS–S	MR	MR–MS	MS–S	MR	MS–S	MS–S	R	MR–MS▲	–	MR–MS▲	–	University of Adelaide	2012
Fitzroy◆	good	S–VS	MR	MS–S	S–VS	S–VS	MR–MS	S▲	–	S	MS–S	MT–MI	MS	I▲	DELWP Victoria	2004
Flagship◆	medium	S–VS	MR–MS	MR–MS	S	MS–S	MR	–	MS–S	R	MR–MS▲	MT▲	MR–MS	MT▲	University of Adelaide	2006
Fleet	medium	S–VS	MR–MS	MR	MR	MS–S	MR	MS–S	MS–S	R	MR–MS▲	MT–MI▲	MR–MS	MT▲	University of Adelaide	2006
Flinders◆	good	S–VS	MR–MS	S	R	MR–MS	MR	S–VS	MS	S	MR–MS▲	–	MR–MS▲	–	InterGrain	2014
Gairdner◆	medium–good	S–VS	MR–MS	S	S	S	MR	S	MS–S	S	MS▲	I-VI	MR–MS	MI–I▲	DAFWA	1998
GrangeR◆	good	S–VS	MR–MS & S	S–VS	R	MR	R–MR	S	S	R	MR	MT–MI▲	MR	MI–I▲	Heritage Seeds	2013
Grimmett◆	medium	VS	S–VS	S	S	S	MR	S▲	MR	–	MR–MS	MI–I	MS–S	MI▲	DAFF Qld	1982
Grout	good	VS	MR–MS & S	S	R & S	VS	MR	S▲	MS	–	MS	MT	MS	MT–MI▲	DAFF Qld	2005
Hindmarsh●	good	VS	MS	S–VS	MR–MS & S	S	MR–MS	S	S	R	MR–MS	T–MT▲	MR–MS	MT–MI▲	DELWP Victoria	2006
La Trobe◆	good	VS	MS	S	MR–MS & S	S	MR	MS–S	S	R	MR–MS	MT▲	MR–MS	MT▲	InterGrain	2013
Mackay	medium–good	S–VS	MR–MS & S	S	MR	MR–MS	MR	S–VS▲	MR–MS	–	MS▲	MI	MR–MS	MI–I▲	DAFF Qld/NSW DPI	2002
Navigator◆	medium	S–VS	MR–MS & S–VS	MR–MS	R & S–VS	VS	MR	S	MS	R	MR–MS▲	MI–I▲	MR–MS	MI–I▲	University of Adelaide	2012
Oxford	good	S–VS	MS–S	S	R	MR	R & S	S	MS–S	S	MR–MS▲	I▲	MR▲	I–VI▲	Nickerson/Heritage Seeds	2009
Rosalind	good	S	MR	S–VS	MR–MS & S	MR–MS	–	–	–	R	MR▲	T▲	MS▲	T▲	InterGrain	2015
Schooner◆	medium	S	MR–MS	MS–S	S	S–VS	MR	MS–S	S	VS	MR–MS▲	MT▲	MS▲	–	University of Adelaide	1983
Scope CL◆	medium	S–VS	MR	MS–S	R–MR	S	MR	S	MS	S	MR–MS▲	MI▲	MR–MS▲	MI▲	DELWP Victoria	2010
Shepherd	good	S–VS	MR & S	S–VS	R & MS–S	MR	MR	MS–S	–	–	MS–S	MI▲	MR–MS	MI▲	DAFF Qld/DAFWA	2008
SouthernStar	medium	S	MR–MS	MS	S	MS	MR	–	–	R	–	–	–	–	Sapporo Breweries/University of Adelaide	2014
Spartacus CL	medium–good	VS	MR & S	S–VS	MR & S	S	–	–	S	R	MR–MS▲	–	MS▲	–	InterGrain	2016

Table 20. Variety characteristics and reaction to diseases (continued)

Variety?	Straw strength	Leaf scald	Net Blotch net form	Net Blotch spot form	Powdery mildew	Leaf rust	BGYR (stripe) rust	Crown rot	Common root rot	Cereal cyst nematode resistance	RLN *P. thornei* Resistance	RLN *P. thornei* Tolerance	RLN *P. neglectus* Resistance	RLN *P. neglectus* Tolerance	Issued by	Year registered
SY Rattler	good	S–VS	MS	S–VS	R	MR	MR	S	MS–S	–	MR–MS▲	M–I▲	MR▲	MI–I▲	Syngenta Seeds/GrainSearch	2011
Tilga	medium	S	MR–MS & S	MR	S	S–VS	MR	VS	VS	VS	–	–	–	–	NSW DPI/DELWP Vic.	1997
Tulla	good	S	MS	S	S–VS	S	MR	–	–	VS	–	–	–	–	NSW DPI	2003
Urambie■	very good	MS	MR–MS	S	MR–MS	S	R	–	–	–	MR▲	–	MS▲	–	NSW DPI	2005
Westminster◆	good	S	MS–S	S	R	R–MR	R	MS–S	MR–MS	–	MS▲	I▲	MR–MS▲	VI▲	Nickerson/GrainSearch	2010
Yambla■	good	S	S	S	MS–S	S	R–MR	–	–	S	–	–	–	–	NSW DPI	1998

Where ratings are separated by '&' the first is correct for the majority of situations, but different pathotypes are known to exist and the latter rating reflects the response to these pathotypes, ■ = suitable for grazing and grain recovery, ▲ = provisional rating, – = Insufficient data. ◆ May be accepted as malting. Accredited by Barley Australia. ● Food grade.

Resistance ratings – The root-lesion nematode (*P. thornei* & *P. neglectus*) rating systems were revised during 2014 and some cultivars may have different ratings to previous years. Resistance ratings that appear in this planting guide are national consensus ratings based on glasshouse and field data collected in the northern and southern grain regions.

Tolerance ratings – The root-lesion nematode (*P. thornei* & *P. neglectus*) rating systems were revised during 2014 and some cultivars may have different ratings to previous years. Tolerance ratings that appear in this planting guide are based on field data collected in the northern grain region rather than national consensus ratings.

DAFWA = Department of Agriculture and Food Western Australia; NSW DPI = NSW Department of Primary Industries, DAFF Qld = Department of Agriculture Fisheries and Forestry, Queensland;

DELWP Victoria = Department of Environment, Land, Water and Planning Victoria.

Resistances

R (Resistant) indicates a high level of resistance; disease should not be seen and grain yield should not be affected.

R–MR (Resistant–Moderately Resistant) indicates a high level of resistance; very low levels of disease may be seen and grain yield should not be reduced.

MR (Moderately Resistant) indicates low levels of disease may develop in favourable conditions, some yield loss may occur but fungicide control unlikely to be economic.

MR–MS (Moderately Resistant–Moderately Susceptible) indicates low to moderate levels of disease may develop in favourable conditions, some yield loss may occur. Fungicides may be economic.

MS (Moderately Susceptible) indicates moderate levels of disease may develop in favourable situations with moderate yield losses. Fungicide applications likely to be economic.

MS–S (Moderately Susceptible–Susceptible) indicates significant disease may develop in favourable situations with moderate yield losses. Fungicide application likely to be economic.

S (Susceptible) indicates high levels of disease may occur with substantial yield losses. Fungicide applications should be budgeted.

S–VS (Susceptible–Very Susceptible) indicates high levels of disease may occur with substantial yield losses. Disease may require close monitoring and proactive fungicide control.

VS (Very Susceptible) indicates very high levels of disease may occur in favourable seasons with serious yield losses. Will require close monitoring and proactive fungicide control. Likely to develop some disease even when conditions less favourable.

Tolerances

VT (Very Tolerant) indicates a high level of tolerance and grain yield is unlikely to be reduced.

T (Tolerant) indicates a high level of tolerance and grain yield is unlikely to be reduced.

T–MT (Tolerant–Moderately Tolerant) indicates disease may develop in favourable conditions, some yield loss may occur.

MT (Moderately Tolerant) indicates disease may develop in favourable conditions, some yield loss may occur.

MT–MI (Moderately Tolerant–Moderately Intolerant) indicates disease may be conspicuous in favourable situations with moderate yield losses.

MI (Moderately Intolerant) indicates disease may be conspicuous in favourable situations with moderate yield losses.

MI–I (Moderately Intolerant– Intolerant) indicates high levels of disease may occur with substantial yield losses.

I (Intolerant) indicates high levels of disease may occur with substantial yield losses.

VI (Very Intolerant) indicates high levels of disease may occur with substantial yield losses.

Fathom.[Φ] Feed. Fathom is a feed quality variety developed using wild barley to improve stress tolerance and water use efficiency. It has a long coleoptile and shows particularly good early vigour and weed competitiveness. Early maturity, similar to Hindmarsh, best suited to lower and medium rainfall environments. Fathom is a moderately tall variety, but shows good straw strength and has excellent grain plumpness with screenings levels lower than Hindmarsh. Developed by the University of Adelaide. Seednet.

Fitzroy.[Φ] Malt. A medium to medium–late maturing variety with better disease resistance than Gairdner and acceptable grain size. Fitzroy is a semi-dwarf plant with good seedling vigour and good straw strength. Best suited to northern NSW and Queensland barley growing areas. Best results will be achieved in more favourable environments. Can exhibit low test weights under stressed conditions. Seednet.

Flinders.[Φ] Malt. Flinders is a medium–late maturing high-yielding barley variety, potentially offering yields greater than Baudin or Gairdner. It has a prostrate growth habit like Baudin, with maturity similar to Gairdner and suited to earlier sowing opportunities. Short coleoptile, so deep sowing should be avoided. Flinders has good resistance to crop lodging and head loss. It offers a useful disease resistance package, in particular resistance to powdery mildew. InterGrain.

Gairdner.[Φ] Malt. Adapted to medium to higher rainfall areas (>400 mm). Mid to late season maturity and strong straw. Best sown early. Gairdner has a thin grain, producing significantly greater screenings losses relative to Schooner and is also around 1% lower in grain protein. Resistance to BYDV. Developed by DAFWA. Heritage Seeds.

GrangeR. Malt. A medium–late, high-yielding, broadly adapted barley with excellent malt extract, good diastatic power, and targeted for the domestic malting industry as a potential Gairdner replacement. Performs better than Oxford under late planting conditions. GrangeR is on average 10 cm taller than Baudin and 3–4 cm taller than Gairdner, but with better lodging resistance; higher test weight; a potentially larger kernel size (2–4 grams/1000 grains); and lower screenings. Licensed to Heritage Seeds by Nickerson–Limagrain, UK.

Grimmett. Malt. A reliable malting variety for the northern region. Suitable for mid-season and late plantings, particularly in western areas. Very good grain size. Consider seed treatment for net blotch and/or powdery mildew.

Grout.[Φ] Feed. A quick maturing variety with good grain size, suited to northern NSW and Qld. Matures up to two weeks earlier than Grimmett from a mid-May to mid-June planting. Vigorous seedling with a high tillering ability and erect growth habit. Medium height with moderate standability, better than Grimmett and similar to Mackay. Leaf rust needs to be managed, rated as susceptible–very susceptible. Seednet.

Hindmarsh.[Φ] Food. An erect, semi-dwarf variety, which flowers earlier than Schooner, and is widely adapted to low and medium rainfall areas. Excellent yield potential, grain plumpness close to Schooner, and high test weight. Short coleoptile, so deep sowing should be avoided. It has been given a new classification of 'food', and may be segregated for human food and possibly used for Shochu (Japanese distilled spirit) and for malt production in some markets. Developed by Victorian DEPI. Seednet.

La Trobe.[Φ] Malt. La Trobe is an early maturing semi-dwarf variety with good yield potential in low to medium production environments. It has very similar growth habit and plant architecture to Hindmarsh. It has excellent head retention, lodging resistance and good physical grain characteristics. Similar disease profile to Hindmarsh. La Trobe also possesses good pre-harvest sprouting tolerance. InterGrain.

Mackay.[Φ] Feed. A mid-season variety with good resistance to lodging. Large grain size. Bred by DAFF Qld. Heritage Seeds.

Navigator.[Φ] Malt. Navigator is mid–late maturing, similar to Gairdner but offering higher yield potential, significantly improved physical grain quality. Navigator needs to be monitored for disease, in particular leaf rust, the net form of net blotch and powdery mildew. Production is targeted for the south-eastern region of SA and northern NSW where production contracts are available. Seednet.

Oxford. Feed. A medium–late maturing variety similar to Gairdner. High yield potential, with wide adaptation. Excellent head retention with above average test weight and excellent grain colour. Good straw strength and resistance to lodging. Resistant to powdery mildew and moderately resistant to leaf rust. Heritage Seeds.

Schooner. Malt. Formerly a major central and southern malting variety, favoured for its reliability in maintaining grain size, although lower yielding than later releases. Can be prone to pre-harvest head loss.

Scope CL.[Φ] Malt. An imidazolinone-tolerant barley, which provides tolerance to label rates of Intervix® herbicide. Check current herbicide registrations for registered product rates. Tall, early–mid season variety, with a flowering time and head loss susceptibility similar to Buloke. Developed by Agriculture Victoria Services and Seednet.

Shepherd.[Φ] Feed. It is slightly later maturing than Grout, but similar growth habit with erect vigorous early growth. Suited to medium rainfall areas of northern NSW and Qld. Seednet.

SY Rattler.[Φ] SY Rattler is a high-yielding mid-maturity potential malting barley with medium height and stiff straw. SY Rattler has all the necessary quality for the domestic brewing markets coupled with excellent grain quality. Undergoing malt evaluation by Barley Australia. SY Rattler was bred by Syngenta and seed is available through GrainSearch.

Tilga. A feed variety suited to western areas. Tall, with moderate straw strength in high-yielding situations. Good grain size. Tilga has some light blue aleurone (skin) grain. Use a seed dressing as Susceptible to loose smut.

Tulla.[Φ] Feed. A main season variety. Acid soil tolerant. Similar yields to Tantangara on nonacid soils. Bred by NSW DPI. Waratah Seeds.

Urambie.[Φ] Feed. It is best suited to grain and grazing situations. Two-row barley, adapted to early sowing, having early maturity combined with a cold requirement to initiate heading. Sowing window is early May to mid-June; earlier if grazed. Consistent yields across seasons, but low grain quality. Waratah Seeds.

Westminster.[Φ] Malt. A medium–late maturity variety similar to Gairdner, Westminster has a high yield potential and performs well under high rainfall or irrigation. Medium–tall variety with good straw strength and improved head retention compared with Gairdner. Introduced malt barley from Nickerson International Research, licensed to GrainSearch in Australia.

The following are more recently named or released varieties. Only limited seed may be available of some lines in 2016.

Admiral.[Φ] Malt. Limited information on the performance of Admiral in NSW. A new malting barley developed by Cargill (Joe White Maltings) and the University of Adelaide. It is a semi-dwarf variety with stiff straw and maturing slightly later than Gairdner, hence is suited to high-yield potential environments and also early-sowing opportunities. Seed will be available from Seednet for 2016 sowing with the potential for production contracts to malting companies.

Charger.[Φ] A new specialist malting barley developed by Carlsberg and Heineken Breweries in collaboration with the University of Adelaide. It is mid maturing with good straw strength. Charger has shown consistently high grain yield, particularly in favourable environments. Contract production is exclusively managed by Australian Grain Growers Cooperative.

Compass.[Φ] A potential new malt barley developed by the University of Adelaide as an early to mid-season maturing variety option and is due to complete Barley Australia malt accreditation in March 2018. It has a similar growth habit to Commander, but is earlier flowering, with improved straw strength, lodging resistance and the net form of net blotch resistance. Later flowering than Hindmarsh. More susceptible to leaf scald than Commander. Powdery mildew resistance is variable depending on the pathotype. Leaf rust resistance is variable, rated very susceptible in northern NSW. Seednet.

Rosalind.[Φ] Feed. A new, broadly adapted, high-yielding mid-season barley that has performed well across NSW. Maturity is later than La Trobe and earlier than Buloke. It has a short coleoptile length, moderate plant height and an erect growth habit. Good straw strength and head retention. High level of pre-harvest sprouting tolerance, with good physical grain package, grain plumpness similar to La Trobe. Released for the 2015 season. InterGrain.

SouthernStar.[Φ] There is limited information on this variety's performance in NSW. A potential new malting barley developed by Sapporo Breweries and the University of Adelaide. SouthernStar is based on the variety Flagship and incorporates a patented novel gene for improved beer quality. It has almost identical agronomic characteristics to Flagship with good early vigour. SouthernStar also has sensitivity to sprouting so timely harvest must be a priority. SouthernStar can be grown under production contracts with Barrett Burston Maltings and Cargill.

Spartacus CL.[Φ] A new Clearfield barley suited for sowing in NSW. Spartacus CL is an early-maturing semi-dwarf barley with a maturity similar to La Trobe. Spartacus CL is a high-yielding barley, which allows the use of Clearfield technology in-crop to control barley or brome grass and is ideal for following either Clearfield canola or wheat, where herbicide plant back issues might be a concern. Similar height and plant type to La Trobe. Short coleoptile length. Moderately good straw strength and head retention, with a good physical grain quality. High level of pre-harvest sprouting tolerance. Currently undergoing malt evaluation with Barley Australia. InterGrain.

Diseases

Sound management is the key to minimising losses from disease. Avoid sowing barley into barley stubble and carefully consider whether or not to sow barley into wheat stubble. An improved level of resistance to specific leaf diseases is available in some new barley varieties, and

this is the preferred management option if these varieties are suitable for your region.

Paddock management and crop rotation are preferred controls for root and crown rots. Seed dressings control smuts and delay the build-up of leaf scald and powdery mildew early in the season. A new seed treatment is available (Systiva), which appears to provide a good level of control against net blotches in barley.

Varying pathotypes of the main diseases, leaf rust, leaf scald and net blotches occur in different regions across NSW and other barley-growing regions.

Growers should be aware that the variety's disease rating will depend on which pathotype(s) of a pathogen is present in their region.

For a number of varieties, you will see two distinct ratings. Growers are advised to show caution and monitor their crops carefully and be prepared, where feasible, to apply foliar fungicides to manage the leaf disease should the variety begin to show susceptibility.

Leaf diseases

Rusts

Four rusts: stem rust, barley leaf rust, barley grass stripe rust and wheat stripe rust, can affect barley in NSW, with barley leaf rust the major concern. Varieties such as Baudin, Grout and Navigator are very susceptible to leaf rust. There is also concern around the increased susceptibility of Compass to a newer pathotype of leaf rust in the north of NSW, changing its rating to very susceptible. Varieties that are rated very susceptible to leaf rust should be monitored carefully as they can build up leaf rust to damaging levels on other varieties, since many widely-grown varieties are rated as susceptible. Care should be taken to destroy volunteers of any susceptible or very susceptible barley variety over summer to limit leaf rust build-up early in the season.

Stem rust is not usually a problem on main season sowings. Stem rust infection occurs at higher temperatures and can develop on very late-sown susceptible varieties in some seasons.

Barley stripe rust is a major disease of barley in some overseas countries, but is not present in Australia. However, barley grass stripe rust and wheat stripe rust can develop to a small extent on some barley varieties, particularly if the diseases are severe on nearby barley grass or wheat. Barley stripe rust poses a significant threat to the Australian barley industry. Report any unusually severe infections of stripe rust on barley to your agronomist or NSW DPI plant pathologist and send samples to the Australian cereal rust survey, contact details can be found in the Industry Information section on page 53.

Net blotch

There are two forms: the spot form and the net form. Both forms survive in infected barley stubble, but the net form can also be seed-borne. It can be difficult to distinguish between the two forms and mixed infections are possible.

The spot form produces small, dark brown spots or blotches up to 10 mm long. Blotches are round–oval when small, becoming more straight-sided as they enlarge. Larger blotches are often surrounded by a yellow margin, particularly towards the leaf tip.

The net form also produces small, round–oval dark brown spots at first, but these elongate into dark brown streaks along the leaf, often giving a netted appearance. Severely affected leaves wither. Only the net form can infect grain, which can result in seed-borne infections if this seed is retained for sowing next season.

The spot form of net blotch is widespread as most varieties are susceptible. The net form has been less common in the southern region, because most of the major varieties have good levels of resistance, however, it can be a major disease in northern NSW if susceptible varieties are grown.

It is advisable to use a seed treatment that will control the seed-borne stage of the net form of net blotch. Growers should be aware that the fungicide flutriafol, commonly applied as a fertiliser treatment, is not effective in controlling either the net or spot form of net blotch. Planting seed retained from crops infected with the net form should be treated with an appropriate dressing. See Table 66 Cereal seed dressings for details. Note this only disinfects the seed and will not provide protection against infection from spores coming off infected stubble.

A new fungicide seed treatment called Systiva has been recently registered for use in barley, with trial results indicating that it appears to provide useful levels of control against stubble-borne infections of both the net and spot forms of net blotch. The product is based on a Group 7 fungicide from the SDHI class and growers should be aware that this class of fungicide is considered to be vulnerable to resistance development and should not be repeatedly used.

Scald

This is the major leaf disease in the higher rainfall areas of central and southern NSW. In susceptible varieties it can reduce grain yield by more than 50%. Scald has high levels of genetic diversity, which enables it to rapidly overcome host resistance. Most current varieties are rated susceptible and should be closely monitored. To reduce the risk of scald developing, avoid sowing barley on barley stubble.

Fungicides applied to fertiliser or as a seed treatment provide useful early control. Fungicide sprays at growth stage GS31 and GS39 can provide an economic response in susceptible varieties with high yield potential, in seasons conducive to scald development.

PLS (Physiological leaf spotting)

Under some circumstances, barley plants might develop various forms of leaf spots that are not caused by a pathogen. Spots can vary from tiny white/yellow flecks to dark brown or black blotches. These physiological leaf spots can be easily mistaken for diseases but, not being related to pathogens, applying fungicides is not warranted. Some varieties (e.g. Gairdner and GrangeR) are more prone to developing physiological leaf spots than others, and growers are advised to consult their agronomist/adviser or NSW DPI pathologist if uncertain of the causes of leaf spotting.

Table 21. Disease and crop injury guide – barley

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Foliar diseases				
Scald *Rhynchosporium commune*	'Scalded' patches with dark brown margins on leaf.	More common and severe in south, favoured by wet weather.	Rainsplashed spores from barley and barley grass residues and secondary infection from infected leaves during the season. Can be seed-borne	Resistant varieties; rotation with non-host crops. Fertiliser, seed and foliar fungicides; avoid sowing into barley and barley grass residues. Clean seed.
Net blotch – net form *Pyrenophora teres* f. *teres*	First, as small elliptical dark brown spots that elongate into fine, dark brown streaks on the leaf blades giving a netted appearance. Severely affected leaves wither. It also infects heads.	Favoured by wet weather and early sowing.	Airborne spores from infected plants and stubble. Carried on seed.	Resistant varieties; rotation with non-host crops. Stubble removal. Clean seed. Fungicide seed treatments. Appropriate foliar fungicides.
Net blotch – spot form *Pyrenophora teres* f. *maculata*	Small, dark brown, round to oval spots or blotches up to 10 mm long becoming more straight-sided as they enlarge. Larger blotches are often surrounded by a yellow margin, particularly towards the leaf tip.	Favoured by wet weather and early sowing.	Airborne spores from infected plants and stubble.	Resistant varieties; rotation with non-host crops. Stubble removal. Fungicide seed treatments. Appropriate foliar fungicides.
Powdery mildew *Blumeria graminis* f.sp. *hordei*	White to grey cottony fungal growth on leaf and leaf sheath.	More common in north and south–western regions, more prevalent in winter and early spring.	Airborne spores from infected trash and infected plants.	Resistant varieties; seed and foliar fungicides.
Barley leaf rust *Puccinia hordei*	Very small pustules of orange–brown powdery spores on leaves and leaf sheaths.	Favoured by moist conditions and temperatures around 15–22 ℃.	Airborne spores from living plants.	Resistant varieties; clean fallows; foliar fungicides to protect flag-1 to flag-2 leaves. Monitor very susceptible varieties regularly.
Stripe rust *Puccinia striiformis*	Pustules and stripes of yellow powdery spores on leaves.	Barley stripe rust is not present in Australia. However, some varieties can develop small amounts of barley grass stripe rust and wheat stripe rust. Promoted by cool nights (8–15 ℃) with dews.	Airborne spores from living plants.	Rarely required. Resistant varieties, foliar fungicides not likely to be required.
Stem rust *Puccinia graminis* f. sp. *tritici*	Elongated pustules of dark brown spores on stems, leaves and awns.	Favoured by warm (15–30 ℃) moist conditions. Only likely to be a problem in very late crops or where crops are in close proximity to other infected cereal crops.	Airborne spores from living plants.	Clean fallows. Resistant barley varieties; control stem rust in other cereals (wheat, rye, triticale); foliar fungicides.
PLS (physiological leaf spotting)	Range from tiny white or yellow flecks to conspicuous dark brown to black spots and blotches on leaves.	Most prevalent under mild, moist growing conditions. Some genotypes are more susceptible. Grimmett often develops white flecking; Gairdner and GrangeR prone to brown blotching.	Not a pathogen. (Note that some brown flecking might be a resistant reaction to other diseases and in some regions, a reaction to adverse soil nutrient levels.)	Avoid susceptible varieties. Confirm cause before considering fungicide application as they will provide no control of PLS as this is not disease.
Sunblotch (physiological reaction to nutrient stress and sunlight)	Orange to dark brown spots more common on upper surface of leaf; leaf death.	Occurs sporadically.Conditions causing it yet to be defined.	Not a pathogen.	No practical control option.
Virus diseases				
Barley yellow dwarf *Barley yellow dwarf virus* (BYDV) or *Cereal yellow dwarf virus* (CYDV)	Yellowing, dwarfed infected plants, reduced seed set.	Most common near perennial grass pastures and in early-sown crops.	Transmitted by aphids from infected grasses and cereals.	Sow varieties with better resistance. Consider using an insecticide seed treatment (e.g. imidacloprid) to limit early infections from aphid vectors. Control insecticide application in-crop to control aphids at early growth stages if required.
Wheat streak mosaic *Wheat streak mosaic virus* (WSMV)	Light green leaf streaks and blotches, stunted plants, reduced seed set.	Not yet observed in barley. Has occurred in wheat in southern irrigation areas and early-sown grazing wheat crops on the tablelands and slopes.	Transmitted by the wheat curl mite.	No control required.
Root and crown diseases				
Take all *Gaeumannomyces graminis* var. *tritici*	Blackened roots and crown, stunting, white heads, pinched grain.	More common in south, favoured by wet winter and early spring, then dry. Less severe on barley than on wheat.	Soilborne on grass and cereal residues.	Crop rotation to provide one year free of grass hosts. Some seed treatments provide a level of suppression.
Rhizoctonia bare patch *Rhizoctonia solani*	Patches of spindly, stunted plants with erect leaves; spear point root rot; plant death.	Associated with minimum or reduced tillage; often aggravated by Group B herbicides.	As fungal threads in soil; soil-borne on residues of many grass, cereal and broadleaf plants.	Crop rotation, soil disturbance to 5–10 cm below sowing depth at or within 2–4 weeks before sowing; avoid the build-up of Group B herbicides which can cause root pruning. Some seed treatments provide suppression only.
Crown rot *Fusarium pseudograminearum*	Browned stem bases, stunted or plant death if severe early infection, white heads not common in barley, pinched grain.	More common in north and western areas becoming common in south, favoured by moisture/heat stress during season.	Stubbleborne on grass and cereal residues.	Crop rotation. More tolerant varieties. Grass weed control. Balance inputs to available soil water. Inter-row sowing and avoid delayed sowing to minimise losses.

Table 21. Disease and crop injury guide – barley (continued)

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Common root rot *Bipolaris sorokiniana*	The root between the crown and seed (sub-crown internode) is always dark; roots and sometimes the stem base are brown; white heads, pinched grain	Scattered through the crop. Plants can have reduced tillering and appear to have ill-thrift. Exacerbated by deep sowing.	Stubbleborne on grass and cereal residues; also survives as spores in the soil.	Resistant varieties; crop rotation; optimise nutrition; be careful with sowing depth.
Eyespot *Tapesia yallundae*	Lodging, eyespot with sharp bend in stem 3–5 cm above ground.	South and Central West Slopes, eastern Riverina. Less severe on barley than on wheat.	Rainsplashed spores from crop or grass residue during winter.	Crop rotation.
Smuts				
Loose smut *Ustilago tritici*	Black powdery heads on diseased plants; black lumps in harvested grain.	Statewide; presence can make grain unacceptable to maltsters.	Airborne spores infect developing seeds at flowering.	Seedapplied fungicides.
Covered smut *Ustilago segetum* var. *hordei*	Ball of black powder replaces the seed.	Statewide, presence can make grain unacceptable to maltsters.	Spores on seed coat infect seedling before emergence.	Seedapplied fungicides, resistant varieties.

Powdery mildew

Powdery mildew can occasionally be severe on seedlings and tillering barley in northern and central NSW, and is favoured by high humidity but reduced by rainfall. High nitrogen levels in crops can also favour development. Foliar fungicides are often applied, but in many cases too late after powdery mildew infection has already damaged the crop. Growing resistant varieties is the best management strategy as the powdery mildew pathogen of barley has been found to have developed a level of resistance to some triazole fungicides in other regions. Some seed treatments provide effective and economic control of powdery mildew at the seedling stage in areas where the disease frequently develops. See Table 66 Cereal seed dressings for details.

Managing diseases with foliar fungicides

Using foliar fungicides in disease management is increasing and can provide economic returns when applied correctly at the appropriate growth stage. Applying foliar fungicides should be an economic decision based on the following factors:

- Accurate disease diagnosis.
- Yield potential.
- Potential loss (varietal susceptibility, growth stage, effect on yield and quality).
- Appropriate application time.
- Cost of fungicide and application.
- Duration of control.
- Amount of disease present.
- Future disease development (weather).
- Stock/harvest withholding periods.

With most diseases, application should aim to protect the flag-1 and flag-2 leaves in barley, which are the main contributors to yield. Losses from diseases in the vegetative stage are relatively small compared with infection of the adult plant. Consequently, in most cases, spraying at this stage is not worthwhile. In areas where severe powdery mildew infection frequently occurs on seedlings, an appropriate seed dressing generally provides better and more economic control than in-crop spraying.

Control duration varies with the fungicide product and application rate; therefore, early sprays before stem elongation might require repeat applications to protect key leaves that were not initially emerged.

Fungicide resistance has been documented in a number of foliar pathogens in Australia such as barley powdery mildew and Septoria tritici blotch (*Zymoseptoria tritici*) in wheat. This means that repeated applications of the same fungicide group should be avoided and label instructions need to be followed.

Root and crown diseases

Barley is susceptible to the same root diseases (Pythium, Rhizoctonia and common root rot) as wheat. With crown rot, yield losses are usually not as severe in barley as for wheat because of barley's earlier maturity, which provides an escape from late season stress that exacerbates expression. However, barley is very susceptible to crown rot infection and builds up inoculum levels within the rotation. Barley can still suffer significant yield loss from crown rot if moisture stress occurs during crop development. Barley varieties also differ in their susceptibility and yield loss in the presence of crown rot infection. As with wheat, crown rot control relies on adopting integrated management strategies, which includes effective rotations, stubble management, fallow moisture storage, grass weed control, sowing time, inter-row sowing, cereal crop and variety choice.

Smuts

Both malting and feed barley receival standards have a zero tolerance for smuts. Grain appearance is damaged by smuts, making it less attractive for human and animal consumption. Control is readily achieved by using seed dressings at sowing. Treat all seed for sowing each year and ensure good coverage during the application process.

Using a seed dressing that will also control scald and powdery mildew is advisable.

Do not sow untreated seed retained from a crop where any smut was visible in heads during the season. Even low levels of infection within a paddock can result in significant carry-over of spores on grain that will infect the next barley crop, as the spores are dispersed when infected heads are harvested. See Table 66 Cereal seed dressings for details.

Black point

This darkening of the grain coat at the embryo (shoot) end can occur during wet periods from flowering to harvest. All varieties can be affected, depending on seasonal conditions. There are no known control measures as this is a physiological condition and not a disease.

Badly discoloured grain is unacceptable for malting, although affected seed is usually satisfactory for sowing.

Marketing

Barley may be freely traded on both the domestic and export market. Before adopting new barley varieties, look at what marketing options are available in your region. Not all new varieties will be accepted by the bigger grain receival sites, so alternative arrangements might need to be sought or grain stored on farm before delivery to an end user.

Take care not to over-thresh barley at harvest, which damages the grain. Ideally, markets seek malting barley with 10.5% protein.

Feed barley is traded through major traders and private merchants, or direct to domestic end-users such as stockfeed manufacturers, feed-lotters and other farmers. Prices tend to be lower around harvest time, and are usually higher during winter.

Barley is more difficult than most other cereals to store for more than three months because of its susceptibility to grain insect attack.

Grain insect treatment WARNING: Malting barley may only be treated with a limited number of grain protectants for insect control. Check with the end user before treatment to ensure a particular pesticide is acceptable. Refer to Grain insects – options for control on page 115 for more details.

Current barley delivery standards are available from your local grain trader or from Grain Trade Australia (GTA),

Malting varieties

Malting barley varieties in Australia are accredited by Barley Australia and undergo rigorous testing to ensure they meet malting standards both for domestic and international markets. The Barley Australia website has a list of currently accredited varieties. Malting variety delivery will depend on segregations in your region and must meet the GTA quality standards/specifications for malt barley.

Food grade varieties

This is a new classification, which Barley Australia introduced in 2010. Barley varieties will need to meet all the physical quality parameters that apply to accredited malting barleys, such as protein, test weight, screenings and retention, before they can be accepted into food barley segregations.

Feed varieties

NSW Feed Barley No. 1: two-row varieties with white aleurone layer only.

Further reading

Barley Australia

Qld DAF – Barley information

GTA – Barley Trading Standards

GRDC – *Wheat & barley leaf symptoms: The back pocket guide*

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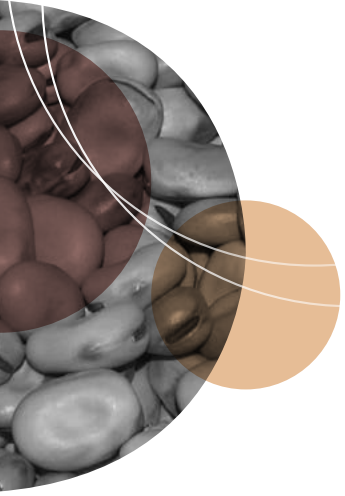


Oats

Crop management

This widely adapted and reliable cereal is the major winter cereal grazing crop. It also offers rotational benefits where conditions are not suitable for broadleaf break crops. Oats can tolerate some cereal diseases such as take-all, crown rot and common root rot. Other benefits include its easy establishment and comparatively low cost compared with other grazing crops. Oats are a versatile crop in farming systems. They can adapt to acid soils, are used for hay, silage, pasture renovation and grazing-out, and are suitable for broadleaf weed control by in-crop herbicides.

Sowing

Except for very high tablelands areas, January and February sowings should be avoided. Hot conditions, soil temperatures consistently above 25 °C, and rapidly drying soils can cause patchy establishment.

Optimum sowing times are shown for each variety in the respective zones. Sowing later than recommended increases the risk of lower yields. In wet, acid soil conditions sow grain-only varieties at the earliest recommended time.

Direct-drilling of early-sown varieties is easier in paddocks cropped the previous year. New paddocks can be direct-drilled early with machinery that gives adequate penetration and minimum soil disturbance following chemical fallow. Early forage production from direct-drilled crops is less than from crops sown into cultivated seedbeds.

A sowing depth of 5 cm is ideal, but oats can be sown as deep as 7 cm if moisture seeking.

Nutrition

Apply fertiliser at above the normally recommended rates to crops used for grazing and grain, as they have a longer productive period than grain-only crops.

To achieve grain protein of 10% and above in high yielding varieties such as Mitika and Possum, avoid sowing into low fertility paddocks.

Sowing rates

High sowing rates give rapid growth rates and high forage yields. Use high rates where dense weed populations are expected, when conditions are likely to be wet during winter, in low pH soils, and/or in paddocks with low soil fertility, or if seed quality is substandard.

Seed size varies significantly between oat varieties and season, so it is important to know the 1000 grain weight of the selected variety to calculate the required sowing rate. The sowing rates shown should be used as a guide only and growers should calculate their own sowing rates based on the 1000 seed weight, target plant population and seed establishment percentage. See Calculating seed rate on page 6 for an example of seed rate calculation.

Higher tablelands/tablelands/slopes

» 80–120 kg/ha, grazing and grain
» 60–80 kg/ha, grain-only

Slopes/plains

» 60–80 kg/ha, grazing and grain
» 40–60 kg/ha, grain-only

Early-sown – grazing only

» 100–130 kg/ha

Irrigation

» 100–150 kg/ha, grazing and grain
» 80–120 kg/ha, grain-only

Hay production (Sowing rates are 30–50% higher than grain crops in the same region)

» 60–100 kg/ha dryland
» 80–140 kg/ha irrigated

Grazing

The ideal stage to start grazing is when plants are well anchored and the canopy has closed. Continuous grazing might be better for fattening stock than rotational grazing. Maintain adequate plant material to give continuous and quick regrowth, e.g. a minimum of 1000–1500 kg/ha of dry matter.

For the best recovery after grazing, do not graze below 5 cm for prostrate varieties, or below 10 cm for more erect types. The higher grazing height is particularly important with erect growing varieties. Over-grazing greatly reduces the plant's ability to recover.

(See Managing grazing cereals, page 61).

Grazing value

Financial returns from grazing can be based on:

» Changes in body weight throughout the grazing period. Weight gains of 1.2 kilograms per head per day for steers, and 200 grams per head per day for lambs are common.

» Stock value before and after grazing.
» Current agistment rates for stock.
» Hand feeding costs for the same period.

On the tablelands and slopes, grazing oats significantly reduces the grazing pressure on pastures and can often reduce the necessity for hand feeding during winter.

On the slopes and plains, grazing oats means lucerne pastures can be spelled in autumn.

Grain recovery

An accurate method for assessing the correct time for stock removal is to find where the immature head is in the stem (slice it open and look above the highest node); if stock graze the immature head, yields are drastically reduced as plants have to grow new tillers. August is traditionally the month when livestock are removed from grazed crops to allow optimum grain recovery for harvest. In drier areas and on lower fertility paddocks, earlier stock removal should improve grain recovery. With later maturing varieties on the tablelands, stock removal can be delayed with little overall reduction in grain recovery.

Weeds

Planning in the previous season to prevent annual weeds, especially grass weeds, from setting seed by pasture cleaning, spray topping or early fallow, helps to reduce in-crop weeds and improves crop production.

Some post-sowing pre-emergent herbicides and early post-emergent herbicides will control annual ryegrass, but timing is critical. Broadleaf weeds can be effectively controlled with either early or late post-emergent herbicides, but again, timing is most important.

Higher sowing rates and narrow row spacings improve competition against weeds. Maintain crop canopy (bulk) to discourage weed recovery.

Diseases

Barley yellow dwarf virus (BYDV) is transmitted by aphids. Early-sown crops are more at risk. Sow tolerant varieties or be prepared to control aphids to prevent virus transmission. Imidacloprid is registered for use on cereal crops as a seed dressing to manage aphids and BYDV spread in cereal crops, see Table 66 Cereal seed dressings for available products.

Significant production losses can result from either stem or leaf rust. With the development of new pathotypes in some regions for stem rust, there are no remaining genetic resistances available in commercially grown varieties to fully protect crops. Leaf rust resistance levels in some varieties provide useful field tolerance to the disease. Monitor crops in season for these rusts. Rusts can be managed by selecting appropriate varieties for sowing, avoiding sowing later-maturing varieties and applying late irrigations, and adjusting grazing management (see Managing grazing cereals page 61) or controlled by using foliar fungicides in the crop.

Insects

Earth mites and armyworm commonly affect crops. Earth mites can affect young crops, so monitor and control as necessary. They should be suppressed in the previous spring by applying an insect spray with the fallow weed control program.

Aphids are a major concern and in high numbers can cause feeding damage to establishing oat crops. The main issue with aphids is BYDV spread. Growers should treat their seed with an appropriate insecticidal seed dressing to reduce early aphid feeding and BYDV transmission.

Armyworms can cause severe damage to the ripening crop and should be monitored. Chewed leaf margins and/or oat spikelets on the ground are sure signs of armyworm presence. Always inspect the denser areas of the crop.

Producing quality grain

There are strong domestic and export markets with premium payments for oats with a high test weight (kg/hL) – see Table 25 Varieties. Producers aiming at milling markets should consider Bannister, Mitika, Possum, Mortlock, Williams, Wombat or Yallara.

For high-quality feed grain oats for livestock, consider low husk lignin varieties Mannus, Mitika, Yarran or Yiddah. Avoid over-grazing dual-purpose crops or grazing too late into early spring as this will affect grain quality and yield. Crops maturing under hot, dry conditions result in low grain quality.

Choose paddocks with good soil moisture retention characteristics. Use moderate sowing rates and sow at the suggested time. Pay attention to weeds and provide adequate nutrition, but be careful not to apply excessive fertiliser rates (especially nitrogen), which can result in delayed maturity.

Marketing

Before harvest, careful weed and insect control will ensure the best quality product to take to market. In crops used for hay, ensure even curing after cutting.

Prevent weed seeds and insects contaminating grain. If the grain is to be stored for longer than three months, protect against insects. Store in the best possible facility to ensure a quality product.

Grain size, plumpness, variety, husk lignin content, protein and hectolitre (hL) weight are some of the buyers' criteria for feed grain sales. To aid marketing, samples should be protein and energy tested and premiums sought. Varieties and samples vary considerably.

As a marketing aid, collect a representative running sample at harvest from each truckload.

Bannister, Mitika, Possum, Mortlock, Williams, Wombat or Yallara are accepted milling varieties. The newer varieties Bannister, Williams and Wombat, whilst acceptable as milling oats, could have limited opportunities for segregation in NSW storage systems. Growers should contact prospective buyers before growing these varieties. Echidna and Yarran may also be accepted.

Variety selection

When selecting a variety consider:

» **Region.**

» **Crop use.** For grazing only, for dual-purpose grazing and grain, for hay, for silage, or for grain-only?

» **Grazing value.** When is feed most important – in early or late winter?

» **Hay.** Freedom from leaf and stem diseases, resistance to lodging, and maturity to cutting time?

» **Grain.**
- To keep on-farm or sell?
- To keep – high yield and low husk lignin content?
- For sale – market requirements? White or cream colour, 'attractive'?
- For feed – high test weight, protein and low husk lignin content?
- For milling? As specified by milling companies.

» **Forage only varieties.**
The suggested sowing time for forage-only varieties is mid February to early April. As Saia has a much smaller seed than other varieties, use lower sowing rates, for instance, 60–80 kg/ha.
As many of these varieties are late/very late for grain maturity, they may not be suitable for grain production in many regions.
Grazing management for the more erect types needs to be different from the usual heavy grazing of dual-purpose grazing and grain varieties. Avoid heavy grazing to below 10 cm if plant recovery is expected. More upright varieties are best suited to grazing with cattle. **For coastal and northern regions, consider varieties with the best rust resistance ratings**.

» **Herbicide tolerance**. Refer to the NSW DPI guide *Weed control in winter crops*.

Figure 3. Map of NSW showing oat growing zones

Varietal characteristics

Most varieties are suitable for grazing. Variety selection depends on the crop use; sowing date; likely diseases and tolerance to acid soil; grain quality; and possible market outlet.

Growers are warned that there are now no commercial varieties with resistance to all the current field pathotypes of stem rust. Growers should also be aware that there are a number of leaf (crown) rust pathotypes present in NSW, with pathotypes present in central and northern NSW that have overcome many of the resistance genes in oat varieties bred for southern Australia.

Milling varieties

Bannister.$^{\Phi}$ Released in Western Australia in 2012 as a milling oat variety for the western region. It has high grain yield potential and has performed well in trials in southern NSW. It is taller than Mitika and heads about 3–4 days later than Mitika. It is susceptible to and intolerant of cereal cyst nematodes. Bannister is resistant (R) to leaf rust and moderately resistant (MR) to bacterial blight. Bannister has a slightly lower hectolitre weight and slightly higher screenings compared with Mitika. Seednet.

Mitika.$^{\Phi}$ Mitika is a dwarf milling oat released in 2005. It is earlier maturing than Possum and Echidna, favouring Mitika in a dry finish. Mitika was R to stem rust until 2010, when a new pathotype of stem rust was identified, rendering it susceptible (S). It is moderately susceptible (MS) to leaf rust. Mitika has improved Resistance to bacterial blight and is superior to Echidna for septoria resistance. Mitika is S to BYDV, septoria and red leather leaf disease. It is very susceptible (VS) to and intolerant of cereal cyst nematode and moderately intolerant of stem nematode and is not recommended in areas where either of these nematodes are a problem. Mitika has high hectolitre weight, low screenings and high groat percentage compared with Echidna. Mitika also has improved feed quality with low husk lignin and high grain digestibility. Heritage Seeds.

Mortlock. A medium height, strong-strawed grain oat. Can be leniently grazed. It has a consistently high test weight, protein content and lower screening losses with light coloured grain, but discolours easily. Low yielding compared with Mitika and Possum. Released by Agriculture Western Australia in 1983.

Possum.$^{\Phi}$ Possum is a dwarf milling grain variety. It is a replacement for Echidna in medium and high rainfall areas. Possum has a similar yield to Echidna in high rainfall zones and slightly lower yield in medium rainfall zones. Possum also has a high husk lignin content like Echidna. It has better milling quality than Echidna and has a similar hectolitre weight and fewer screenings than Euro. It is an improvement compared with Echidna for stem rust, leaf rust and septoria resistance. Like Echidna, Possum is S to bacterial blight and BYDV and VS to and intolerant of cereal cyst nematode. Possum is not recommended for areas where cereal cyst or stem nematode is a problem. Possum is S to red leather leaf and intolerant of stem nematode. Developed by SARDI, released in 2003. Seednet.

Yield performance experiments from 2004 to 2009 – the more trials, the greater the reliability.

Table 22. Higher Tablelands dual-purpose compared with Eurabbie = 100%

Variety	1st grazing DM Eurabbie = 2.37 t/ha	2nd grazing DM Eurabbie = 2.51 t/ha	Grain recovery Eurabbie = 2.94 t/ha	Ungrazed Eurabbie = 4.57 t/ha
Bass	94	95	85	92
Bimbil	88	93	87	84
Blackbutt	89	91	84	89
Eurabbie	**100**	**100**	**100**	**100**
Mannus	87	91	87	72
Nile	99	97	85	93

Consider Nile, Bass and Blackbutt for very early sowing. Eurabbie is outstanding for grain recovery after grazing.
Mannus is outstanding for grain quality.

Table 23. Tablelands/Slopes dual-purpose compared with Bimbil = 100%

Variety	1st grazing DM Bimbil = 2.90 t/ha	2nd grazing DM Bimbil = 2.34 t/ha	Grain recovery Bimbil = 2.07 t/ha	Ungrazed Bimbil = 2.50 t/ha
Bimbil	**100**	**100**	**100**	**100**
Blackbutt	102	97	86	86
Cooba p	106	106	87	87
Eurabbie	114	107	119	118
Mannus	99	97	98	101
Yarran p	103	95	105	105
Yiddah	109	111	86	85

Consider Eurabbie or Blackbutt for the Tablelands, or areas with later maturity. Eurabbie is outstanding for grain recovery after grazing. Preferred varieties for feeding grain to livestock are Mannus, Yiddah and Yarran.

Table 24. Slopes/Plains dual-purpose compared with Bimbil = 100%

Variety	1st grazing Bimbil = 2.09 t/ha	2nd grazing Bimbil = 2.34 t/ha	Grain recovery Bimbil = 2.26 t/ha	Ungrazed Bimbil = 2.59 t/ha
Bimbil	**100**	**100**	**100**	**100**
Cooba ▲	106	106	97	86
Eurabbie	107	107	112	120
Mannus	99	97	101	94
Yarran ▲	106	95	120	103
Yiddah	111	111	103	87

For the Slopes, consider Eurabbie, Mannus, Bimbil and Yiddah for grazing and especially Eurabbie and Mannus for grain recovery. For the Plains consider Yarran, Yiddah and Coolabah for grazing and especially Yiddah for grain recovery. Preferred varieties for feeding grain to livestock are Mannus, Yiddah and Yarran.

Table 25. Grain only varieties compared with Mitika (2011–2015) – the more trials, the greater the reliability.

Variety	North-east	Number of trials	South-east	Number of trials	South-west	Number of trials
	Mitika = 3.26 t/ha		Mitika = 3.85 t/ha		Mitika = 3.77 t/ha	
Bannister	110	5	105	17	103	14
Mitika	**100**	**5**	**100**	**17**	**100**	**14**
Possum	102	5	101	17	99	14
Williams	110	5	101	17	100	14
Wombat	105	5	99	17	97	14
Yallara	106	5	97	17	95	14

The table presents NVT 'Production Value' multi environment trial(MET) data on a regional mean basis from 2011–2015.
Preferred milling varieties are Mitika and Yallara. Preferred variety for feeding grain to livestock is Mitika. ▲ Outclassed.

Table 26. Varieties

Variety	Grazing		Straw strength after grazing	Grain maturity	Test weight (kg/hL)	Husk lignin content*	Diseases				Acid soils – sensitivity to aluminium
	Early dry matter production	Grazing recovery					Stem rust ✦	Leaf (crown) rust ✦	BYDV	Red leather leaf	
Dual-purpose varieties											
Bass	medium	excellent	good	late	medium	low	S	S	T	–	Tol
Bimbil	medium	excellent	good	early–mid	high	low	S	MS	MS	–	–
Blackbutt	slow	excellent	good	late	low–medium	medium ●	S	S	MT	–	Tol
Cooba ▲	medium	excellent	fair	early–mid	high	low	MS–S	MS–S	MT	–	Int
Coolabah ▲	quick	moderate	fair	early	medium	high	MS–S	S	MT	–	Sen
Eurabbie	quick	excellent	very good	late	low–medium	low	S	MS–S	VS	–	Tol
Mannus	medium	excellent	good	mid	high	low	S	MS	MS	–	–
Nile	quick	excellent	good	very late	medium	low	S	S	T	–	Tol
Yarran ▲	medium	moderate	good	early	high	low	S	MS	VS	–	Int
Yiddah	slow	excellent	good	early	high	low	MS	S	MT	–	–
Grain only varieties#											
Bannister	quick	poor	–	early–mid	med–high	high	MR & S	R	MS	MS	–
Mitika	quick	poor	very good	early	high	low	MR & S	MS & S	MS & S	S	–
Mortlock ▲	quick	poor	good	early–mid	high	high	S	S	MS	–	Tol
Possum	quick	poor	very good	early–mid	med–high	high	MS & S	MS	S	MS & S	–
Williams	quick	poor	–	mid	med-high	high	MR & S	R	MR & MS	MS	–
Wombat	quick	poor	–	early–mid	high	high	MS & S	MS	MR	MS	–
Yallara	quick	poor	good	early–mid	high	high	S	MS	MS	MS	–

– = Insufficient data, R = Resistant, R–MR = Resistant to Moderately resistant, MR = Moderately resistant, MR–MS = Moderately resistant to Moderately susceptible, MS = Moderately susceptible, MS–S = Moderately susceptible to Susceptible, S = Susceptible, VS = Very susceptible. Where ratings are separated by '&' the first is correct for the majority of situations, but pathotypes are known to exist in some regions and the later rating reflects the response to these pathotypes. ✦ Field resistance to the rusts on crops differ depending on season, maturity and strains present. Sen = Sensitive, Int = Intermediate, MT = Moderately tolerant, Tol = Tolerant. # Ratings for the grain only varieties are from the SARDI Oat Breeding and Pathology programs, they are from SA screening, and might not represent the reaction to stem and leaf rust in NSW where more virulent pathotypes are present. ▲ Outclassed, Yarran (BYDV), Cooba, Coolabah & Mortlock (grain yield). * Refer to **Table 30 Hull lignin rating** of a range of oat varieties. ● Lignin content of Blackbutt can be variable.

Table 27. Sowing times

	January		February				March				April				May				June		
Variety Weeks	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Higher tablelands/tablelands: Dual-purpose – grazing and/or grain recovery																					
Bass, Blackbutt, Nile	>	★	★	★	★	★	★	★	★	★	<	<									
Eurabbie			>	>	★	★	★	★	★	★	★	★	★	★	<	<					
Bimbil, Mannus					>	>	★	★	★	★	★	★	★	★	<	<					
Tablelands/slopes: Dual-purpose – grazing and/or grain recovery																					
Blackbutt					>	★	★	★	★	<	<	<	<								
Eurabbie					>	★	★	★	★	★	★	<	<								
Cooba ▲						>	★	★	★	★	<	<	<	<	<						
Bimbil, Mannus, Yiddah								>	★	★	★	★	<	<	<						
Coolabah ▲, Yarran ▲									>	★	★	★	★	<	<						
Slopes/plains: Dual-purpose – grazing and/or grain recovery																					
Cooba ▲, Eurabbie						>	★	★	★	★	★	<	<	<	<						
Bimbil, Mannus, Yiddah								>	★	★	★	★	★	★	<	<	<				
Coolabah ▲, Yarran ▲									>	★	★	★	★	★	<	<	<				
Tablelands/slopes grain only																					
Bannister, Possum, Williams, Wombat															>	★	★	★	<	<	
Mitika, Mortlock ▲, Yarran ▲															>	>	★	★	★	<	
Slopes/plains grain only																					
Bannister, Possum, Williams, Wombat, Yallara															>	★	★	★	★	<	<
Mitika, Mortlock ▲, Yarran ▲															>	★	★	★	★	★	<

> Earlier than ideal, but acceptable. ★ Optimum sowing time. < Later than ideal, but acceptable. ▲ Outclassed varieties.

Warning: High soil temperatures (>25 °C) with early sowings may reduce germination and establishment.

Williams.[Φ] Released in Western Australia in 2013, Williams has a high grain yield potential and has performed well in trials throughout NSW. Williams is an early- to mid-season variety similar to Yallara, but 3–7 days later than Mitika. It is taller than Mitika by 15 cm, 5 cm taller than Bannister, and 15 cm shorter than Yallara. Williams is R to leaf rust and, depending on the stem rust pathotype present, can range from MR to S. It is susceptible to and intolerant of cereal cyst nematodes. Williams is R to bacterial blight and MR–MS to BYDV. Williams has a lower hectolitre weight and higher screenings than Mitika. Williams is not recommended for low rainfall areas due to extremely high screenings. Heritage Seeds.

Wombat.[Φ] A dwarf milling variety, which is similar in height to Possum and slightly taller than Mitika. It is a mid-season variety flowering about six days later than Mitika. Wombat was the first dwarf milling variety with cereal cyst nematode resistance and tolerance. It is also moderately tolerant to stem nematode. Wombat has a high hectolitre weight and low screenings compared with the feed variety Potoroo, which was the first dwarf variety with cereal cyst nematode resistance and tolerance. It also has a high groat percentage, slightly higher than Mitika. Developed by SARDI. Seednet.

Yallara.[Φ] A medium–tall, early- to mid-season variety similar to Euro for flowering and maturity. Yallara was released in 2009. Yallara is a Euro look-alike milling line with slightly better grain quality, but not as susceptible to stem rust. It is resistant but intolerant to cereal cyst nematode. It is moderately susceptible to BYDV and Septoria. Yallara is susceptible and intolerant to stem nematode and moderately susceptible to red leather leaf disease.

Yallara has excellent grain quality. It has a high hectolitre weight, low screenings and a high groat percent. Yallara has bright, plump grain suitable for the milling industry and specialised feed end uses like the horse racing industry as well as human consumption. Yallara was evaluated for hay production and although the hay yield may be lower than popular hay varieties it has excellent hay quality. Seednet.

Feed grain, hay and grazing varieties

Aladdin.[Φ] A new late maturity grazing variety with good semi-erect early growth and quick recovery from grazing. A new leaf rust pathotype affecting Aladdin was identified in 2015. Selected for Queensland and northern NSW. Released by DAF Qld and Heritage Seeds in 2012, and available through Heritage Seeds.

Bimbil. A dual-purpose type suitable for early- to mid-season sowing, grazing and grain recovery. Early and total dry matter production are similar to Cooba. Grain yield and grain recovery after grazing are better than Cooba. Straw is shorter and stronger than Cooba but it can still lodge. High groat percentage. Bred by NSW DPI at Temora. Released in 1993.

Blackbutt. Popular on the higher tablelands and tablelands/slopes, especially for early sowing. Late maturing provides extended grazing with excellent grain recovery. Straw is strong and of medium height. Good R to frost damage after grazing. Tends to have small grain and a low test weight. Bred by NSW DPI at Glen Innes. Released in 1975.

Bond.[Φ] A semi-erect medium–late maturing forage oat with high dry matter yields in both initial growth and regrowth. Dry matter production is equal to or better than Taipan. Maturity is 7–10 days earlier than Taipan. Good germination and establishment with early sowings into warm soil. High level of Resistance to all current pathotypes of crown rust. Suited to central and northern NSW and south east Qld growing environments. AustWest seeds.

Brusher.[Φ] A tall, early- to mid-season hay variety with improved hay digestibility. Resistant and moderately intolerant to cereal cyst nematode. Intolerant of stem nematode. Low husk lignin. Released by SARDI in 2003. AEXCO.

Comet.[Φ] A new medium–late maturity grazing variety released by Pacific Seeds. It has, semi-erect early growth, with early growth similar to Aladdin. High level of R to leaf rust. Available through Pacific Seeds.

Cooba. Suitable for early sowing, extended grazing and good grain recovery in most areas. Early growth is slow. It is mid-season maturing. Medium straw height and strength, average grain size, low husk percentage, high test weight and high groat percentage. Bred by NSW DPI at Glen Innes, selected at Temora. Released in 1961.

Cooee. A forage oat that has good early growth and dry matter production for multiple grazings. Erect habit with good regrowth, with fine stems. Late maturing. Released by Wrightson Seeds in 2010.

Coolabah. Suitable for lenient grazing and good recovery for grain in most areas. Quick early growth. Early maturing. Straw of medium height and strength. Fairly long grain, satisfactory test weight, high husk percentage. Bred by NSW DPI at Temora. Released in 1967.

Drover.[Φ] Intermediate growth habit. Suitable for grazing and hay. Released by Pacific Seeds in 2006.

Empire. A late flowering forage oat with very good rust resistance suitable for grazing and hay production. Marketed by Seed Force and Australian Premium Seeds.

Eurabbie. Eurabbi has a winter habit. It is semi-dwarf with similar maturity to Blackbutt and later than Cooba by about 10 days. Can be very short after heavy late grazing, possibly resulting in harvesting difficulties. Grazing management is crucial for high grain recovery yields at sufficient height. Excellent grain recovery yields, despite its susceptibility to BYDV. Grain quality is generally inferior and very similar to Blackbutt in tablelands/slopes situations. Generally lower quality than Cooba from slopes/plains samples. Bred by NSW DPI at Temora. Released in 1998.

Forester.[Φ] A very late hay variety adapted to high rainfall and irrigated cropping regions. It is three days later than Riel and three weeks later than Wintaroo. Forester has excellent early vigour and lodging, and shattering resistance. Good foliar disease resistance spectrum. It is MR to cereal cyst nematode. Good hay colour, but like all late hay varieties might not resist hot dry winds as well as earlier varieties. Forester has excellent hay quality. Released by SARDI in 2012. Forester seed is available from AGF Seeds, Smeaton, Victoria.

Galileo.[Φ] A forage oat that has good emergence, vigour and early growth. Good dry matter production for early grazing. Late maturing, similar to Enterprise. Moderately tolerant to BYDV; MR to crown rust. Released by Heritage Seeds in 2006.

Genie.[Φ] A late maturity erect grazing variety with quick early growth and very high dry matter yields. Susceptible to leaf and stem rust in the northern region. Selected for Queensland and northern NSW. Released by DAF Qld and Heritage Seeds in 2008 and available through Heritage Seeds.

Graza 51.[Φ] An erect, quick-growing, medium to late grazing variety developed by Agriculture Canada. Susceptible to leaf and stem rust in the northern region. Released by Pioneer Hi-Bred in 2007. Seed available through Elders.

Graza 80.[Φ] An erect, quick-growing, late maturing grazing variety developed by Agriculture Canada. Susceptible to leaf and stem rust in the northern region. Released by Pioneer Hi-Bred in 2005. Seed available through Elders.

Graza 85.[Φ] A new grazing forage oat released by Elders. Medium–medium-quick maturity, with good early vigour, quicker to first grazing than Graza 80. A high tillering oat with soft, broad leaves, with a low growing point. Very limited information available on its performance in NSW. Seed available through Elders.

Kangaroo.[Φ] A tall, mid–late season hay variety. Cereal cyst nematode resistant and moderately tolerant. High husk lignin. Released by SARDI in 2005. AEXCO.

Mammoth.[Φ] A long season forage oat variety; limited information on performance in NSW. Heritage Seeds

Mannus.[Φ] A tall, strong-strawed, mid maturing variety for feed grain. Grain yield after grazing is similar to Eurabbie on the tablelands/slopes but lower on the slopes/plains. Physical grain quality is better than Eurabbie. Large uniform grain size with high test weight, high groat percentage, medium protein and fat content. Low lignin husk. Moderately susceptible to BYDV, more R than Eurabbie and Yarran. The variety might exhibit physiological yellowing in winter. Bred by NSW DPI at Temora. Released in 2006. Waratah Seeds.

Moola.[Φ] A grazing variety with rapid early growth developed by Agriculture Canada and released in 1998 by DAF Qld. Susceptible to leaf and stem rust in the northern region.

Mulgara.[Φ] A tall, mid-season hay oat slightly earlier in heading time than, and similar in height to, Wintaroo with cereal cyst nematode and stem nematode resistance and tolerance. Mulgara is an improvement compared with Wintaroo for resistance to stem rust and bacterial blight, lodging and shattering resistance and early vigour. Hay yield is an improvement compared with Brusher but slightly lower than Wintaroo. Hay quality is similar to Wintaroo. Mulgara has excellent hay colour and resists brown leaf at hay cutting. Grain yield and quality is similar to Wintaroo with lower screenings, higher protein and groat percentage. Mulgara has high husk lignin. Released by SARDI in 2009. AEXCO.

Nile. A medium height, late maturing variety producing good winter grazing in tablelands districts. Grain recovery yields depend heavily on good, late spring finishing conditions. It has good BYDV tolerance. Released by Tasmanian Department of Agriculture in 1982.

Outback. A forage oat that has quick early growth and dry matter production. Susceptible to leaf rust. Erect habit and mid–late maturity. Released in 2005, marketed by Seed Distributors.

Quoll.[Φ] A high yielding semi-dwarf grain oat. Resistant to crown rust and some R to stem rust. Released by SARDI in 1999. Heritage Seeds.

Saia. A grazing only type. Has a much smaller seed than most other varieties, so use lower sowing rates. Produces early feed and extended grazing. Recovery from grazing is sometimes poor. Tall, fine, weak straw. Highly tolerant to aluminium and manganese toxicity. Its blackish grain can be regarded as a contaminant if mixed with white grained varieties. Introduced from Brazil.

SF Colossus. A late flowering forage oat suitable for grazing and producing hay. Medium seed size compared with mainline oat varieties reducing overall seed rates (kg/ha). Marketed by Seed Force.

Table 28. Disease guide – oats

Disease/Cause	Symptoms	Occurrence	Spread	Control
Foliar diseases				
Bacterial stripe blight *Pseudomonas striafaciens* pv. *striafaciens*	Water soaked stripes on leaves, drying to tan/red stripes, leaf death.	More severe in early maturing crops in wetter seasons.	Rain splash, insects, seedborne.	Nil
Barley yellow dwarf *Barley yellow dwarf virus* (BYDV)	Yellowing, dwarfing of infected plants, floret blasting, leaf reddening in some varieties.	Most common near perennial grass pastures and in early-sown crops.	Transmitted by aphids from infected grasses and cereals.	Resistant and tolerant varieties; controlling aphids, insecticidal seed treatments.
Leaf (Crown) rust *Puccinia coronata* f.sp. avenae	Orange powdery pustules on upper leaf surface.	In wet seasons; more important on the coast.	Airborne spores from living plants.	Graze infected crops in autumn, Varieties with the best possible field resistance. Foliar fungicides.
Leaf spots Several fungi	Leaf spots, leaf death.	Usually minor.	Depends on disease.	None.
Red leather leaf *Spermospora avenae*	Long lesions with reddish borders and light centres. Leaves may look and feel leathery.	Higher rainfall, cool wet weather.	Oat stubble. Stubble and rain splash.	Avoid susceptible oat varieties and rotate crops.
Stem rust *Puccinia graminis* f.sp. *avenae*	Reddishbrown, powdery, oblong pustules with tattered edges on leaf and stem; progressive death of plant.	More important inland, from spring to summer in warm, wet weather.	Airborne spores from living plants.	Early maturing varieties to avoid rust. Foliar fungicides.
Smuts				
Smuts *Ustilago avenae, U. segetum* var. *hordei*	Replacement of florets by black sooty mass.	Statewide.	Spores on or in the seed infect the seedling after sowing.	Thorough treatment of seed with appropriate fungicide.

SF Tucana. A late-flowering forage oat suitable for grazing and hay production. Seven days later in flowering than SF Colossus. Marketed by Seed Force.

Taipan.Φ An erect plant with quick, early growth and high dry matter yields. Ideally suited to cattle, particularly in a continuous grazing situation. Susceptible to leaf and stem rust in the northern region. Released by Pacific Seeds in 2001.

Tammar.Φ A tall, mid–late season hay variety, later in cutting time than Kangaroo or Tungoo. Tammar has a good foliar disease resistance profile and has improved stem rust resistance compared with Tungoo. Has good lodging resistance, comparable with Kangaroo. Tammar has excellent hay colour and resists brown leaf at cutting and has similar hay yields to Kangaroo and Tungoo, but lower than Wintaroo. Released by SARDI in 2012. AEXCO.

Tungoo.Φ A medium–tall, mid–late season hay variety. Tungoo combines resistance and moderate tolerance to cereal cyst nematode and stem nematode. Resistant to red leather leaf disease; MS–S to stem rust; MR to leaf rust. Hay yield is similar to Kangaroo but grain yield and grain quality is poor. Hay quality is similar to Wintaroo (better than Kangaroo), although it tends to be higher in neutral detergent fibre (NDF) than Wintaroo, but not as high as Kangaroo. Early vigour is not as good as Kangaroo. Low husk lignin. Released by SARDI in 2010. AEXCO.

Wintaroo.Φ A tall, mid-season hay variety. Resistant and moderately tolerant to cereal cyst nematode and tolerant to stem nematode. Low husk lignin. Released by SARDI in 2002. AEXCO.

Yarran. A medium height, early- to mid-season maturing variety for feed grain. Performs better than Coolabah for grain recovery, or grain-only on the slopes/plains, but is slightly inferior to Coolabah for grazing production. In very dry years it outyields Echidna in grain-only trials. Large grain with a high test weight, protein percentage and medium to low husk content. Very susceptible to BYDV. Bred by NSW DPI at Temora. Released in 1988.

Yiddah.Φ A tall, strong-strawed, early maturing variety for feed grain. It can be sown earlier than Yarran and has quicker early feed production. Grain yield after grazing is similar to Yarran. Physical grain quality is better than Yarran. Very large grain with high test weight and protein percentage and low husk content. Low lignin husk. Moderate tolerance to BYDV, effective stem and some crown rust resistance. Bred by NSW DPI at Temora. Released in 2001. Waratah Seeds.

Oat varieties that are no longer in commercial seed production by the respective marketing or seed company but may still be available on a limited basis.

Barcoo. A semi-prostrate grazing variety with medium maturity, suitable for early- to mid-season sowing, grazing and grain recovery. Released by Pacific Seeds in 1996.

Bass.Φ Suitable for early sowings on the higher tablelands. Provides extended grazing with good grain recovery. Strong straw. Good BYDV tolerance. Released by the Tasmanian Institute of Agricultural Research and the Department of Primary Industries, Water and the Environment in 1998.

Culgoa II. A semi-prostrate variety mainly for grazing. Slow initial growth. Released by DAF Qld in 1991. **Dawson.**Φ A Medium–late maturity grazing variety with erect early growth and high dry matter yields. Susceptible to leaf rust. Ideally suited to cattle, particularly in a continuous grazing situation. Released by Pacific Seeds in 2008.

Table 29. Hay varieties

Variety	Grazing		Straw strength after grazing	Maturity	Diseases					Acid soils – sensitivity to aluminium
	Early dry matter production	Grazing recovery			Stem rust ✦	Leaf (crown) rust ✦	BYDV	Red leather leaf	Bacterial blight	
Bass	medium	excellent	good	late	S	S	T	–	–	Tol
Bimbil	medium	excellent	good	early–mid	S	MS	MS	–	R	–
Blackbutt	slow	excellent	good	late	S	S	MT	–	R	Tol
Cooba ▲	medium	excellent	fair	early–mid	MS–S	MS–S	MT	–	R	Int
Coolabah▲	quick	moderate	fair	early	MS–S	S	MT	–	R	Sen
Nile	quick	excellent	good	very late	S	S	T	–	R	Tol
Yarran ▲	medium	moderate	fair	early	S	MS	VS	–	R	Int
Yiddah	medium	excellent	good	early	MS	S	MT	–	–	–
Specialist hay varieties#										
Brusher	medium	–	good	early–mid	MS & S	MS & S	MS	MS	MR & MS	–
Forester	medium	–	–	very late	R & S	MR & MS	MR & S	R & MR	MS & S	–
Kangaroo	medium	–	–	mid–late	MS & S	MS & S	MR & S	MS	MR & MS	–
Mulgara	medium	–	–	early–mid	MS	MR & MS	MS	MS & S	MR	–
Tammar	medium	–	–	late–mid	MR & S	MR & MS	MS	R & MS	MR	–
Tungoo	medium	–	–	mid–late	MS & S	MS	MR & MS	R	MR	–
Wintaroo	medium	–	fair–good	mid	S	S	MR & MS	MS	MR & MS	–

– = Insufficient data, R = Resistant, R–MR = Resistant to Moderately resistant, MR = Moderately resistant, MR–MS = Moderately resistant to Moderately susceptible, MS = Moderately susceptible, MS–S = Moderately susceptible to Susceptible, S = Susceptible, VS = Very susceptible. Where ratings are separated by '&' the first is correct for the majority of situations, but pathotypes are known to exist in some regions and the later rating reflects the response to these pathotypes. ✦ Field resistance to the rusts on crops differ depending on season, maturity and strains present.

Sen = Sensitive, Int = Intermediate, MT = Moderately tolerant, Tol = Tolerant. Select more than one variety, with at least one from the early maturing group and another from mid or late maturing group. # Ratings for the specialist hay varieties are from the SARDI Oat Breeding and Pathology Programs, they are from SA screening, and may not represent the reaction to stem and leaf rust in NSW where more virulent pathotypes are present. ▲ Outclassed, Yarran (BYDV), Cooba and Coolabah (grain yield).

Enterprise. An erect, grazing forage oat. Provides good early grazing. Poor recovery after hard grazing and/or frosting. After grazing, grain maturity is much later than Blackbutt. Released by Heritage Seeds in 1993.

Graza 50. An erect, quick-growing grazing variety developed by Agriculture Canada. Released by Pioneer Hi-Bred in 1994. Austgrains International.

Graza 68. A semi-erect, medium-growing grazing variety developed by Agriculture Canada. Released by Pioneer Hi-Bred in 1998. Austgrains International.

Gwydir. Semi-prostrate grazing variety developed jointly by the University of Queensland, DAF Qld and Pacific Seeds. Released by Pacific Seeds in 1999.

Lordship. A long season, late maturing variety. Maturity is similar to Enterprise and Graza 50. Excellent early vigour and forage production. Will grow tall if ungrazed, but is moderately resistant to lodging. Good BYDV resistance. Released by Heritage Seeds in 2000.

Nugene.[Φ] A semi-erect grazing oat with quick, early growth. Late maturing after grazing. Susceptible to leaf and stem rust in the northern region. Released by DAF Qld and Heritage Seeds in 2000. Heritage Seeds.

Quamby. A very erect variety, similar to Enterprise. Very late maturing. If grazed when tall, does not recover well. Released by the Tasmanian Department of Agriculture in 1988.

Volta.[Φ] A semi-erect grazing variety. Medium–late maturity. Susceptible to leaf and stem rust in the northern region. Selected for Queensland and northern NSW. Released by DAF Qld and Heritage Seeds in 2003 and available through Heritage Seeds.

Warrego. A semi-prostrate grazing oat with quick, early growth. Developed by North Dakota State University and released by Pacific Seeds in 1999.

Table 30. Forage, silage or hay varieties

Variety	Growth habit	Speed to grazing	Flowering time[#]	Diseases	
				BYDV	Leaf (crown) rust
Aladdin	semi-erect	medium–quick	late	–	S*
Barcoo	semi-prostrate	medium	mid	–	S*
Bass	semi-prostrate	medium	mid	T	S
Blackbutt	prostrate	slow	mid	MT	S
Bond	semi-erect	quick	late	–	–
Comet	semi-erect	medium–quick	mid–late	–	R
Cooee	erect	very quick	mid	–	S
Culgoa II	semi-prostrate	slow	mid–late	–	S
Dawson	erect	very quick	mid–late	–	S
Drover	semi-prostrate	medium	mid–late	–	S*
Empire	erect	medium–quick	late	–	–
Enterprise	erect	medium	late	–	S
Eurabbie	semi-prostrate	medium	mid	S	S
Galileo	semi-erect	quick	late	MT	S
Genie	erect	very quick	late	–	S
Graza 50	erect	quick	late	–	S
Graza 51	erect	quick	med–late	–	S
Graza 68	semi-erect	medium	late	MT	S
Graza 80	erect	quick	late	–	S
Graza 85	semi-erect	quick		–	–
Gwydir	semi-prostrate	medium	late	–	S
Lordship	semi-erect	very quick	late	T	S
Mammoth	-	quick	-	T	–
Mannus	prostrate	medium	mid	MS	MS & S
Moola	semi-erect	quick	late	–	S
Nile	semi-prostrate	medium	mid–late	T	S
Nugene	semi-erect	quick	late	–	S
Outback	erect	quick	med–late	–	S
Quamby	erect	medium	mid–late	–	S
Saia	erect	medium	early	T	S
SF Colossus	–	–	mid–late	–	–
SF Tucana	–	–	late	–	–
Taipan	erect	quick	late	–	S
Volta	semi-erect	medium	mid–late	I	S
Warrego	semi-prostrate	medium	mid–late	–	S

– = Insufficient data, I = Intolerant, R = Resistant, MR = Moderately resistant, MS = Moderately susceptible, MT = Moderately tolerant, S = Susceptible, Sen = Sensitive, Tol = Tolerant.

* Virulent pathotypes have been detected for these varieties, however, they are not common. Crops should therefore be inspected regularly for the presence of leaf rust.

[#] These varieties are rated according to flowering time and not grain maturity, the relative flowering times may change depending on which region in NSW they are grown, particularly in southern NSW. Feeding value of oat grain.

The GRDC-supported *Premium grains for livestock production* project demonstrated large differences between varieties in whole grain digestibility. Cattle feeding trials have subsequently demonstrated that these differences translate into large differences in grain digestibility. Grain testing from the 2014 harvest has shown on average a 17% increase in digestibility of Mitika oats over other grain oat varieties grown at sites in central and southern NSW.

The varietal differences in the lignin content of the oat husk causes most of the difference in whole grain digestibility. Where varieties have a high husk lignin content, digestion of both the husk and the underlying grain is poor. Husk lignin content is assessed using a simple staining test (phloroglucinol stain test). Table 31 shows a list of lignin ratings of a range of oat varieties.

While other seasonal factors affect whole grain digestibility, varieties with a high husk lignin rating will inherently have low whole grain digestibility. NIR tests have been developed to measure the feeding value of grains.

Feed quality tests can accurately measure whole grain digestibility, protein levels and metabolisable energy. For livestock feeding, grain protein is an important attribute. Oats can vary widely in protein levels due to varietal factors, paddock variability, fertiliser inputs and yield levels. Oats with low protein levels (<12%) can limit growth rates of young animals.

Table 31. Hull lignin rating of a range of oat varieties – low is better for ruminant feed value

Low	Medium	Medium–High	High
Bass, Bimbil, Brusher, Carbeen, Cooba, Eurabbie, Graza 68, Mannus, Mitika, Mulgara, Nile, Tungoo, Wintaroo, Yarran, Yiddah	Blackbutt (variable), Graza 80, Quoll	Euro, Potoroo, Wandering	Bannister, Carrolup, Coolabah, Dawson, Drover, Dunnart, Echidna, Forester, Genie, Graza 50, Kangaroo, Mortlock, Nugene, Possum, Taipan, Williams, Wombat, Yallara

Oaten hay

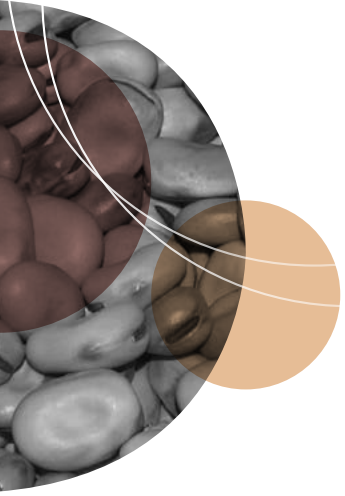
For information on quality and marketing of oaten hay, including export options, contact the **Australian Fodder Industry Association (AFIA)** **(see page 53 for details)**.

Further reading

SARDI website for new variety brochures and further information on hay only varieties.

Contributing authors

Glenn Roberts, former Oat Breeder, NSW DPI, Temora; Pamela Zwer and Sue Hoppo, Oat Breeders, SARDI, Adelaide; Frank McRae, former Technical Specialist Cereals, NSW DPI, Orange; Bruce Winter, Plant Breeder (Oats), DAF Qld, Toowoomba.



Industry information

Seed testing laboratories

The key to getting a reliable seed testing result is making sure you collect a representative sample of your seed lot and using an accredited laboratory. There are a number of commercial seed testing services available to growers. The following list is not exhaustive and others are available.

SGS Australia Pty Ltd
59 Bancroft Road, PINKENBA Queensland 4008
t: 07 3622 4700 f: 07 3622 4770
e: au.food.agriculture@sgs.com

Seed Services Australia
Primary Industries and Regions South Australia
GPO Box 1671, ADELAIDE South Australia 5001
t: 1300 928 170 or 08 8303 9549 f: 08 8303 9508
e: seeds@ruralsolutions.sa.gov.au

Futari Grain Technology Services
34 Francis Street [PO Box 95], NARRABRI NSW 2390
t: 02 6792 4588 f: 02 6792 4221
e: info@futari.com.au

EM Pascoe Seed Testing services
12 Ridge Road Greensborough VICTORIA 3088
t: 03 9434 5072 f: 03 9434 5072
e: elizabethpascoe@gmail.com

GrainCorp Technical Services
30 Barwan Street, NARRABRI NSW 2390
t: 1800 809 482 or 02 6792 8605 m: 0408 860 995
f: 02 6792 3825
e: jlowien@graincorp.com.au

Industry organisations

Australian Fodder Industry Association Inc.
www.afia.org.au
Docklands, 101b/757 Bourke Street, MELBOURNE Victoria 3008
t: 03 9530 2199 e: **info@afia.org.au**

Australian Oilseeds Federation
www.australianoilseeds.com
PO Box H236, AUSTRALIA SQUARE NSW 1215
t: 02 8007 7553 f: 02 8007 7549
e: admin@australianoilseeds.com.au

Grain Growers Association
www.graingrowers.com.au
Level 19, 1 Market Street, SYDNEY NSW 2000
PO Box 1355, QUEEN VICTORIA BUILDING NSW 1230
t: 1800 620 519 or 02 9286 2000 f: 02 9286 2099
e: enquiry@graingrowers.com.au

Grain Trade Australia (GTA)
Formerly National Agricultural Commodities Marketing Association (NACMA)
www.graintrade.org.au
Level 7, 12 O'Connell Street, SYDNEY NSW 2000
PO Box R1829, ROYAL EXCHANGE NSW 1225
t: 02 9235 2155 f: 02 9235 0194
e: admin@graintrade.org.au

NSW Durum Wheat Growers Association
Chairman: Ross Durham
Nombi, MULLALEY NSW 2379
t: 02 6743 7841 m: 0427 437 841
e: **ross@nombi.com.au**

SA Durum Wheat Growers Association
www.durumgrowerssa.org.au
Secretary: Ann Price m: 0429 962 032
e: SADGAsecretary@gmail.com

Pulse Australia Ltd
www.pulseaus.com.au
Level 10 Farrer House
24–28 Collins Street, MELBOURNE Victoria 3000
m: 0425 717 133
e: tim@pulseaus.com.au

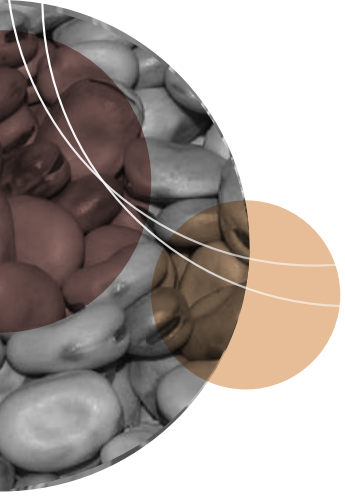
The University of Sydney
Plant Breeding Unit – Cereal Rust
107 Cobbitty Road, COBBITTY NSW 2570
t: 02 9351 8800 f: 02 9351 8875

Variety Central
http://varietycentral.com.au
Contact: Denis McGrath
m: 0408 688 478 f: 03 4206 7015
e: **denis@seedvise.com.au**

National Cereal Rust Survey

Cereal rust samples can be collected and mailed to the address below. Rusted plant samples can be mailed in paper envelopes; do not use plastic wrapping or plastic lined packages.

Send to:
Australian Cereal Rust Survey
Plant Breeding Institute
Private Bag 4011, NARELLAN NSW 2567



Triticale

Crop management

This high yielding feed grain crop is suited to all soil types, but has yield advantages on light, acid soils high in exchangeable aluminium. In these soils, triticale significantly out-yields wheat, barley and sometimes oats in all seasonal conditions, wet or dry.

In low soil fertility, triticale responds well to high inputs of seed and fertiliser. Adequate fertiliser needs to be applied to achieve optimum yields.

On the better wheat soils, and in better seasons, triticale yields are equal to or exceed those of wheat. However, in dry springs triticale yields may be 10–15% below wheat, due to its longer grain-filling period.

Triticale often suffers more from frost damage than wheat, hence it should generally be sown later. It flowers earlier than most wheats, but matures at about the same time.

Triticale usually commands a lower price per tonne at the farm gate. An exception to this can be where there is strong local demand for feed grain, where a better cash return with low transport costs could be expected.

Phosphorus (P)**.** Consider using 15–25 kg P/ha, depending on expected yield, paddock history, soil test results and soil type.

Nitrogen (N)**.** Give particular attention to nitrogen supply. Triticale used for grazing and grain could use up to 100 kg/ha of N. Consider applying 60–100 kg/ha of N as a topdressing if soil nitrogen levels are low.

Long fallow paddocks following good legume pastures generally have satisfactory nitrogen levels. Long fallow paddocks have the highest yield potential because of stored moisture and have the greatest potential to respond to soil nitrogen. Yield increases are likely when nitrogen is applied to paddocks with low nitrogen status.

The contribution of pulse crops and pastures to soil nitrogen depends on the amount of plant material produced and/or the subsequent grain yield. The actual amount of soil nitrogen accumulated is highly variable.

Cover crop. The low tillering growth of some varieties and good shattering tolerance of triticale has proven useful as a cover crop for undersowing pastures on the slopes and tablelands.

Sowing rates

Aim to achieve the same plant populations as for wheat by setting the seeder 25–40% above the setting recommended for district wheat sowings. The higher setting is needed because the:

» grain is larger than wheat, and flows more slowly

» plants tiller less than wheat.

See page 6 for calculating sowing rates.

Table 32. Sowing rates for triticale

Purpose/growing conditions	Sowing rate (kg/ha)
Grain only	60–100
Grazing and grain	100–120
Irrigation and favourable environments	100–120
Undersowing pasture	15–30

Check germination and seed size to calculate sowing rate.

Grazing

The ideal stage to start grazing dual-purpose varieties is when plants are well anchored and the canopy has closed. Continuous grazing is better than rotational grazing for fattening stock. Maintain adequate plant material to give continuous and quick regrowth of the crop (1000–1500 kg DM/ha).

For the best recovery after grazing, do not graze below 5 cm for prostrate varieties, or below 10 cm for more erect types.

The higher grazing height is particularly important with the erect-growing varieties. Over-grazing greatly reduces the plant's ability to recover. (**See** Managing grazing cereals page 61).

Disease

Triticale is susceptible to loose smut. It is slightly less susceptible to take-all than wheat; early sowing increases the risk. It has vastly superior tolerance over wheat to Septoria tritici blotch. Although it does not usually exhibit severe symptoms of yellow spot, it will harbour this disease. Triticale is also susceptible to crown rot.

Growers should check to ensure their current variety has adequate field resistance to both the Jackie and Tobruk pathotypes of stripe rust or consider using foliar fungicides to control the disease in-crop if required.

Seed treatment should be considered for controlling seedling stripe rust in susceptible varieties, especially those sown early for grazing.

Table 33. Dual-purpose yield performance experiments from 2004 to 2009

Compared with Endeavour = 100%

Variety North	1st Grazing DM Endeavour = 2.63 t/ha	2nd Grazing DM Endeavour = 2.39 t/ha	Grain recovery Endeavour = 2.41 t/ha
Breakwell▲	99	97	85
Crackerjack▲	103	87	100
Endeavour	**100**	**100**	**100**
Tobruk▲	76	111	111
South	Endeavour = 2.19 t/ha	Endeavour = 2.23 t/ha	Endeavour = 2.98 t/ha
Breakwell▲	93	102	83
Crackerjack▲	101	85	90
Endeavour	**100**	**100**	**100**
Tobruk▲	76	108	110

▲Outclassed – Breakwell, Crackerjack and Tobruk (stripe rust).

Table 34. Suggested sowing times for triticale

Variety	Weeks	February		March				April				May				June				July	
		3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Endeavour		>	★	★	★	★	★	★	★	<	<										
Cartwheel			>	★	★	★	★	★	★	<	<										
Tobruk▲			>	★	★	★	★	★	★	★	★	★	★	★	★	<					
Breakwell▲				>	★	★	★	★	★	<	<										
Crackerjack▲, Tuckerbox										>	★	★	★	★	★	★	<				
Bogong▲, Canobolas▲, Kosciuszko▲, Yowie, Yukuri											>	★	★	★	★	★	<				
Astute, Berkshire▲, Bison, Credit▲, Fusion, Goanna, Hawkeye, Jaywick, Rufus▲, Tahara▲, Tickit▲												>	★	★	★	★	★	<			
Chopper▲, KM10, Speedee▲													>	>	★	★	★	★	★	<	<

Aim to sow in the earlier part of the optimum time indicated to achieve maximum potential yield, particularly in western areas. The actual date selected is influenced by soil moisture, soil fertility and the likelihood of frost in a particular paddock at flowering.

> Earlier than ideal, but acceptable. ★Optimum sowing time. < Later than ideal, but acceptable. ▲Outclassed. Limited data available on Astute, Bison, Cartwheel, Goanna, KM10 and Yowie in NSW.

Table 35. Grain only yield performance experiments from 2008 to 2015 (Compared with Fusion = 100%)

Variety	North-east Fusion = 4.14 t/ha	Number of trials	South-east Fusion = 4.57 t/ha	Number of trials	South-west Fusion* = 6.09 t/ha	Number of trials
Astute	104	6	105	10	–	–
Berkshire▲	95	15	93	29	100	6
Bison	101	6	101	10	–	–
Bogong▲	99	15	96	29	104	6
Canobolas▲	97	13	95	26	106	5
Chopper▲	89	15	87	29	87	6
Fusion	**100**	**11**	**100**	**22**	**100**	**5**
Goanna	87	10	86	18	91	4
Hawkeye	95	15	95	29	102	6
Jaywick	92	15	93	29	103	6
KM10	87	4	89	7	–	–
Rufus▲	85	15	84	29	87	6
Tahara▲	84	15	83	29	86	6
Tobruk▲	85	5	85	11	–	–
Tuckerbox	76	13	76	25	85	5
Yowie	86	11	86	22	96	5
Yukuri	74	15	75	29	95	6

▲Outclassed – Berkshire, Bogong, Canobolas, Chopper, Rufus, Tahara and Tobruk (all stripe rust).
* Includes some irrigation trials.

No recent data is available for the NSW north-west region as only a limited number of trials were conducted in the period of 2008–2015. The table presents NVT 'Production Value' MET (multi environment trials) data on a regional mean basis from 2008–2015.

Variety selection

Grazing and grain recovery: Endeavour, Cartwheel and Tuckerbox.

Outclassed: Breakwell, Crackerjack and Tobruk (all stripe rust).

Grain only: Astute, Bison, Fusion, Hawkeye, Jaywick, and Yukuri – for main season sowings (mid May–June).

Outclassed: Berkshire, Bogong, Canobolas, Chopper, Rufus, Tahara and Tobruk (for earlier sowings in higher rainfall areas) (all stripe rust).

Marketing

Triticale is predominantly used as a stockfeed, often processed into prepared ration mixes or pellets. As with other cereal grains, care is needed when introducing stock to triticale due to grain poisoning issues.

The market is small compared with other grains such as barley. Grain is traded domestically through merchants or direct to end users in the dairy, feedlot, pig and poultry industries.

Prices offered are often relative to Australian Standard White wheat and are influenced by the:

- supply and price of other grains such as barley, wheat, sorghum and possibly oats
- quality and quantity of grain
- location of grain and transport costs
- seasonal effects on the grazing industries.

Prices tend to be lowest at, or soon after, harvest and rise during winter.

Aim for a maximum 12% moisture, with a test weight of 65 kg/hL with a minimum of admixture. Grain protein and metabolisable energy levels (ME) should be known before negotiating sales. ME levels are similar to wheat.

Since triticale is often grown in acid soils and later in the rotation, low protein grain can result, affecting marketability and price. Adequate nitrogen fertiliser should be applied to alleviate this problem.

Storage

Triticale grain is very prone to weevil attack, more than barley. Be careful of high grain moisture contents (**see page 115, Grain insects – options for control**).

Varietal characteristics

These varietal notes must be read in conjunction with **Table 36 Variety characteristics and reactions to diseases**.

Dual-purpose grazing varieties

Breakwell. A semi-awnless dual-purpose variety. Good straw strength. Better dry matter production than Jackie and superior grain recovery. Later maturing than Jackie (nine days). Seed royalty only. Released by University of Sydney in 2004. Waratah Seeds.

Crackerjack.$^{\Phi}$ A medium season dual-purpose variety. Optimum sowing time from mid April. Excellent establishment and early vigour. Excellent grain recovery after grazing and produces grain with a high test weight. Tall when mature and can be prone to lodging if not grazed. Susceptible (S) to stripe rust head infection; rated moderately susceptible (MS) to the Tobruk pathotype of stripe rust. Released by Heritage Seeds in 2003.

Endeavour.$^{\Phi}$ A semi-awnless dual-purpose variety. Excellent dry matter production and grain recovery after grazing. Released by the University of Sydney in 2007. Waratah Seeds.

SF Bolt. For forage only. A new forage triticale bred in New Zealand for lower acid detergent fibre (ADF) and higher ME to make it suitable for grazing, green chop or whole crop silage. It can be autumn or spring sown. Very limited data on performance in NSW. Marketed by Seed Force.

Tobruk.$^{\Phi}$ A fully awned, dual-purpose and long season grain-only variety. Strong winter habit. Excellent grain yield after grazing. Susceptible to stripe rust head infection, rated MS–S to the Tobruk pathotype of stripe rust. Consider seed treatment for stripe rust when sown early for grazing. Released by the University of Sydney in 2007. Waratah Seeds.

Tuckerbox. A reduced awn, medium season, tall, dual-purpose triticale. A variety suitable for hay or silage. Tuckerbox is most suited to production areas of 450 mm annual rainfall or greater, but will grow to maturity in lower rainfall areas or in tough seasons. Approximately one week later than Rufus to heading, slightly earlier than Yukuri. Selected at Sherlock, South Australia, by Kath Cooper. Non-PBR. Cooper & Elleway and Yankalilla Seeds.

New varieties with potential for the 2016 season

Cartwheel.$^{\Phi}$ New for 2016. Tested as AT674. A long season dual-purpose triticale that is suitable for an early March to early April sowing. A stripe rust resistant replacement for Tobruk. Good early forage production when sown in March and recovers from grazing to give excellent grazing in winter. Straw strength is good and has shorter stature than Tobruk. Grain yield after grazing is equivalent to Tobruk. Seed is available from Waratah Seeds.

Grain only varieties

Berkshire.$^{\Phi}$ A main season variety, especially suited to the pig industry. Suitable for central and southern NSW, and eastern Victoria. Good straw strength. Released by University of Sydney in 2009. Waratah Seeds.

Bogong.$^{\Phi}$ An early–mid season maturing variety. Maturity is 1–2 days faster than Everest or Treat. Widely adapted spring variety that performs best in medium to high rainfall areas or in late maturing environments. Strong straw. Released by the University of New England in 2008. Seednet.

Canobolas.$^{\Phi}$ An early–mid season maturing variety. Maturity is 1–2 days faster than Everest. Spring variety, suited to the NSW slopes and tablelands. Strong straw. Released by the University of New England in 2008. Seednet.

Table 36. Variety characteristics and reaction to diseases

Variety	Grazing production	Straw strength	Maturity	Resistances						Acid soils–sensitivity to aluminium
				Stem rust	Leaf rust		Stripe rust	Cereal cyst nematode	RLN *P. neglectus*	
						Tobruk Pathotype	Yr 17–27 Pathotype			
Dual-purpose										
Breakwell▲	quick–early	very good	mid–late	R	R	S–VS	MR	R	–	V. Tol
Cartwheel	quick–early	very good	mid–late	R	R	–	R	–	–	–
Crackerjack▲	quick–early	moderate	mid	R	MR–MS	MS[a]	R–MR	–	–	–
Endeavour	quick–early	very good	late	R	R	R–MR	R–MR	R	–	V. Tol
Tobruk▲	quick–early	very good	mid–late	R	R	MS–S[a]	MR	–	–	–
Tuckerbox	quick–early	–	mid	MR	R	MR–MS	MR	R	–	V. Tol
Grain only										
Astute#	NR	very good	early–mid	R–MR	R–MR	–	R–MR	–	–	V. Tol
Berkshire▲	NR	good	early–mid	R	R	MS	MR–MS	–	–	–
Bison#	NR	good	early–mid	R–MR	R–MR	–	R	R	R	V. Tol
Bogong▲	NR	very good	early–mid	R–MR	R–MR	MS	MR–MS	–	–	V. Tol
Canobolas▲	NR	good	early–mid	R	R	MS–S	MR–MS	–	–	V. Tol
Chopper▲	NR	very good–good	very early	MR	R	MS–S	MR–MS	R	MR	–
Fusion	NR	medium-good	mid	R	R	MR[b]	R–MR	R	R	V.Tol
Goanna#	NR	good	early–mid	R	R	MR–MS	R–MR	R	–	–
Hawkeye	NR	good	mid	R–MR	R	MR, MS–S[b]	MR, MS[b]	R	R	V. Tol
Jaywick	NR	good	early–mid	MR–MS	R	MR, MR–MS[b]	R–MR, MS[b]	R	R	V. Tol
KM10#	NR	good	very early	R	MR–MS	–	R	S	–	–
Rufus▲	NR	good	early–mid	R	R	MS	MR–MS	R	R – MR	V. Tol
Tahara▲	NR	moderate	early–mid	R	R	MS	MR–MS	R	R	V. Tol
Yowie#	NR	good	mid	R	R	MR–MS, MS[b]	MR	R	–	–
Yukuri	NR	good	mid–late	R	R	R–MR	R–MR	S	–	V. Tol

NR = Not recommended, R = Resistant, R–MR= Resistant to Moderately resistant, MR = Moderately resistant, MR–MS= Moderately resistant to Moderately susceptible, MS = Moderately susceptible, MS–S= Moderately susceptible to Susceptible, S = Susceptible, S–VS=Susceptible to Very susceptible, VS=Very susceptible. V. Tol = Very tolerant,
▲Outclassed. [a] Susceptible to head infection. [b] mixed population, some plants are more susceptible to stripe rust.

Where ratings are separated by '&' the first is correct for the majority of situations, but different pathotypes are known to exist at a low level and the latter rating reflects the response to these pathotypes. – Unknown or no data. #Limited data available on Astute, Bison, Goanna, KM10 and Yowie in NSW.

Chopper.[Φ] A very early maturing variety, 3–4 days earlier than Speedee and 7–15 days earlier than Tahara. Fully awned spring triticale, a possible replacement for Speedee, offering improved yield and reduced lodging. Suited to short growing seasons or late sowing. Semi-dwarf variety, shorter than many of the current varieties, reducing the risk of lodging. Released by AGT in 2010. Available from AGT Affiliates.

Fusion.[Φ] A mid maturity grain triticale resistant to cereal cyst nematode. Tested as TSA0291, Fusion is a unique, line bred from a cross between triticale parents and a bread wheat parent called Stylet. Fusion maintains exceptionally high yields under tough conditions such as drought or tight finishes. Fusion is best suited to medium yield potential environments and has performed well across all regions of NSW. Fusion is available through AGT Affiliates. AGT.

Goanna. An early–main season, spring type, grain triticale. Fully-awned, tall, white-chaffed variety. Good physical grain quality. Goanna was bred at Sherlock, South Australia by Kath Cooper. Marketed by Cooper & Elleway.

Hawkeye.A A broadly adapted mid season variety. Good early vigour and highly stable across environments. Moderately resistant (MR) to stripe rust, some plants could have a higher Susceptibility to stripe rust. High yield potential. Excellent physical grain quality. Released by AGT in 2007. Available from AGT Affiliates.

Jaywick.[Φ] A broadly adapted mid season variety. Stable grain yield even in a tough finish. Moderately resistant to stripe rust; some plants could have a higher Susceptibility to stripe rust. Good physical grain quality. Selected from University of Adelaide germplasm. Released by AGT in 2007. Available from AGT Affiliates.

Rufus. A widely-adapted main season variety maturing a few days earlier than Tahara. Reduced awn, tall, large grain, suitable for fodder conservation and grain production. Resistant (R)–MR to root lesion nematode (*Pratylenchus neglectus*). Released by University of New England in 2004.

Tahara. A main season variety with wide adaptability. Its straw can be weaker in high yielding conditions and it has lower grain protein. Released by DEPI Victoria in 1987.

Yowie. A later-maturing main season variety (slightly later heading than Tahara), spring type, grain triticale. Moderately resistant–MS to stripe rust. The variety has a low level of plants, which have a lower rating of Moderately susceptible. Fully-awned, medium–tall, white-chaffed variety. Selected at Sherlock, South Australia by Kath Cooper. Non-PBR and marketed by Cooper & Elleway.

Yukuri. A later-maturing main season variety. Medium height with wheat-like, high test-weight grain. It matures 7–10 days later than Tahara. Reduced awns make it suitable for fodder conservation. Resistant to leaf rust, although MS to the Mackellar pathotype of leaf rust. Released by UNE in 2004. Non-PBR.

New varieties with potential for the 2016 season

Astute.[Φ] A new release for 2016. Tested as TSA 0466. Mid maturity variety suited to the medium to high rainfall areas of NSW, with high yield potential. Astute is a suitable replacement for Hawkeye, with a similar flowering time. Astute is a fully awned variety, with good lodging resistance. Seed is expected to be available for the 2016 planting season through AGT Affiliates. AGT.

Bison.[Φ] An early to mid maturity variety, suited to low–medium yield potential environments. Tested as TSA 0451. Reduced awned variety; possible replacement for Rufus with improved stripe rust resistance. Seed expected to be available for the 2016 planting season through AGT Affiliates. AGT.

KM10. A quick maturing line, suited to late sowing or short season environments. Reduced awned variety with quick early growth. Could be suitable for fodder production systems as it has good early growth. It could be used as part of an annual ryegrass management program where sowing is delayed and/or the option for cutting as silage is used. Non PBR variety. Selected at Sherlock, South Australia, by Kath Cooper. Marketed by Cooper & Elleway.

Further reading

Triticale: A guide to the use of triticale in livestock feeds, 2002. van Barneveld R. Grains Research and Development Corporation.

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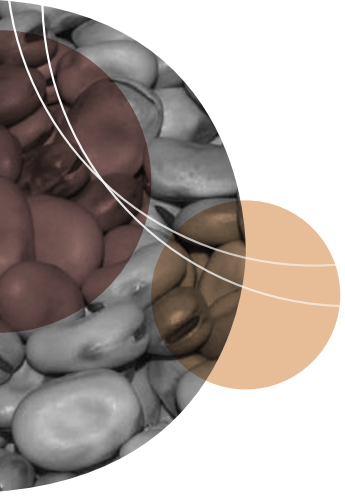

Cereal rye

Crop management

Cereal rye is a winter growing cereal that tolerates high aluminium levels in acid soils, and performs well on lighter soils. Cereal rye is even more tolerant of high aluminium levels than triticale, also regarded as an acid soil tolerant crop choice. It is used for early sowings as a dual-purpose cereal, providing abundant, quick, early stock feed and as a grain-only crop.

Rotations

Paddocks with higher fertility are preferred as most crops are sown for the dual purposes of grazing and grain. It is often used as a grazed cover crop undersown with sub clover pasture to provide ground cover, whilst the clover establishes on lighter soil types. Tolerance to take-all disease makes cereal rye suitable for sowing after grassy pastures.

Self-sown cereal rye can be a problem in subsequent cereal crops because of a high level of seed dormancy, so it should be sown after other cereal crops. When sown the year before a broadleaf crop such as lupins, volunteer cereal rye can be controlled with herbicides.

Role of cereal rye

Cereal rye is very distinct from wheat for bread-making; the dough lacks elasticity and gas retention properties. Used alone, it produces a distinctive black bread. Lighter rye loaves are produced from rye and wheat mixtures. Rye flour, rye meal and kibbled rye are all end products. Rye flour and meal are used in rye bread and biscuits. Plump grain is highly sought after for kibbled rye manufacture.

Cereal rye should be mixed with other grains when fed to monogastrics, especially chickens. It has a high soluble pentosan content, which can cause decreased weight gain and sticky droppings in chickens.

Cereal rye is the preferred cereal option for erosion control as it withstands adverse conditions such as cold, waterlogging, low soil pH and drought better than other cereals. Cereal rye has a more extensive root system in the top 30 cm than both wheat and oats. This root system increases soil stabilisation and allows the plant to explore more of the topsoil profile, increasing the plant's tolerance to dry conditions.

Vineyards sow cereal rye early as a 'between row' green manure crop, which is mulched into the soil before vine budburst.

Sowing

Grain only

Cereal rye is adapted to all soils however, its major fit is on the lighter acid soils where yields are usually 70–100% of wheat and triticale when sown between May and June.

On the more traditional wheat soils, cereal rye yields about 50–70% of wheat. When sown late (in July) and in dry springs, yields are often less than 50% of comparable wheat yields. Whilst it heads early, its longer grain-filling period and later maturity limits its performance in the western areas of the grain belt. Lodging is common.

Grazing and grain recovery

Growth is rapid, with grazing possible four weeks after emergence if tillering and the secondary root system development has occurred to anchor the plant. When sown early, it compares very favourably with other cereals for quick feed and total dry matter production. Ungrazed crops should be sown from late May until the end of June. Where sown for grain, it should be grazed only if excessive early growth or premature heading is evident. Grazing should be completed by early July.

Sowing rates

Sowing rates vary with seed size, target plant populations and establishment percentage. Growers should target 120–150 plants /m^2 for grazing and grain crops. Higher populations are needed for green manure crops.

Comparative seed rates for grazing and grain crops are 60–70 kg/ha and green manure 80–100 kg/ha.

Harvesting

Grain is harvested at about the same time as wheat. Cereal rye is tall and the bulky straw makes harvest slow due to the large volume going through the harvester.

Harvest as soon as the grain dries and hardens. Ripe crops that are left to stand are likely to shed grain. Maturity is often uneven, so inspect the whole paddock before harvest.

A standard wheat header is suitable for harvesting cereal rye. Adjustments need to be made to the harvester settings to avoid grain losses and damage because the grain is lighter and longer than wheat. Tall crops are likely to lean or lodge, so crop lifters might be necessary.

Clean out all machinery after harvest to prevent other cereal grains becoming contaminated with cereal rye.

Varieties

Growers should be aware that cereal rye is a cross pollinating species and will out-cross. To maintain pure seed and varietal type growers should regularly source new seed. The availability of seed of the older cereal rye varieties is limited and some could no longer be under commercial seed production.

Ryesun. A main season variety with adequate stem rust resistance. Likely to lodge under good conditions.

Southern Green. Forage rye that was developed for very rapid growth to first grazing. High tiller density and leaf development, and strong tiller survival after initial grazing. Spring habit, likely to lodge under good conditions. Marketed by PGG Wrightson Seeds.

Vampire.[◊] A main season cereal rye, with better lodging resistance and higher yield than Ryesun. Rapid early growth, suitable for grazing and grain recovery. Released by the University of Sydney and marketed by Waratah Seeds.

Westwood.[◊] A main season variety with similar maturity to Ryesun. Adequate stem and leaf rust resistance. Higher yielding and better lodging resistance than Ryesun. Seed royalties apply. Released by George Weston Technologies in 2003.

Diseases

Cereal rye has tolerance to take all, making it a useful break crop following grassy pastures. All commercial

At the early boot stage, the last flowering part – the pollen – is being formed. This occurs earlier in barley than in wheat or triticale. cereal rye varieties have resistance to the current pathotypes of stripe rust. However the out-crossing nature of the species will mean that under high disease pressure, a proportion of the crop (approaching 15–20% of the plant population) may show evidence of the disease. Other diseases are usually insignificant.

Marketing

Grain is generally traded direct to merchants, with prices fluctuating according to supply and demand. Some merchants may offer sowing contracts, usually with a guaranteed price based on a fixed area and estimated yield. Seek out all the available market opportunities before embarking on growing for grain production only.

Grain receival standards will depend on contractual arrangements with your buyer. Growers should confirm these before entering into any contracts. The current Grain Trade Australia standard for cereal rye grain CSG-60 has a minimum test weight of 70 kg/hL and maximum screenings of 5% through a 1.6 mm screen.

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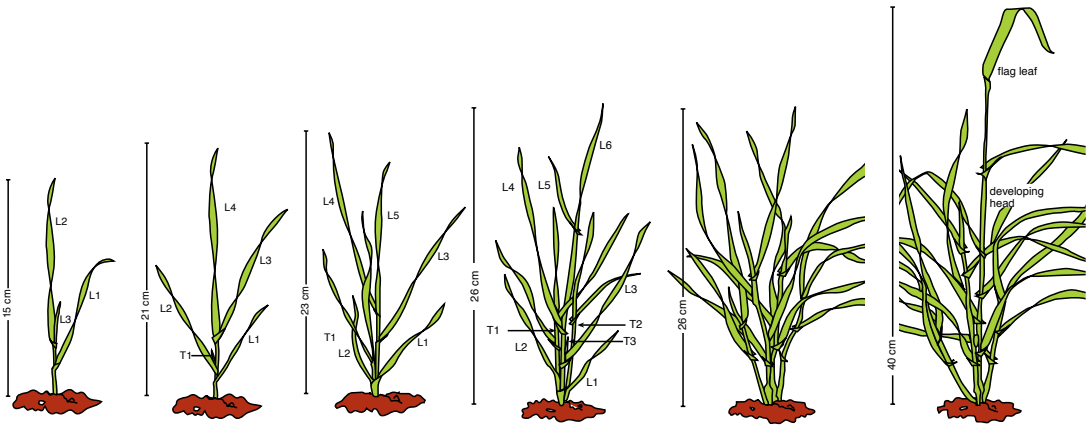
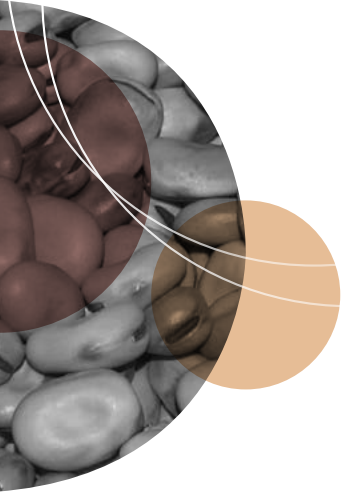


Crop growth stage					
2-leaf stage Two leaves (L) have unfolded; third leaf present, yet to fully expand.	**Start of tillering** First tiller (T1) appears from between a lower leaf and the main shoot. Usually 3 or 4 leaves are on the main tiller.	**Tillering stage** Tillers come from the base where leaves join the stem and continue forming, usually until there are 5 leaves on the main shoot. Secondary roots developing.	**Fully tillered stage** Usually no more tillers form after the very young head starts forming in the main tiller. Tillering completed when first node detected at base of main stem.	**Start of jointing** Jointing or node formation starts at the end of tillering. Small swellings – joints – form at the bottom of the main tiller. Heads continue developing and can be seen by dissecting a stem.	**Early boot stage** The last leaf to form – the flag leaf – appears on top of the extended stem. The developing head can be felt as a swelling in the stem.
Zadoks decimal code					
2 leaves unfolded (Z12).	4 leaves unfolded (Z14). Main shoot and 1 tiller (Z21).	5 leaves on main shoot or stem (Z15). Main shoot and 1 tiller (Z21).	6 leaves on the main shoot or stem (Z16). Main shoot and three tillers (Z23).	First node formed at base of main tiller (Z31).	Z35–Z45.

There is no difference between spring wheat varieties sown on the same day in the rate of appearance of new leaves.

At the early boot stage, the last flowering part – the pollen – is being formed. This occurs earlier in barley than in wheat or triticale.

Figure 4. Growth stages of cereal crops



Managing grazing cereals

Choosing a cereal

Forage and dual-purpose cereals are normally grown to help overcome winter feed shortages.

Oats and other grazing cereals have higher winter growth rates than most pastures. Saved autumn growth from early-sown crops can also be used to carry feed through into winter. Crop and variety selection, and sowing time will influence the total amount of feed available. Dual-purpose varieties should be chosen where a grain harvest is required after grazing. For hay production, cereal types with large awns such as barley, some triticales, cereal rye and some wheats should be avoided. The same applies with grazing when head emergence cannot be controlled.

Ideally there should only be one type of cereal sown in a paddock as stock will preferentially graze one cereal over another.

Oats will generally produce more overall forage than wheat, barley, cereal rye or triticale. Grain recovery, however is not so clear cut, with winter wheats and triticale often having similar, or better yields than oats.

Table 37. Average dry matter yield performance for cereals in NSW

Crop type	Dry matter 1# (kg/ha)	Dry matter 2# (kg/ha)
Oats	2593	2324
Barley	2183	2570
Wheat	1922	2222
Triticale	2303	2525

Dry matter results are an average of combined across sites analysis for each crop type from the NSW DPI mixed cereal trials in NSW from 2004–2010.

Quality tests on the forage value of oats, wheat, barley, cereal rye and triticale grown under similar conditions, show no significant differences in protein, energy or digestibility. The decision to sow an alternative cereal to oats is, therefore, mostly made with regard to paddock suitability, grain recovery and expected higher grain returns. Soil acidity also influences cereal choice, as species and/or varieties vary in their tolerance to soil aluminium. Even when highly acid soils are limed, acid-tolerant types should be grown where the subsoil is acidic.

Consideration should also be given to the diseases that affect the various grazing cereals. Diseases such as *Barley yellow dwarf virus* (BYDV) or *Wheat streak mosaic virus* can limit what is grown in a particular area. The availability of seed insecticide dressings may reduce the impact of diseases such as BYDV on the crop by reducing the levels of early aphid feeding activity which spreads the virus. **See Table 66 Cereal seed dressings on page 120** for a list of currently available seed dressings for aphid control. Cereal rust diseases can also be an issue and susceptible varieties should be avoided. Forage quality and palatability decreases with high foliar rust loads.

Growth habit

Understanding a variety's winter habit and maturity will influence the choice of variety, sowing time and expected grazing performance.

Winter habit

Varieties with a strong winter habit, such as Mackellar wheat and Blackbutt oats, are suitable for early sowing as head initiation does not occur until there has been exposure to periods of cold temperature (vernalisation – this exposure can be cumulative). Once these requirements have been met, head initiation begins as warmer temperatures and increasing day length occurs. The degree of winter habit will depend on each variety's genetics. Varieties described as semiwinter types require a shorter cold temperature exposure to initiate heading.

Maturity

Cereals described as late maturing do not necessarily have a strong winter habit. Without this requirement for vernalisation, these types, when sown early in warm/long day conditions, will quickly initiate heads. Removing the immature heads with grazing will kill tillers with a subsequent loss in forage production from delayed regrowth. Late maturing types without a winter habit, when sown early, often require quick early grazing to retard early growth and head initiation. This earlier than normal grazing will assist subsequent regrowth.

Sowing

Cereals used for either grazing or grain production will only attain maximum production if seed rates are kept high and crop nutrition is adequate. Optimum seed rates will vary with climate and region. Nutritional requirements will likewise vary according to climate, soil type and paddock history. Where nitrogen fertiliser is required, split applications are suitable for dual-purpose

cereals. For example, applying some nitrogen at sowing and following up with topdressing(s) after grazing for subsequent hay/silage or grain production.

Early sowings, particularly on the higher tablelands, will allow more growth before the onset of cold winter temperatures. However, sowing too early in other areas can cause germination and establishment problems if soil temperatures are high.

Early crop vigour could be reduced with stubble retention and reduced tillage practices.

Wider row sowings can also affect forage yields. At Gulgong, for instance, on a light granite soil, a 25 cm row spacing resulted in a reduction of nearly 12% in early dry matter production of Coolabah oats compared with a 17.5 cm row spacing.

Grazing management

The earliest time to start grazing is when the plants are well anchored and have reached the tillering stage (Zadoks [Z] 21–29). For most grazing types under good growing conditions, this will occur 6–8 weeks after plant emergence, depending on variety. Should you need to graze earlier than this, check how well the young plants are anchored by doing a 'twist and pull test' by holding the plant between the thumb and forefinger and pulling as you twist the plant. If the plant remains anchored, grazing livestock should not be able to pull it out. At this early stage, choosing livestock with sound teeth will help reduce any plant damage.

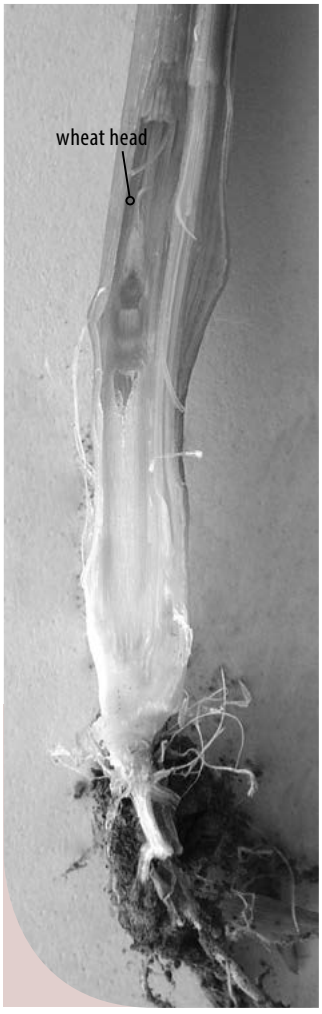


Figure 5. Cross section showing wheat head in young plant.

Grazing withholding periods must be observed on crops sown with treated seed. Withholding periods vary from a few days up to 12 weeks, depending on the product and rate used. For the current withholding periods for the main seed fungicide and insecticide dressings, **see Table 66 Cereal seed dressings**. Always check the pesticide label before cereal crops sown with treated seed are grazed.

Delaying early grazing of winter types allows more feed to be accumulated and saved for winter. For erect types, crops should be 20–25 cm high and for prostrate types, 10–15 cm high. Varieties without a strong winter habit, but sown in early autumn, should be grazed pre-tillering to retard growth and prevent premature stem elongation/head initiation. When stem elongation occurs, immature heads are located just above the highest node (joint). If these are removed by grazing, tiller death occurs and, while the plant is usually able to produce more tillers, forage production (and grain production) will be severely reduced.

The latest grazing time and severity on crops intended for grain recovery or hay production should be governed by the position of the immature head in the stem.

Stock should be removed, at the latest, by growth stage Z31. Z31 is determined when the first node is 1 cm or more above the base of the shoot and the gap between the first node and the second is less than 2 cm. Examine the plant for the first sign of stem elongation and the presence of the developing head (**see Growth stages of cereal crops, page 60**). The beginning of stem elongation can be seen by slicing the main tiller with a sharp blade to expose the developing head as shown in Figure 5. A wheat tiller showing the developing wheat head above.

Some growers choose to graze later and remove these heads, particularly if they need the feed for livestock or if the crop or variety is prone to lodging. These growers accept lower grain or hay yields as a tradeoff. Late grazing of semi-dwarf types can also greatly reduce crop height, possibly causing harvesting problems in rocky or uneven paddocks.

Leaf diseases such as rust (oats) or powdery mildew (barley) could also influence the timing and severity of grazing. By removing the canopy and openingup the crop, leaf disease incidence and severity can be greatly reduced.

All cereals in the vegetative stage under good growing conditions are highly digestible and often contain 80–85% moisture (15–20% dry matter). The resulting loose faeces of stock is regarded as normal on highly digestible, high moisture, green feed. Adding hay or roughage to the diet will reduce animal performance as the animal substitutes the hay/roughage for the higher quality forage. While there is adequate fibre in grazing cereals, adding hay is considered by some to have a role in managing mineral balances in the animal. In some cases, adding hay can be of benefit by extending the grazing life of the crop. Veterinary advice should be sought if abnormal scouring occurs, as there are many non nutritional causes of scours including internal parasites. Regularly count worm eggs and again 10 days after a drench is advocated as best practice.

Relative to the mineral requirements of grazing livestock, the forage of dual-purpose wheat (*Triticum aestivum*) has a very high potassium (K) content, but is deficient in sodium (Na), due to the effects of the KNa1 gene. Wheat forage is also often marginal for magnesium (Mg) and the very high K:Na ratio of consumed forage also impedes gut Mg absorption. Livestock that are grazing wheat will therefore benefit from Na and Mg supplements. Supplements of Na:Mg in the form of 1:1 granular salt:Causmag (grade AL4)

have consistently shown 25–30% increases in sheep and cattle growth rates grazing wheat. Trough feeding rates should be sufficient to allow intakes of 20 g supplement/day in growing sheep or 150–180 g/day in growing cattle. At this feeding rate, supplementation is economically worthwhile; the value of the improved liveweight gain can be 15–20 times the cost of the supplement costs. Oat and barley forage have much higher Na content and higher Mg content than wheat forage and, as a result, livestock grazing oats or barley have not responded to Na:Mg supplements in stock growth rates.

However, calcium deficiency diseases, such as milk fever (hypocalcaemia) and rickets, are common following grazing on oats, wheat and triticale in southern and eastern Australia. Little is known about the effects of grazing barley on animal health. Young growing animals and breeding stock in late pregnancy and early lactation are most vulnerable. Calcium balance in the animal on grazing cereals is compromised, hence providing a calcium source is important for animal health. Adding ground limestone has not been shown to improve growth rate of livestock, however, producers are advised to supply limestone with the salt and Causmag mix to avoid the outbreaks of these diseases.

Stocking rates

Stocking densities will depend on specific animal production targets. Research has shown that continuous grazing of winter forage cereals gives better animal performance, as the best feed on offer will always be selected. This will only be achieved if stocking rates are balanced with crop growth rates and the feed on offer is not being significantly depleted (see Table 39).

Growers should consider developing a feed budget to work out how much feed will be required by a set livestock mob and how many grazing days would be available from a particular paddock. This will maximise overall feed production on the whole farm, particularly in high stocking density situations.

High stocking densities are used under rotational grazing, but lower animal performance can be expected than from continuous grazing. With continuous grazing, stock densities should be set so that plants are left with enough residual leaf material to enable both good regrowth and animal performance. Benchmarks exist for both purposes. Residual plant heights of around 5–10 cm for prostrate types and 10–20 cm for erect types will correspond fairly closely to benchmarks of around 1000–1500 kg/ha of dry matter, suitable for lactating ewes, fattening steers and all other classes of livestock.

Feed on offer to stock can be estimated by using crop height as an indicator, or by taking physical crop dry matter cuts. Table 38 shows an estimated relationship between crop height and available dry matter (DM) (kg/ha) for crops 25 cm or shorter. This table should be used as a guide only, with dry matter cuts needing to be taken for a more precise estimate.

Table 38. Drymatter production of cereal crop types by canopy height

Crop	Relationship to crop height DM per each 1 cm crop height[#]
Wheat	60 kg DM/ha
Barley	75 kg DM/ha
Oats	65 kg DM/ha

[#] These relationships are based on a 20 cm row spacing for crops sown at 100 kg/ha. Subtract or add 10% to the estimate for every 2.5 cm increase or decrease in row spacing.
Source: Mingenew–Irwin Group – *Grazing cereals* fact sheet.

Rotational grazing can be used to maximise a crop's grazing value by reducing wastage from trampling and/or frost damage, or by restricting intake per head. Techniques such as strip grazing or limiting access times to the crop can also be used for rationing feed.

Table 39.Sustainable continuous stocking rate for oats

Stock class	Kg of forage dry matter removed per head*	Sustained stocking rate/ha**
Ewes and lambs (6 weeks)	3.2	9.3
Weaned lambs (30 kg)	2.0	15.0
350 kg steers	12.4	2.4
450 kg steers	13.9	2.1
Cow and calf (3 months)	19.1	1.5

* Calculated using GrazFeed™ for green oats at 2000 kg DM/ha, 20 cm tall, 73% DDM assuming 25% spoilage rate.
** Assuming 30 kg DM/ha/ay crop growth. DM–Dry matter. DDM–Digestible dry matter.

Livestock health

Enterotoxaemia (pulpy kidney), hypomagnesaemia (grass tetany), hypocalcaemia (milk fever), bone growth disorders in lambs (rickets), photosensitisation in sheep and nitrate poisoning are some of the possible livestock health disorders that can occur under certain growing and management conditions. Seek advice and plan to minimise the possibility of animal health disorders, for example, ensure stock are vaccinated, graze classes of stock that are less likely to suffer from grass tetany and be careful when introducing stock to grazing crops. Never put hungry stock straight onto a young crop and be careful regrazing a crop that has recently been topdressed with nitrogen.

Contributing authors

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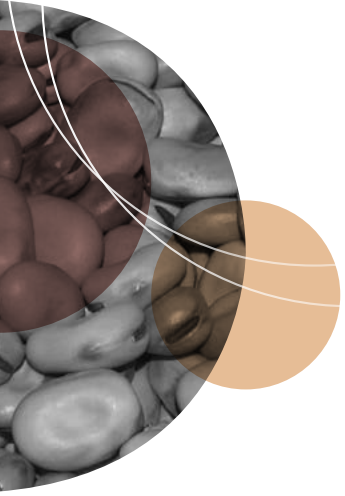

Canola

Crop management

Canola is an excellent break crop as its broad range of herbicide options provides the opportunity to control a range of weeds, especially grasses. It can be an important tool in managing herbicide resistance due to the herbicide options available, and also because of its ability to compete with weeds. Canola is best suited to paddocks with a high nitrogen (N) level as it has a greater nitrogen demand than other widely grown crops. Growing a pulse crop such as field pea and spraying it out (brown manuring) the year before sowing canola can be useful for fixing and conserving more organic N, controlling weeds and storing more soil water as the fallow period is extended. A brown manure pulse crop will also have a low stubble load at sowing, but could increase the risk of diseases such as Sclerotinia. In many areas, canola can be an 'opportunity' crop, targeting paddocks and seasons where stored soil water is above average.

Canola will grow in a range of soils, but is best suited to high fertility paddocks free of hard pans, crusting, waterlogging potential, or subsoil constraints. Avoid acid soils, especially those with high aluminium and manganese levels. Do a soil test to determine pH and nutrient status for both the 0–10 cm and the 10–20 cm depths if there is a risk of a deeper acid layer. Avoid paddocks with major weed problems or choose an appropriate herbicide tolerant variety.

Maintain an adequate break between canola crops to minimise the risk of yield losses from blackleg and Sclerotinia stem rot. Select a paddock as far from last year's canola stubble as possible to minimise the blackleg spore load reaching the new crop. A minimum distance of 500 m is recommended.

Canola is very sensitive to herbicide residues. Plantback periods shown on herbicide labels should be strictly adhered to. Spray equipment previously used to apply Group B herbicides should be thoroughly decontaminated before using on canola.

Sowing

Canola can be sown using no-till techniques or sown into a well-prepared, cultivated seedbed. When sowing into cereal stubble, ensure that straw and header residue is pushed away from the sowing row. Stubble covering the row can reduce canola emergence and early plant growth, and reduce yield. Where conditions allow, aim to drill seed through the main seed box to 1.5–3 cm deep and up to 5 cm in self-mulching clays. Where there is moisture below 1.5–3 cm, a reduced but viable establishment can still be achieved by sowing deeper, provided large seed is sown. This strategy can be used to sow some crop on time in seasons of good summer rainfall that are followed by drying surface seedbeds in autumn. A crop sown on time with a reduced establishment will generally yield more than a late-sown crop. Success with this strategy is very dependent on soil type, soil structure and the amount and timing of follow-up rainfall.

Research has shown that retaining and replanting seed from hybrid crops can reduce yield by 7–17%. In addition, other traits such as flowering and maturity evenness, blackleg resistance and oil content will be affected. However, retaining and replanting open-pollinated (OP) varieties is now widely practised. Where OP varieties are to be retained aim to grade seed to 2 mm diameter and pay particular attention to store seed in a cool, dry place and treat seed evenly with the appropriate seed dressings.

Aim for 40–50 plants/m^2 (20–30 plants/m^2 in northern and western NSW), which can normally be achieved with 2–4 kg/ha of seed. Plant densities as low as 15 plants/m^2, if consistent across a paddock, can still be profitable when crops are sown early and plants have time to compensate. Seed size varies between and within OP varieties and hybrids. Check seed size to calculate the correct number of seeds per square metre to be sown.

Establishment can be reduced by sowing too deep, sowing late into cold, wet soils, and no-till sowing into dense stubble. Use the higher sowing rate, consider sowing the seed at a shallower depth, or select a variety with high vigour in these situations. Hybrids are generally more vigorous than OP varieties, primarily because of the larger seed size.

High plant densities, combined with suitable environmental conditions, can increase the risk of Sclerotinia stem rot infection during flowering.

Table 40. Suggested sowing times

Region		April				May				June			
Week		1	2	3	4	1	2	3	4	1	2	3	4
Northern	West												
	East												
Central	West												
	East												
Southern	West												
	East												
	Irrigation												

Best sowing time

Earlier or later than desirable, possible yield reduction

Earlier – too vegetative, lodging, disease and/or frost risk

Later – spring moisture and heat stress

N.B. The suggested sowing times are a guide. Choose a variety with the correct phenology and maturity grouping for earlier sowings.

Northern region. In the western zone, start sowing mid maturing varieties in late April. Sow early maturing varieties about 1–2 weeks later than mid maturing varieties to minimise frost risk. In the eastern zone, start sowing from the first week of May and finish by the third week in May. Delay sowing further in frost prone areas.

Central and southern regions. Have paddocks ready to sow by mid April. An early break, allowing sowing to occur from mid April, maximises yield potential and oil content. Sowing before mid April can lead to crops becoming too vegetative, increasing their susceptibility to lodging and disease. Crops can also be at greater risk of frost damage. For these reasons, longer season varieties should be chosen for early sowings to increase yield potential and so that flowering and pod-filling occurs in a period of lower frost risk and lower risk of spring moisture and heat stress. Where there is a low risk of frost damage at early pod-fill, early maturing varieties can be planted from the second week of April in the region's western zone.

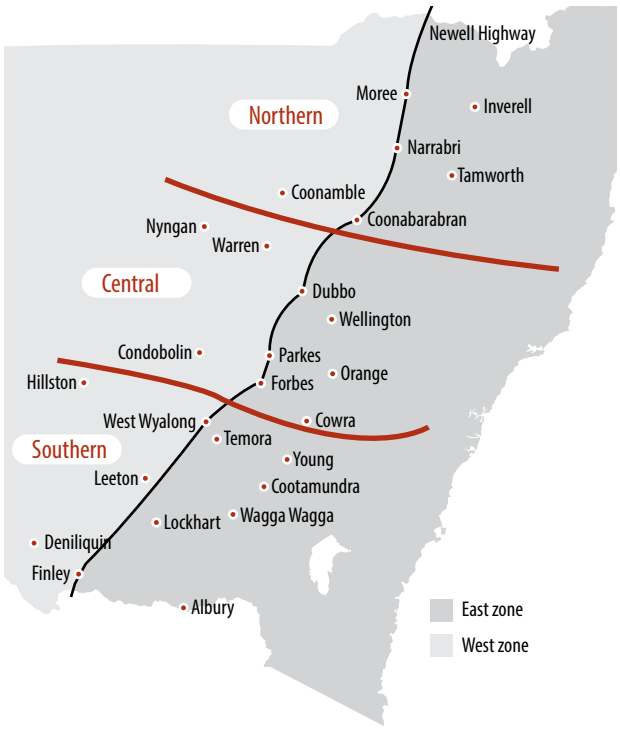

Figure 6. Map of NSW showing canola growing zones

In the eastern zone of central and southern NSW, sow mid–late maturing varieties at the start of the sowing window, and early maturing varieties towards the end of the sowing window. Aim to finish sowing by mid May in the better rainfall areas. Yields can fall by 10% per week after this period.

Southern irrigation areas. Sowing time is often determined by the irrigation season closure by water supply authorities. The risk of winter waterlogging, spring water availability and the risk of high spring temperatures are other considerations. Consider these factors when choosing a variety with suitable maturity. For most situations, mid–early to mid maturing varieties are preferred.

For all regions, **use** Table 40. Suggested sowing times as a guide.

Nutrition

Nitrogen (N). High yielding crops need high nitrogen levels, which can be provided by 2–4 years of legume dominant pasture or by applying adequate N throughout the rotation or before, at, or after sowing. Split application of N at, or just before sowing, followed by topdressing in the vegetative stage is a very effective strategy, allowing N requirements to be adjusted as seasonal conditions dictate. There is no penalty from applying all N at sowing. Crops can be topdressed until the stem elongation stage. Topdressing at early flowering can still be economic in some situations and seasons. However, the total amount of N is more important than the application timing. Deep soil testing for N before sowing or during the seedling stage will help determine appropriate N rates and timing. Where canola follows cereal crops of 3 t/ha or more, consider applying 75–125 kg N/ha if 2–3 t/ha canola yields are anticipated. The continuous cropping systems of the past 20 years are depleting soil fertility.

High application rates of N can reduce oil content; however, there are few documented cases of where canola yield has decreased as a result of very high N application.

Canola is sensitive to high rates of N in close proximity to the seed. No more than 10 kg/ha of N should be sown in direct contact with the seed in the eastern zones of central and southern NSW. In the northern region, and for early sowings in western zones of the centre and south, limit rates to a maximum of 5 kg N/ha with the seed, especially on row spacings of 30 cm and wider.

Sulfur (S). Canola has a high sulfur (S) requirement – more than double that of wheat. Apply 25 kg/ha of sulfate S (not elemental S), unless local experience or a deep soil test clearly indicates that your soil is not deficient, or that a lower rate is adequate. Sulfur is often found deep in the soil profile so soil sampling should include the whole root zone. Recent research has not been able to demonstrate consistent responses to applied sulfur. Apply sulfur fertiliser test strips at sowing to confirm that sulfur is not lacking. Sulfur deficiency can be quickly corrected in-crop by applying sulfate of ammonia.

The main sources of sulfur are sulfate of ammonia, gypsum and single super.

Phosphorus (P). Ensure that adequate phosphorus (P) is applied at sowing. Unless you are planting into a soil high in P, apply at least 8 kg/ha of P for every tonne of canola you expect to harvest. For example, apply 20 kg/ha of P if your target yield is 2.5 t/ha. Low or deficient P levels can limit the crop's potential response to nitrogen. Research has shown that canola can respond to higher rates of up to 12 kg/ha of P for every tonne of grain yield in responsive soils. As with nitrogen, canola seed is sensitive to phosphate fertilisers. Avoid drilling high rates of phosphorus in direct contact with canola seed. Rates as low as 10 kg/ha of P applied in direct contact with seed can reduce establishment, especially with wide row spacings and low soil disturbance.

Micronutrients. Several micronutrients, including boron, molybdenum and zinc, are known to be essential for healthy, high yielding canola crops. In soils with a long cropping history or where deficiencies are suspected, using a supplemented fertiliser at sowing should be considered. Some micronutrients can be applied with pre-emergent herbicides, but check to ensure compatibility.

Pests

There are a number of pests that can affect canola crops, particularly during the emergence, early seedling and flowering growth stages. Pests are best managed using an integrated pest management (IPM) approach. Careful planning before sowing, then regularly monitoring crops after sowing will ensure potential problems are identified and, if necessary, treated early.

Earth mite

Earth mites are the major pests of seedling canola, especially in central and southern NSW. Damage can be caused by redlegged earth mites (RLEM) and blue oat mites (BOM), which often occur in mixed populations. Bryobia mites are an increasing problem in some areas. An effective mite control program starts with a population reduction treatment the previous spring. Learn to identify these three species of mites to ensure that the correct insecticide and rate is applied to the correct species.

Bare earth treatments. Germinating and establishing crops can be protected by:

- Boom spraying the soil surface of previous pasture or high-risk paddocks with a residual insecticide immediately after sowing.
- Perimeter spraying bare ground in low-risk paddocks, not forgetting to spray around trees, rocky outcrops and dams, and along water flow lines. If you are unsure of the level of risk from mites, spray the whole paddock.

There are three registered bare earth sprays that will give several weeks residual protection. Bifenthrin is registered for RLEM, BOM and bryobia mites but the application rate varies according to the mite species being targeted. Alpha-cypermethrin will control RLEM whilst methidathion is registered for both RLEM and BOM.

Seed dressings. Imidacloprid (see Table 68. Canola and pulse seed dressings) and Poncho® Plus (clothianidin + imidacloprid) are registered for use on canola seed for protection against RLEM, BOM and aphids. Poncho® Plus is also registered to control Lucerne flea, wireworm and cutworm. A third seed dressing, Cruiser® Opti (thiamethoxam + lambdacyhalothrin) is registered for suppression of RLEM and Lucerne flea. These seed dressings will protect emerging seedlings for 3–5 weeks after sowing. Use treated seed following a pasture phase if a well-timed spring spray of insecticide has been applied. Apply a bare earth border spray where untreated pastures border the canola crop. Seed companies can supply seed pre-treated with imidacloprid, Poncho® Plus and Cruiser® Opti.

Cosmos® Insecticidal Seed Treatment (active ingredient fipronil) is also registered for control of RLEM in canola.

Even where a seed dressing or bare earth treatment has been used it is advisable to regularly check seedling canola for mite damage.

Lucerne flea

Lucerne flea is an occasional pest found in establishing canola crops. The pest is identified by its action of jumping and hopping between plants rather than flying. It is present across a range of soil types in southern NSW. Early-sown crops are more at risk of attack. Frequent crop inspection from the time of emergence and early control measures are important because of the impact of seedling vigour on crop performance. Ensure that monitoring is sufficient to detect localised patches or hot spots. Seek advice on management and spray strategies.

Slugs

Slugs are a potential problem along the northern, central and southern slopes, and occasionally adjacent to rivers on the western plains. Slugs kill plants at the seedling and rosette stages and can leave large bare soil areas.

Slugs are favoured by wet springs and summers. The abundant growth and damp conditions provide an ideal habitat, which allows slugs to breed and survive into autumn and winter, when they attack newly-sown crops.

Canola sown into dense stubble or next to grassy fence lines, creek banks or damp areas is at the greatest risk as these areas provide an ideal habitat for slugs to survive over summer. Heavy, cracking soils provide additional hiding places for slugs.

Closely monitor crops at risk for 6–8 weeks after sowing so that any infestation can be treated with slug pellets containing metaldehyde.

Diamondback moth

Diamondback moth (DBM) has been observed in canola crops for many years in NSW. The summer of 2001/02 favoured their build-up and they became a serious pest in the drought of 2002. Few, if any, crops have required spraying since, despite major drought in 2006 and 2009. DBM caterpillars do most damage when large numbers are present in seedling crops, or when they move from leaves to graze on developing pods during crop ripening. DBM has developed resistance to a range of insecticides. Future management will involve regular monitoring and careful selection of control methods.

Aphids

Aphid flights can occur in autumn and winter in some years and can infest young canola crops. Crops might need to be treated with insecticide to prevent transmission of viruses, but also to reduce seedling damage and the risk of spring infestations. The green peach aphid is the major vector of *Beet western yellows virus* (BWYV), which caused some crop damage in southern and central NSW in 2014. See treated with imidacloprid, Poncho® Plus and Cruiser® Opti will protect seedling canola for up to five weeks. This is especially important in seasons and at sites where early infestation with aphids occurs. A new GRDC GrowNotes publication *Reducing aphid and virus risk* is now available. Green peach aphid has developed resistance to the synthetic pyrethroid, carbamate and organophosphate groups of insecticides. Transform™ (sulfoxaflor) is a new selective insecticide to control early-season infestations of green peach aphid.

Aphids can also infest crops in the spring, especially in years of moisture stress. High aphid populations are more evident and potentially damaging in dry seasons. Monitoring for beneficial insects is very important as control might not be justified in some cases. If control is warranted, careful selection of an insecticide is essential to ensure that damage is not caused to nearby bee hives or to beneficial insects within the crop. Ensure the harvest withholding period (WHP) of the insecticide is adhered to. Seek advice on thresholds and product registrations or permits before spraying.

Helicoverpa (heliothis) caterpillars

Helicoverpa caterpillars are an occasional pest of canola in southern NSW and might require control measures if they are present in high numbers. In central and northern NSW they are a more frequent pest. Because of the seasonal variation in incidence and infestation timing relative to the crop growth stage, growers should seek advice and check the harvest WHP of the chosen insecticide before deciding to spray.

Other soil pests

As with slugs, there are increasing reports of **European earwigs** causing significant damage to emerging crops, particularly in the South West Slopes region. Stubble retention, combined with wet springs and summers and an early autumn break appear to favour the build-up of these insects. The damage earwigs cause can be difficult to identify and, as control can also be difficult, growers should seek advice if they either suspect or see earwigs.

A number of soil dwelling insect pests such as **cutworms, wireworms, bronzed field beetle, cockchafers and false wireworms** have damaged emerging canola seedlings in recent years. In severe cases, plant stands can be thinned to such an extent that the paddock requires re-sowing. Occurrence of these pests is difficult to predict, so advice on their control should be sought before sowing if any problems are foreseen. The most severe damage tends to occur in crops following pasture, or where stubble has been retained.

Disease

Blackleg

Blackleg is the most important disease of canola, but management does not have to be complex. The most effective strategies to reduce its severity include growing varieties with an adequate level of resistance for your district, separating this year's crop from last year's canola stubble with a buffer zone of at least 500 m (up to 1 km) and using a fungicide seed dressing or fungicide-amended fertiliser.

Typically around 90% of spores that infect new-season crops originate from the previous year's stubble. However, significant numbers of spores from two-year-old stubble can be produced if seasonal conditions have been dry or the stubble is still largely intact. Spores can travel 1–2 km on the wind, but most of them originate more locally. Using fungicide seed dressings containing fluquinconazole or fertiliser treated with flutriafol will also help to minimise any effects and protect seedlings from early infection, which later can cause crown/stem canker**.** Not generally recommended is raking and burning canola stubble as it is the least effective strategy in managing the disease.

Stem/branch infection. Symptoms of stem/branch infection were observed in commercial canola crops in southern NSW in 2015. These symptoms were first observed in 2010 in a small number of commercial crops. Symptoms include either single or a number of branches dying off prematurely without a crown canker developing at the stem base. Yield loss occurs when pods shatter prematurely before harvest. These symptoms could be confused with Sclerotinia stem rot. The cause of this blackleg symptom is thought to be related to an earlier sowing time, where some crops are elongating and flowering during late July–early August when conditions are ideal for infection by airborne spores of the blackleg fungus.

Blackleg resistance groups. All current canola varieties are now assessed for the presence of resistance genes and classified into resistance groups. If the same variety has been grown for two or more seasons, consider changing varieties this season. Consult the *Blackleg management guide* on the GRDC website to determine the resistance group for your current canola varieties and select future varieties that belong to a different group.

Blackleg rating. All varieties are rated according to the independent Australian National Blackleg Resistance rating system; all canola breeding companies participate. The relative differences between varieties are as follows:

- Resistant: R
- Resistant to Moderately resistant: R–MR
- Moderately resistant: MR
- Moderately resistant to Moderately susceptible: MR–MS
- Moderately susceptible: MS
- Moderately susceptible to Susceptible: MS–S
- Susceptible: S
- Susceptible to Very susceptible: S–VS
- Very susceptible: VS

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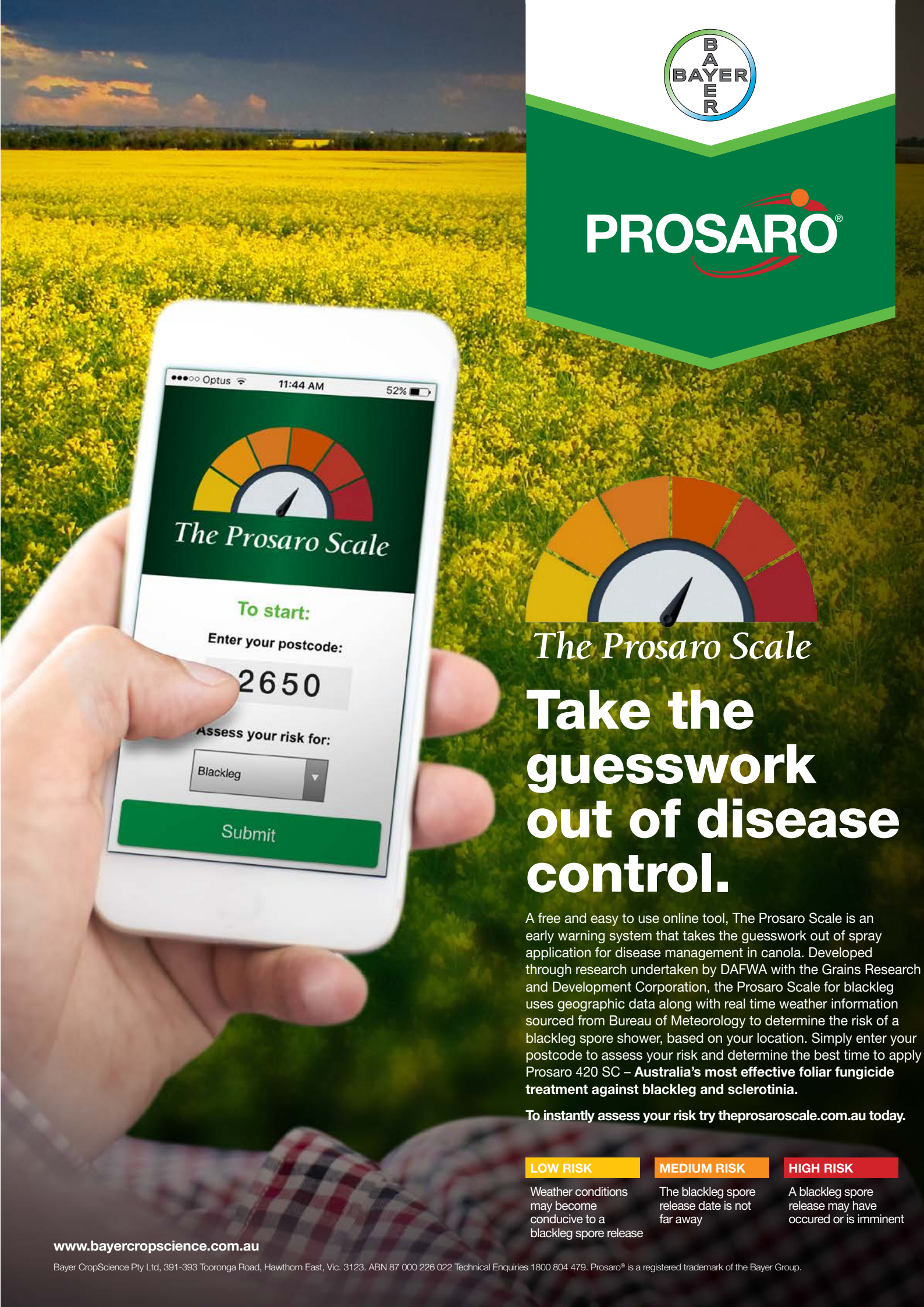

The Prosaro Scale

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LOW RISK	MEDIUM RISK	HIGH RISK
Weather conditions may become conducive to a blackleg spore release	The blackleg spore release date is not far away	A blackleg spore release may have occured or is imminent

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Varieties with a rating of 'Resistant' (R) in high blackleg-risk areas and at least 'Moderately resistant' (MR) in lower blackleg-risk areas will normally give sufficient disease protection.

The blackleg resistance rating for each variety is listed in tables 41 and 42: Comparative performance in NVT Trials – early maturing and.Comparative performance in NVT Trials – mid maturing. **Please note they are the ratings released in spring 2015**. Blackleg resistance ratings can change from year to year. New ratings for 2016 will be available from the GRDC website.

Sclerotinia

Sclerotinia stem rot is a fungal disease that can infect a wide range of broadleaf plants including canola. Prolonged wet conditions in late winter followed by periods of prolonged leaf wetness during flowering favours disease development. Yield losses can be 0–20% in some years, but losses have been as high as 35% in the past. Districts with reliable spring rainfall and long flowering periods for canola appear to develop the disease more frequently. Continuous wheat/canola rotations are also very effective at building up levels of soil-borne sclerotia. Burning canola stubble will not effectively control Sclerotinia as sclerotia survive mainly on or in the soil. Crop rotation with cereals, following recommended sowing times and ensuring crops do not develop heavy vegetative growth, which is likely to reduce air circulation, are the best means of reducing the disease's impact. The inconsistent relationship between the level of petal infection, subsequent stem infection and yield loss make it difficult to reliably predict an economic response from using foliar fungicides in any one year. The environmental conditions for Sclerotinia to develop are very specific and will not occur every year, so even when the fungus is present the disease can fail to develop in dry conditions. Consult your farm adviser and refer to the fact sheet *Sclerotinia stem rot in canola* on the GRDC website. The fungicide Prosaro®, along with products containing iprodione and some procymidone products are registered for managing Sclerotinia.

Viral diseases

Three virus species have been recorded in canola in Australia: *Beet western yellows virus* (BWYV), *Turnip mosaic virus* (TuMV) and *Cauliflower mosaic virus* (CaMV). Of these, BWYV is the more common with the potential to cause yield losses in canola. Commercial canola varieties appear resistant to TuMV. However, some lines of condiment mustard and juncea canola (both *Brassica juncea*) have been severely affected by TuMV in trials in northern NSW. The importance of CaMV in canola and *B. juncea* is not known. All three viruses are spread by aphids from weeds, which act as hosts. BWYV can come from a range of weed, pasture and crop species. Turnip weed, wild radish and other *Brassica* weeds are important hosts of TuMV.

Substantial yield losses from viruses, particularly BWYV, can occur even when there are no obvious symptoms. Seed treated with either imidacloprid or Poncho® Plus is recommended to protect crops from early infestation with aphids. Further information on viruses and control options is available in Agnote DPI 495 *Virus diseases in canola and mustard*

A new GRDC GrowNote: *Reducing aphid and virus risk* is also available.

Windrowing and harvesting

Although all varieties have improved shattering tolerance, windrowing is still favoured in most areas as it greatly reduces seed loss during heavy winds. It also allows harvest to start 7–10 days earlier as there is no waiting for green plants to dry down. Cutting the crop higher than 30 cm reduces the risk of windrows being blown across the paddock in windy/stormy conditions. When windrowing, ensure the crop is cut at the recommended stage of maturity i.e. when 40–60% of the ripening seeds on the main stem have started to change to a bronze colour and most seeds are firm when rolled between the forefinger and thumb. Windrowing too early increases the risk of immature green seed in the sample, reducing yield and oil content. As the crop is at the correct stage for windrowing for only 3–4 days, careful and regular monitoring of the ripening crop is essential to ensure it is done on time. The delivery standard for grain moisture is a maximum 8%.

Direct harvesting is increasingly seen as a viable option in the absence of shattering. Direct harvesting is a cost-effective option for crops that have a yield potential of around 1 t/ha or lower, have a short plant height, or the plant stand is low and stems cannot hold the windrow above the ground. In practise there could be justification to use both windrowing and direct harvesting on portions of the overall farm crop to ensure the crop is harvested at its optimum stage for yield and oil content.

New varieties

There are expected to be 58 canola varieties on the market in NSW for 2016.

New releases – there are 12 for NSW

- ATR-Mako(t), Monola® 416TT and Nuseed GT-42 from Nuseed Pty Ltd
- Banker CL and Rimfire CL from Heritage Seeds
- Bayer 3000TR® from Bayer
- DG 460RR from Landmark
- DG 560TT from Landmark
- Hyola® 504RR from Pacific Seeds
- Pioneer® 45T01 (TT) from DuPont Pioneer
- SF Turbine TT from Seed Force

» Victory® V5003RR from AWB

Outclassed, but still available

» Hyola® 50

Withdrawn

» Pioneer 44C79 (CL), Pioneer 44Y84 (CL), Hyola® 400RR, Hyola® 500RR, Hyola® 505RR, Hyola® 971CL, Monola® 605TT

Varietal characteristics

The amount of information on the following varieties varies, as some of them are new and have very limited independent data. Some statements about the newer varieties are based on seed company information. Blackleg resistance ratings and resistance groups published for each variety are for spring 2015 and based on blackleg nursery data from 2012–2015. **Resistance ratings and resistance groups are updated each year**. Check 2016 ratings and groups for all varieties. Ratings can be found on the GRDC website. Some varieties could have a provisional rating, denoted as (P).

Note: Varieties are grouped according to their physiological maturity in **tables** 41 **and** 42**.**
A variety's maturity rating describes its windrow/harvest time. Varieties grow and respond to temperature, vernalisation and day length (photoperiod). Some varieties might flower early when sown very early (early April) where they only respond to temperature. It is important to understand that the relative maturity of some varieties changes in different environments, particularly from north to south, but also from east to west. Confirm the relative maturity of an unfamiliar variety with your local adviser.

Oil content. Oil data presented in tables 41 and 42. **Comparative performance in NVT Trials** is the average oil content across a group of sites for that maturity grouping (early or mid) in 2015. The more sites, the more reliable the data for comparison purposes. Some of the newer varieties have oil data from a smaller number of sites. This data should be viewed with caution. Oil content is influenced by seasonal conditions and crop nutrition. Oil tends to be lower in years with a hot dry finish and higher in years with a mild, moist finish. Variety rankings for oil usually remain the same in these contrasting seasonal finishes.

Varieties. Canola varieties are either hybrid or open-pollinated (OP). Within these breeding groups there are five herbicide tolerance groups; 1. Conventional; 2. Triazine tolerant; 3. Imidazolinone tolerant; 4. Roundup Ready; 5. Dual tolerant—Triazine tolerant plus Roundup Ready.

Conventional varieties

AV-Garnet. Φ Mid to mid–early maturing OP variety. Medium height. Widely adapted. Blackleg rating spring 2015 MR–MS and resistance group A. Tested in NVT trials 2006–2015. Bred by DEPI Victoria. Marketed by Nuseed Pty Ltd.

AV-Zircon. Φ Mid maturing OP variety. Medium height. Blackleg rating spring 2015 MR and resistance group A. Tested in NVT trials 2011–2015. Bred by DEPI Victoria and Nuseed Pty Ltd. Marketed by Nuseed Pty Ltd.

Hyola® 50. Mid to mid–early maturing hybrid. Widely adapted. Blackleg rating spring 2015 R and resistance group AD. Tested in NVT trials 2005–2014. Bred by Canola Breeders International. Marketed by Advanta Seeds.

Nuseed Diamond. Early maturing hybrid. Medium height. Suited to low–medium rainfall zones. Blackleg rating spring 2015 R–MR and resistance group ABF. Tested in NVT trials 2012–2015. Bred and marketed by Nuseed Pty Ltd.

SF Brazzil. Late maturing, winter dual-purpose OP variety. Suited to early sowing and winter grazing in very high rainfall zones. Blackleg rating 2015 R–MR and resistance group BC. Not tested in NVT trials. Marketed by Seed Force.

SF Sensation. Very late maturing, winter dual-purpose hybrid. Suited to early sowing and winter grazing in very high rainfall zones. Blackleg rating spring 2015 R–MR and resistance group B. Not tested in NVT trials. Marketed by Seed Force.

Victory® V3002. Early–mid maturing conventional specialty (high stability oil) hybrid, slightly later than Victory® V3001. Blackleg rating spring 2015 R–MR and resistance group ABF. Tested in NVT trials 2011–2015. Bred by Cargill and DEPI Victoria. Marketed by AWB under contract.

Triazine tolerant (TT) varieties

Triazine tolerant (TT) varieties can have lower yield and oil content than some Roundup Ready varieties. However, they can give good yields in weedy paddocks when sprayed with atrazine and/or simazine herbicides.

ATR-Bonito. Φ Early to early-mid maturing OP variety. Plant height slightly shorter than ATR-Gem. Suited to medium–low rainfall zones. Blackleg rating spring 2015 MR and resistance group A. Tested in NVT trials 2012–2015. Bred by Nuseed Pty Ltd and DEPI Victoria. Marketed by Nuseed Pty Ltd. An EPR applies.

ATR-Gem. Φ Mid-early maturing OP variety. Widely adapted. Slightly shorter plant height than Tawriffic TT. Blackleg rating spring 2015 MR and resistance group A. Tested in NVT trials 2011–2015. Bred by Nuseed Pty Ltd and DEPI Victoria. Marketed by Nuseed Pty Ltd.

ATR-Mako. Φ New release (coded NT0252). Mid-early maturing OP variety. Suited to medium–high rainfall zones. Slightly taller plant height than ATR-Gem. Blackleg rating spring 2015 MR and resistance group A. Tested in NVT trials 2014 and 2015. Bred and marketed by Nuseed Pty Ltd. An EPR applies.

ATR-Stingray. Φ Early maturing OP variety. Short plant height. Blackleg rating spring 2015 MR and resistance group C. Tested in NVT trials 2010–2015. Bred by Nuseed Pty Ltd and DEPI Victoria. Marketed by Nuseed Pty Ltd.

ATR-Wahoo. Φ Mid maturing OP variety, similar to ATR-Marlin. Plant height similar to ATR-Gem. Suited to medium–high rainfall zones. Blackleg rating spring 2015 MR and resistance group A. Tested in NVT trials 2012–2015. Bred by Nuseed Pty Ltd and DEPI Victoria. Marketed by Nuseed Pty Ltd. An EPR applies.

DG 560TT. New release (coded SFR65-009TT). Early-mid maturing hybrid. Moderate height. Suited to medium rainfall zones. No published GRDC blackleg rating or

resistance group 2015. Tested in NVT trials for the first time in 2015. Marketed by Landmark.

Hyola® 450TT. Early–mid maturing hybrid. Medium plant height. Suited to low–medium rainfall areas. Medium plant height. Blackleg rating spring 2015 R and resistance group ABD. Tested in NVT trials 2013–2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

Hyola® 559TT. Mid maturing hybrid. Medium plant height. Suited to low–high rainfall areas. Medium plant height, taller than Hyola® 450TT. Blackleg rating spring 2015 R–MR and resistance group ABD. Tested in NVT trials 2012–2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

Hyola® 650TT. Mid–late maturing hybrid. Medium plant height. Suited to medium–high rainfall areas. Blackleg rating spring 2015 R and resistance group ABE. Tested in NVT trials in 2013–2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

Monola® 314 TT. Early maturing OP specialty oil variety. Medium plant height. Suited to low–medium rainfall zones. Blackleg rating spring 2015 R–MR and resistance group not known. Tested in NVT trials in 2013–2015. Bred and marketed by Nuseed Pty Ltd.

Monola® 416 TT. New release (coded NL0852). Early–mid maturing OP specialty oil variety. Suited to medium–low rainfall zones. Short-medium plant height. No published GRDC blackleg rating or resistance group 2015. Tested in NVT trials in 2014 and 2015. Bred and marketed by Nuseed Pty Ltd.

Monola® 515 TT. Mid maturing OP specialty oil variety. Suited to medium rainfall zones. Blackleg rating spring 2015 R–MR and resistance group not known. Tested in NVT trials in 2014 and 2015. Bred and marketed by Nuseed Pty Ltd.

Pioneer® 45T01 (TT). New release. Mid maturing hybrid. Medium plant height with strong, early vigour. Suited to medium–high rainfall zones. Blackleg rating spring 2015 MR–MS and resistance group AB. Tested in NVT trials 2013–2015. Marketed by DuPont Pioneer.

Pioneer® Sturt TT. Early to early–mid maturing OP variety. Short–medium plant height. Adapted to low–medium rainfall zones. Blackleg rating spring 2015 MS and no seedling resistance group. Tested in NVT trials 2011–2014. Bred by NPZ Australia Pty Ltd. Marketed by DuPont Pioneer. An EPR applies.

Pioneer® Atomic TT. Mid maturing hybrid. Medium height. Suited to medium rainfall zones. Blackleg rating spring 2015 MS and resistance group AB. Tested in NVT trials 2012–2015. Bred by NPZ Australia Pty Ltd. Marketed by DuPont Pioneer.

SF Turbine TT. New release (coded SFR65-008TT). Early-mid maturing hybrid. Moderate height. Suited to medium rainfall zones. No published GRDC blackleg rating or resistance group 2015. Tested in NVT trials for the first time in 2015. Bred by NPZ Australia. Marketed by Seed Force.

CLEARFIELD® (imidazolinone tolerant) varieties

These varieties are tolerant to Intervix® and Sentry™ imidazolinone herbicides and are part of the CLEARFIELD® Production System.

Archer. Mid–late maturing hybrid. Medium–tall plant height. Blackleg rating spring 2015 MR–MS and no seedling resistance group. Tested in NVT trials 2011–2015. Marketed by Heritage Seeds.

Banker CL. New release (coded HSHC 134 (CL), 2015 and PHI-1401 in 2014). Mid maturing hybrid. Medium plant height. Blackleg rating spring 2015 MR and resistance group A. Tested in NVT trials in 2014 and 2015. Marketed by Heritage Seeds.

Carbine. Early–mid maturing hybrid. Medium plant height. Blackleg rating spring 2015 MR–MS and resistance group A. Tested in NVT trials 2011–2013. Marketed by Heritage Seeds.

Hyola® 474CL. Mid–early maturing hybrid. Medium plant height. Suited to medium-low to medium rainfall areas. Blackleg rating spring 2015 R and resistance group BF. Tested in NVT trials 2011–2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

Hyola® 575CL. Mid to mid–early maturing hybrid. Medium–tall plant height. Suited to medium–high rainfall areas. Blackleg rating spring 2015 R and resistance group BF. Tested in NVT trials 2010–2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

Hyola® 577CL. Mid to mid-late maturing hybrid. Medium–tall plant height. Suited to high rainfall areas. Blackleg rating spring 2015 R and resistance group not known. Tested in NVT trials in 2013–2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

Hyola® 970CL. Long season winter dual-purpose graze and grain hybrid. Early–mid autumn and spring sowing for high to very high rainfall areas. Blackleg rating spring 2015 R–MR and resistance group H. Not tested in NVT trials. Marketed by Advanta Seeds.

Pioneer® 43C80 (CL). ϕ Early maturing OP variety. Adapted to low rainfall areas. Medium plant height. Blackleg rating spring 2015 MR and resistance group C. Tested in NVT trials in 2008–2009 and 2011–2012. Bred and marketed by DuPont Pioneer.

Pioneer® 43Y85 (CL). Early maturing hybrid. Short–medium plant height. Suited to medium–low rainfall areas. Blackleg rating 2014 MR and resistance group A. Tested in NVT trials in 2011–2014. Bred and marketed by DuPont Pioneer.

Pioneer® 44Y87 (CL). Early–mid maturing hybrid. Medium plant height. Suited to medium rainfall areas. Blackleg rating spring 2015 MR and resistance group A. Tested in NVT trials 2012–2015. Bred and marketed by DuPont Pioneer.

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Table 41. Comparative performance in NVT trials[1] – early maturing

Variety	North west	North east	South west	South east	Oil % #	Blackleg rating spring 2015 ##	Blackleg group spring 2015 ##
	2011–2015	2011–2015	2011–2015	2011–2015	2015	2015	
Early maturing conventional trials – mean seed yield expressed as a % of AV-Garnet							
AV-Garnet	100 (7)	100 (4)	100 (3)	n.d.	41.3 (3)	MR–MS	A
Nuseed Diamond	**120 (4)**	**129 (2)**	**n.d.**	**n.d.**	**43.4 (3)**	**R–MR**	**ABF**
Victory V3002	108 (6)	107 (3)	103 (2)	n.d.	42.0 (3)	R–MR	ABF
AV-Garnet t/ha	2.41	1.46	1.46				
Early maturing Triazine tolerant (TT) trials – mean seed yield expressed as a % of ATR-Stingray							
ATR-Bonito	101 (5)	98 (4)	102 (2)	n.d.	42.7 (3)	MR	A
ATR-Gem	98 (5)	94 (2)	100 (2)	n.d.	43.0 (2)	MR	A
ATR-Stingray	**100 (7)**	**100 (4)**	**100 (3)**	**n.d.**	**43.8 (3)**	**MR**	**A**
Bayer 3000TR	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
DG 560TT	112 (2)	n.d	n.d.	n.d.	39.4 (3)	n.d.	n.d.
Hyola® 450TT	110 (3)	104 (3)	n.d.	n.d.	44.3 (1)	R	ABD
Hyola® 559TT	112 (5)	107 (3)	n.d.	n.d.	42.3 (3)	R–MR	ABD
Monola® 314TT	97 (2)	n.d.	n.d.	n.d.	44.4 (1)	MR	Not identified
Monola® 416TT	96 (2)	n.d	n.d.	n.d.	42.6 (1)	n.d.	n.d.
Pioneer® Atomic TT	108 (4)	95 (2)	n.d.	n.d.	41.2 (3)	MS	AB
SF Turbine TT	109 (2)	n.d	n.d.	n.d.	40.7 (3)	n.d.	n.d.
ATR-Stingray t/ha	1.91	1.47	n.d.				
Early maturing Clearfield trials – mean seed yield expressed as a % of Hyola® 474CL							
Hyola® 474CL	**100 (7)**	**100 (4)**	**100 (3)**	**n.d.**	**43.2 (3)**	**R**	**BF**
Hyola® 575CL	100 (7)	101 (4)	100 (3)	n.d.	43.0 (3)	R	BF
Pioneer® 44Y87(CL)	101 (5)	92 (4)	98 (2)	n.d.	40.8 (3)	MR	A
Pioneer® 44Y89(CL)	106 (3)	105 (3)	n.d.	n.d.	42.0 (3)	R–MR	BC
Rimfire CL	91 (3)	82 (3)	n.d.	n.d.	41.8 (3)	R–MR	AB
Hyola® 474CL t/ha	n.d.	n.d.	n.d.				
Early maturing Roundup Ready trials – mean seed yield expressed as a % of Hyola® 404RR							
Hyola® 404RR	**100 (4)**	**n.d.**	**100 (3)**	**n.d.**	**43.9 (1)**	**R–MR**	**ABD**
IH30 RR	99 (3)	n.d.	95 (2)	n.d.	47.0 (1)	MR	AB
Nuseed GT-41	98 (3)	n.d.	95 (2)	n.d.	42.8 (1)	R–MR	ABF
Pioneer® 43Y23(RR)	100 (4)	n.d.	99 (3)	n.d.	42.9 (1)	R–MR	B
Pioneer® 44Y24(RR)	99 (3)	n.d.	99 (2)	n.d.	43.8 (1)	R–MR	C
Hyola® 404RR t/ha	2.35	n.d.	1.63				

Number of trials in brackets ( ). The more trials, the greater the reliability. n.d. No data.

1 Based on predicted yields from an analysis across all sites (2011–2015 NVT trials).
New varieties have less trial data supporting the 5 year dataset and hence should be viewed with some caution, especially where there are only 2 trial results.

Oil content, adjusted to 6.0% moisture content, is expressed as a region-wide average for the maturity trial grouping and is for 2015 only. Number of trials in brackets ( ).

Blackleg ratings are the published ratings for spring 2015. Ratings will be updated in 2016 and may be available before sowing.

Blackleg rating disclaimer

NSW DPI publishes this rating system on the basis of the best information available at the time of publication. However, nursery and grower experience has shown that disease severity can vary between locations and years depending on seasonal conditions and possible changes in the fungus for reasons that are not currently understood. Therefore, growers can sometimes experience significant variation from the averages shown in these ratings.

Pioneer® 44Y89 (CL). Early–mid maturing hybrid. Short–medium plant height. Suited to low–medium rainfall areas. Blackleg rating spring 2015 R–MR and resistance group BC. Tested in NVT trials 2013–2015. Bred and marketed by DuPont Pioneer.

Pioneer® 45Y86 (CL). Mid maturing hybrid. Medium–tall plant height. Suited for dual-purpose (graze and grain) option in full season environments. Blackleg rating spring 2015 MR–MS and resistance group AB. Tested in NVT trials 2010–2015. Bred and marketed by DuPont Pioneer.

Pioneer® 45Y88 (CL). Mid maturing hybrid. Medium plant height. Suited to high rainfall areas. Blackleg rating spring 2015 MR and resistance group A. Tested in NVT trials in 2012–2015. Bred and marketed by DuPont Pioneer.

Rimfire CL. New release (coded HSHC 133 (CL) in 2014). Mid to mid–early maturing hybrid. Medium plant height. Blackleg rating spring 2015 R–MR and resistance group AB. Tested in NVT trials 2013–2015. Marketed by Heritage Seeds.

SF Edimax CL. Late-maturing dual-purpose winter hybrid. Seed Force indicate very high biomass with excellent yield and oil content. Suited to early sowing and spring sowing in high rainfall areas. Blackleg rating spring 2015 R–MR and resistance group C. Not tested in NVT trials. Marketed by Seed Force.

Roundup Ready® varieties

DG 460RR. New release (coded SN-ACL 12-1586). Early-mid maturing hybrid. Short plant height. Blackleg rating spring 2015 R–MR and resistance group A. Tested in NVT trials for the first time in 2015. Bred by Seednet and marketed by Landmark.

DG 550RR. Mid maturing hybrid. Blackleg rating spring 2015 MR and resistance group AB. Tested in NVT trials 2013 and 2014. Bred by Seednet and marketed by Landmark.

Hyola® 404RR. Early to mid–early maturing hybrid. Medium plant height. Suited to low–medium rainfall areas. Blackleg rating spring 2015 R–MR and resistance group ABD. Tested in NVT trials 2010–2014. Bred by Pacific Seeds and marketed by Advanta Seeds.

Hyola® 504RR. New release (coded M26120 in 2014). Mid maturing hybrid. Medium plant height. Suited to medium–high rainfall areas. No published GRDC blackleg rating or resistance group 2015. Tested in NVT trials 2014 and 2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

Hyola® 600RR. Mid to mid–late maturing hybrid. Medium-tall plant height. Suited to medium–high to very high rainfall areas. Blackleg rating spring 2015 R and resistance group ABD. Tested in NVT trials in 2014 and 2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

IH30 RR. Early maturing hybrid. Suited to low–medium rainfall areas. Blackleg rating spring 2015 MR and resistance group AB. Tested in NVT trials 2012–2015. Bred and marketed by Bayer.

IH51 RR. Mid maturing hybrid with Bayer's pod shatter reduced trait PodGuard. Suited to later windrow timings or direct harvesting. Suited to medium–high rainfall areas. Blackleg rating spring 2015 R–MR and resistance group A. Tested in NVT trials in 2014 and 2015. Bred and marketed by Bayer.

IH52 RR. Mid maturing hybrid. Suited to medium–high rainfall areas. Blackleg rating spring 2015 R–MR and resistance group AB. Tested in NVT trials 2013–2015. Bred and marketed by Bayer.

Monola® 513GT. Early–mid maturing OP specialty oil variety. Suited to medium–low rainfall zones. Medium plant height. Blackleg rating spring 2015 MR and resistance group A. Tested in NVT trials 2012–2015. Bred and marketed by Nuseed Pty Ltd.

Monola® G11. Early–mid maturing specialty oil hybrid. Medium plant height. Suited to medium–low rainfall zones. Blackleg rating spring 2015 MR and resistance group ABS. Tested in NVT trials in 2013–2015. Bred and marketed by Nuseed Pty Ltd.

Nuseed GT-41. Early maturing hybrid. Medium plant height. Suited to low–medium rainfall zones. Blackleg rating spring 2015 R–MR and resistance group ABF. Tested in NVT trials 2012–2015. Bred and marketed by Nuseed Pty Ltd.

Nuseed GT-42. New release (coded NCH14G055). Early to early-mid maturing hybrid. Suited to medium–low rainfall zones. Medium plant height. Blackleg rating spring 2015 R, resistance group not known. Tested in NVT trials 2014 (1 trial) and 2015. Bred and marketed by Nuseed Pty Ltd.

Nuseed GT-50. Mid maturing hybrid. Medium–tall plant height. Suited to medium–high rainfall zones. Blackleg rating spring 2015 R–MR and resistance group ABF. Tested in NVT trials 2012–2015. Bred and marketed by Nuseed Pty Ltd.

Pioneer® 43Y23 (RR). Early maturing hybrid. Blackleg rating spring 2015 R–MR and resistance group B. Tested in NVT trials 2011–2015. Bred and marketed by DuPont Pioneer.

Pioneer® 44Y24 (RR). Early–mid maturing hybrid. Medium plant height. Suited to medium–high rainfall areas. Blackleg rating spring 2015 R–MR and resistance group C. Tested in NVT trials 2011–2015. Bred and marketed by DuPont Pioneer.

Pioneer® 44Y26 (RR). Early–mid maturing hybrid. Medium–tall plant height. Suited to medium–high rainfall areas. Blackleg rating 2015 R–MR and resistance group ABS. Tested in NVT trials in 2013–2015. Bred and marketed by DuPont Pioneer.

Pioneer® 45Y25 (RR). Mid maturing hybrid. Medium plant height. Suited to medium–high rainfall areas. Blackleg rating spring 2015 R–MR and resistance group BC. Tested in NVT trials 2012–2015. Bred and marketed by DuPont Pioneer.

Victory® V5002RR. Mid maturing RR specialty (high oleic, low linolenic oil) hybrid. Blackleg rating spring 2015 MR and resistance group AB. Tested in NVT trials 2011–2015. Bred by Cargill and DPI Victoria. Marketed by AWB under contract.

Table 42. Comparative performance in NVT trials[1] – mid maturing

Variety	North West	North East	South West	South East	Oil % #	Blackleg rating spring 2015 ##	Blackleg group spring 2015 ##
	2011–2015	2011–2015	2011–2015	2011–2015	2015	2015	2015
Mid maturing conventional trials– mean seed yield expressed as a % of AV-Garnet							
AV-Garnet	**100 (5)**	**100 (3)**	**100 (4)**	**100 (5)**	**42.2 (4)**	**MR–MS**	**A**
AV-Zircon	99 (5)	94 (3)	100 (4)	97 (5)	42.2 (4)	MR	A
Nuseed Diamond	120 (4)	117 (2)	118 (3)	105 (4)	42.6 (4)	R–MR	ABF
Victory® V3002	106 (5)	106 (3)	106 (4)	102 (3)	42.0 (4)	R–MR	ABF
AV-Garnet t/ha	1.92	1.65	2.24	2.82			
Mid maturing Triazine Tolerant (TT) trials – mean seed yield expressed as a % of ATR-Gem							
ATR-Bonito	104 (7)	104 (7)	102 (7)	102 (22)	43.0 (11)	MR	A
ATR-Gem	**100 (8)**	**100 (7)**	**100 (8)**	**100 (26)**	**42.6 (11)**	**MR**	**A**
ATR-Mako	104 (4)	105 (2)	104 (3)	103 (10)	40.7 (11)	MR	A
ATR-Stingray	99 (9)	100 (7)	97 (8)	97 (24)	42.0 (11)	MR	C
ATR-Wahoo	99 (6)	99 (5)	101 (3)	102 (22)	43.0 (9)	MR	A
DG 560TT	108 (2)	109 (2)	106 (2)	103 (6)	40.6 (11)	n.d.	n.d.
Hyola® 450TT	103 (6)	103 (6)	102 (6)	98 (9)	41.5 (7)	R	ABD
Hyola® 525RT	102 (3)	n.d.	99 (6)	97 (11)	43.1 (7)	R–MR	ABD
Hyola® 559TT	109 (7)	110 (7)	108 (7)	105 (23)	42.3 (11)	R–MR	ABD
Hyola® 650TT	104 (4)	107 (6)	109 (4)	107 (16)	41.8 (11)	R	ABE
Hyola® 725RT	n.d.	n.d.	n.d.	n.d.	44.0 (5)	R–MR	ABD
Monola®416TT	98 (3)	n.d.	95 (4)	95 (7)	42.1 (9)	MR	n.d.
Monola® 515TT	88 (4)	87 (2)	90 (4)	89 (10)	41.8 (9)	R–MR	Not identified
Pioneer 45T01 (TT)	105 (5)	104 (6)	102 (5)	99 (12)	42.3 (10)	MR–MS	AB
Pioneer® Atomic TT	105 (6)	103 (5)	101 (7)	99 (13)	39.3 (4)	MS	AB
SF Turbine TT	109 (2)	111 (2)	109 (2)	106 (6)	40.6 (11)	n.d.	n.d.
ATR-Gem t/ha	1.97	1.97	1.92	2.41			
Mid maturing CLEARFIELD® trials– mean seed yield expressed as a % of Hyola® 575CL							
Archer	103 (6)	101 (7)	102 (6)	101 (24)	42.0 (11)	MR–MS	n.d.
Banker CL	113 (4)	113 (2)	110 (2)	112 (9)	42.4 (11)	MR	A
Hyola® 474CL	100 (9)	100 (8)	99 (9)	99 (23)	42.5 (11)	R	BF
Hyola® 575CL	**100 (9)**	**100 (8)**	**100 (9)**	**100 (27)**	**42.8 (11)**	**R**	**BF**
Hyola® 577CL	100 (6)	100 (6)	101 (5)	102 (17)	43.0 (11)	R	Not identified
Pioneer® 44Y87 (CL)	104 (5)	102 (5)	99 (4)	99 (15)	41.2 (8)	MR	A
Pioneer® 44Y89 (CL)	109 (4)	107 (4)	102 (5)	101 (9)	41.2 (8)	R–MR	BC
Pioneer® 45Y86 (CL)	106 (9)	103 (8)	100 (7)	99 (27)	42.6 (9)	MR–MS	AB
Pioneer® 45Y88 (CL)	105 (6)	105 (6)	104 (5)	105 (22)	40.6 (7)	MR	A
Rimfire CL	104 (5)	102 (4)	100 (6)	99 (13)	41.6 (11)	R–MR	AB
Hyola® 575CL t/ha	2.01	2.07	2.04	2.48			
Mid maturing Roundup Ready trials – mean seed yield expressed as a % of Nuseed GT-50							
DG 460RR	n.d.	n.d.	97 (2)	97 (4)	43.8 (7)	n.d.	A
DG 550RR	90 (3)	n.d.	94 (5)	91 (10)	42.5 (7)	R–MR	AB
Hyola® 404RR	95 (4)	n.d.	95 (9)	93 (19)	44.3 (7)	R–MR	ABD
Hyola® 504RR	n.d.	n.d.	98 (2)	95 (8)	42.5 (7)	n.d.	n.d.
Hyola® 600RR	n.d.	n.d.	n.d.	95 (8)	45.3 (6)	R	ABD
IH51 RR	91 (2)	n.d.	90 (4)	88 (8)	41.7 (7)	R–MR	A
IH52 RR	93 (3)	n.d.	95 (5)	94 (10)	42.0 (7)	R–MR	AB
Monola® 513GT	n.d.	n.d.	86 (6)	87 (10)	46.2 (4)	MR	A
Monola® G11	94 (3)	n.d.	92 (5)	88 (8)	44.0 (6)	MR	ABS
Nuseed GT-41	91 (3)	n.d.	90 (7)	91 (7)	41.9 (4)	R–MR	ABF
Nuseed GT-42	n.d.	n.d.	99 (2)	95 (2)	41.6 (4)	n.d.	n.d.
Nuseed GT-50	**100 (3)**	**n.d.**	**100 (8)**	**100 (18)**	**42.7 (7)**	**R–MR**	**ABF**
Pioneer® 43Y23 (RR)	100 (3)	n.d.	101 (7)	97 (10)	39.5 (4)	R–MR	B
Pioneer® 44Y24 (RR)	99 (4)	n.d.	100 (9)	99 (19)	41.3 (7)	R–MR	C
Pioneer® 44Y26 (RR)	n.d.	n.d.	95 (4)	94 (7)	45.0 (5)	R–MR	ABS
Pioneer® 45Y25 (RR)	102 (3)	n.d.	105 (5)	104 (14)	43.5 (6)	R–MR	BC
Victory V5002RR	93 (4)	n.d.	95 (9)	94 (17)	43.1 (7)	MR	AB
Victory V5003RR	94 (3)	n.d.	94 (5)	95 (10)	43.1 (7)	n.d.	n.d.
Nuseed GT-50 t/ha	2.47	n.d.	2.21	2.92			

1 Based on predicted yields from an analysis across all sites (2011–2015 NVT trials).
New varieties have less trial data supporting the 5 year dataset and hence should be viewed with some caution, especially where there are only 2 trial results.

\# Oil content, adjusted to 6.0% moisture content, is expressed as a region-wide average for the maturity trial grouping and is for 2015 only. Number of trials in brackets ( ).

Blackleg ratings are the published ratings for spring 2015. Ratings will be updated for 2016 and may be available before sowing.

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Victory® V5003RR. New release. Mid maturing RR specialty (high oleic, low linolenic oil) hybrid. Blackleg rating R–MR and resistance group B. Tested in NVT trials 2013–2015. Bred by Cargill. Marketed by AWB under contract.

Dual herbicide tolerant: Triazine tolerant – Roundup Ready varieties

New varieties are being developed that combine two herbicide tolerance traits, allowing improved weed control in paddocks where weeds have developed resistance to other herbicide chemistries.

Bayer 3000 TR®. New release (coded PJTT1). Early maturing dual herbicide tolerant hybrid. Short–medium plant height. Suited to low to low–medium rainfall zones. No published GRDC blackleg rating or resistance group 2015. Tested in NVT trials for the first time in 2015. Bred by NPZ Australia. Marketed by Bayer.

Hyola® 525RT®. Mid maturing RT® dual herbicide tolerant hybrid. Medium plant height. Suited to medium–high rainfall areas. Blackleg rating spring 2015 R–MR and resistance group ABD. Tested in NVT trials in 2013–2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

Hyola® 725RT®. Mid-late maturing RT® dual herbicide tolerant hybrid. Tall plant height. Suited to high–very high rainfall areas. Blackleg rating spring 2015 R–MR and resistance group ABD. Tested in NVT trials 2014 and 2015. Bred by Pacific Seeds and marketed by Advanta Seeds.

Further information

NSW DPI Agriculture website for:

Weed control in winter crops (NSW DPI, 2016)

- *Insect and mite control in field crops* (NSW DPI, 2013)
- *Virus diseases in canola and mustard* – Agnote DPI 495
- *Clubroot of canola and mustard* – Primefact 115
- *Juncea canola in the low rainfall zone of south-western NSW* – Primefact 783
- *Brassica juncea in north-western NSW* – Primefact 786

GRDC website for:

- *Canola best practice management guide for southeastern Australia* (GRDC, 2009)
- *Reducing aphid and virus risk* (GRDC GrowNotes)
- *Blackleg management guide*
- *Sclerotinia stem rot in canola*

Australian Oilseeds Federation website for:

- *AOF Standards Manual*

Contributing authors

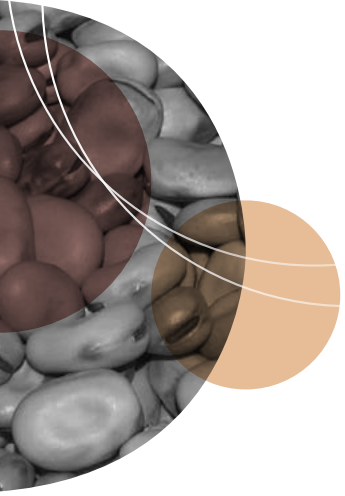
NSW DPI; Leigh Jenkins, Research and Development Agronomist, Trangie; Rohan Brill, Research and Development Agronomist, Wagga Wagga; Kurt Lindbeck, Plant Pathologist, Wagga Wagga.

Table 43. Variety maturities

	Lower rainfall north <550 mm, centre/south <500 mm		Higher rainfall north >500 mm, centre/south >450 mm	
	Early maturing	Early–mid maturing	Mid maturing	Mid–late maturing
Conventional	Nuseed Diamond	Victory® V3002	AV-Garnet AV-Zircon Hyola® 50	
Triazine tolerant (TT)	ATR-Stingray Monola® 314TT Pioneer® SturtTT	ATR-Bonito ATR-Gem Hyola® 450TT Monola® 416TT Pioneer® Atomic TT DG 560TT SF Turbine TT	ATR-Mako Hyola® 559TT Monola® 515TT Pioneer® 45T01 (TT)	ATR-Wahoo Hyola® 650TT
CLEARFIELD®	Pioneer® 43C80 (CL) Pioneer® 43Y85 (CL))	Carbine Hyola® 474CL Pioneer® 44Y87 (CL) Pioneer® 44Y89 (CL)	Banker CL Hyola® 575CL Pioneer® 45Y86 (CL) Pioneer® 45Y88 (CL) Rimfire CL	Archer Hyola® 577CL
Roundup Ready®	IH30 RR Nuseed GT-41 Pioneer® 43Y23 (RR)	DG 460RR Hyola® 404RR Monola® G11 Monola® 513GT Nuseed GT-42 Pioneer® 44Y24 (RR) Pioneer® 44Y26 (RR)	DG 550RR Hyola® 504RR® Nuseed GT-50 Pioneer® 45Y25 (RR) IH51 RR IH52 RR Victory® V5002RR Victory® V5003RR	Hyola® 600RR®
Roundup Ready® plus Triazine tolerant (Dual tolerance)	Bayer 3000TR®		Hyola® 525RT®	Hyola® 725RT®

The relative maturity of varieties can vary depending on location and sowing time. The groupings are made as a guide only and relate to physiological maturity or windrow/harvest maturity.

The winter canola types for grazing and grain recovery are not included in this table. Maturity of these types is generally considered late–very late.



Chickpea

Chickpeas are a winter pulse crop, which are profitable in their own right. In addition, they contribute to crop rotations through their ability to fix nitrogen, and by providing a disease and weed break for cereal crops. However, chickpea crops require systematic monitoring for foliar diseases and insect pests.

Chickpeas are well adapted to warm environments because they tolerate higher temperatures during and after flowering better than other winter pulses such as faba beans, lupins and field peas.

Chickpeas are best suited to loams and self-mulching clay soils that are neutral–alkaline in pH. Acidic (pH_{Ca}<5.2), sodic, saline and/or shallow soils are generally not suitable. Soils that have high chloride levels (>600 mg/kg) in the subsoil (30–90 cm depth) are best avoided. Chickpeas do not tolerate waterlogging, so avoid poorly drained paddocks or those prone to flooding.

Sowing

Seed

Profitable crops start with quality planting seed (i.e. high germination and vigour). Obtain seed from a commercial supplier or from a source known to have negligible levels of seed-borne pathogens. If using grower-retained seed from previous crops, be aware that such seed could be infected with Botrytis, Ascochyta or Sclerotinia, even if the disease did not cause economic damage or was not obvious in the crop. Irrespective of year of harvest and source, all planting seed must be thoroughly treated with a thiram-based fungicide. Information on seed treatment and establishing a profitable crop can be found on the Pulse Australia website. Refer to the Further information section at the end of this chapter on page 89.

Paddock selection

Maintain a distance of at least 500 m (further is better) from 2015 chickpea paddocks and a break of at least three years between chickpeas in the same paddock. These practices work by reducing the amount of disease inoculum available to initiate new season infection. Do not plant chickpeas in paddocks with a history of lucerne, medics, Phytophthora root rot disease, Sclerotinia disease in other broadleaf crops, or waterlogging. Flooding can also carry disease inoculum long distances.

Stubble

In the northern grain zone, no-till crops sown into cereal stubble consistently yield 10% higher than those planted into conventionally prepared or reduced tillage seedbeds. Standing cereal stubble will also help deter aphids (which can transmit viruses) during the early vegetative stage.

Sowing depth

Sow 5–7 cm deep into moisture. If moisture is not present at the desired planting time, chickpeas can be moisture-seeked by placing the seed 10–17.5 cm below the paddock soil surface, depending on moisture depth, and levelling the seedbed before the crop emerges. Use high-quality seed if intending to moisture-seek. Levelling the seedbed will make harvesting easier, especially for later-sown crops, which tend to be shorter in height, and might reduce the risk of herbicide damage to establishing seedlings. Ensure that seed is well covered with at least 7 cm of soil if using Balance® (active ingredient isoxaflutole) or simazine herbicides.

Sowing rate

Aim to establish 20–30 plants/m^2 under most conditions in northern and central NSW. In southern NSW, the target plant density is 35–45 plants/m^2. Aim for the lower end of the range when yield potential is low (e.g. lower initial soil moisture); target the higher end of the range when yield potential is high, such as when good subsoil moisture is available or under irrigation. Adjust sowing rates to take account of seed size, germination, vigour and establishment conditions. Avoid skimping on seed, which could lead to gappy plant stands, as a uniform plant establishment has been found to be highly effective in reducing aphid infestation.

Table 44. Sowing rate (kg/ha) based on 100% germination, 80% establishment and estimated seed weight for each variety

Variety	100 seed weight (g)	Target plant density/m²			
		Northern and Central NSW		Southern NSW	
		20	30	35	45
Almaz	41	103	154	179	231
Flipper	18	45	68	79	101
Genesis 090	30	75	113	131	169
Genesis 425	33	83	124	144	186
Genesis Kalkee	45	113	169	197	253
Howzat	21	53	79	92	118
Jimbour	20	50	75	88	113
Kyabra	26	65	98	114	146
PBA Boundary	19	48	71	83	107
PBA HatTrick	20	50	75	88	113
PBA Maiden	24	60	90	105	135
PBA Monarch	42	105	158	184	236
PBA Slasher	18	45	68	79	101
PBA Striker	21	53	79	92	118
Yorker	21	53	79	92	118

Your calculation

100 seed weight # (grams)		target plant population		establishment percentage* × germination percentage
.....	×	.....	× 1000÷	.....

= your sowing rate ..... kg/ha

To determine your seed weight, weigh 100 seeds in grams.

* Establishment percentage – 90% is a reasonable estimate, unless sowing into adverse conditions.

Row spacing

In northern NSW, there is generally no yield difference between row spacing of 25 cm and 75 cm.

Wide row spacing (up to 100 cm) offers a number of advantages, including:

» planting into heavy stubble in zero-till situations
» in-crop pesticide application by ground rig
» ability to band spray, reducing costs and chemical usage
» the option of inter-row cultivation or shielded spraying
» better airflow to reduce foliar diseases
» more moisture to finish the crop in low moisture situations.

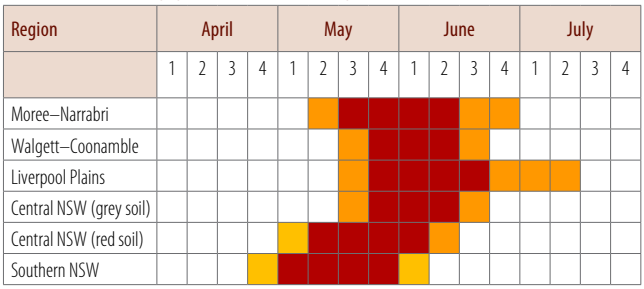
The disadvantages of wide row spacing can include reduced crop competition with weeds and increased crop lodging, making harvesting more difficult (particularly with older, less erect varieties such as Howzat and Yorker). Yield penalties can occur in above average seasons.

Sowing time

Aim to sow in the early–mid period of the sowing window to maximise yield potential and minimise disease levels. Early sowing exposes the crop to more rain events, which can increase the risk of Ascochyta and Phytophthora root rot diseases. It can also result in greater crop biomass, which can increase the risk of Botrytis grey mould (BGM) disease later in the season and increase the risk of lodging. Very early sowing can also lead to potential moisture shortage during the grain fill period, which can reduce seed size and hence yield.

Later sown crops generally have lower yield potential. They can attract greater *Helicoverpa* pressure (as a result of being later maturing than surrounding crops) and are often of shorter height, which can lead to harvesting difficulties. However, later sowing can reduce the risk of Ascochyta and Phytophthora infection events and lessen the risk of Botrytis grey mould.

Table 45. Suggested sowing times



Inoculation

Inoculation is essential for every chickpea crop planted, regardless of soil type or previous history. Use the commercially available Group N chickpea inoculant. Take care with seed inoculation. Treat seed with fungicide first, then apply inoculant separately just before sowing. Avoid inoculating directly into airseeder bins as the seed will need to dry for a short period before being sown. Newly inoculated seed is often sticky and does not flow properly. This can cause uneven seed flow, resulting in patchy establishment across the paddock.

A number of new inoculant products are available for chickpeas, such as freeze-dried and dry granular products. Read and follow the instructions to avoid inoculation problems.

Nutrition

Most growers in NSW use starter fertiliser (MAP, DAP) or other phosphorus-based fertilisers such as Granulock with added zinc (1–2% zinc), due to its availability. A common starter fertiliser rate is 50–75 kg/ha. Responses to zinc are most likely in alkaline soils. These products should be drilled with the seed. If using greater than 100 kg/ha of starter fertiliser, band it slightly away from the seed to avoid fertiliser toxicity, especially on wider (60–100 cm) row spacing. Extra care should also be taken if sowing into marginal moisture seedbed conditions with high rates of fertiliser.

A good way to determine the response from starter fertilisers is to put down test strips, leaving a control (nil) strip for comparison.

Variety selection

When choosing a variety, many factors should be considered including maturity, disease susceptibility, paddock suitability, seed availability, seed size and sowing rate (with reference to sowing machinery), seed cost, harvesting ease and marketing options. A Pulse Breeding Australia (PBA) variety brochure or Variety Management Package (VMP) is available from Pulse Australia, NSW DPI or the relevant seed supply company for each variety. Refer to Table 46 Chickpea variety characteristics and Table 47 Chickpea variety ratings for common chickpea diseases in Australia for yield, varietal characteristics and disease reactions of the different varieties.

There are no new variety releases for the 2016 season.

Desi types

Ambar.Φ Resistant (R) to Ascochyta, similar to Genesis™ 509 and Genesis™ 090, superior to PBA HatTrick and PBA Boundary; susceptible (S) to Phytophthora root rot, so not recommended for northern NSW. Limited evaluation in southern NSW. Developed by DAFWA and UWA from germplasm bred by NSW DPI. Marketed by Heritage Seeds. An EPR of $4.40/tonne applies.

Flipper.Φ Moderately resistant–moderately susceptible (MR–MS) to Ascochyta, less resistant than PBA HatTrick and PBA Boundary; MS to Phytophthora, less resistant than PBA HatTrick; S to viruses. Tall, erect variety with very good lodging resistance and medium sized seed. Bred by NSW DPI; commercial partner is Seednet with seed available through Seednet agents. An EPR of $3.30/tonne applies.

Jimbour. Susceptible to Ascochyta. Suited to areas where Ascochyta is not considered a major threat and experience shows that the disease can be managed in susceptible varieties; MS–MR to Phytophthora. Bred by DAF Qld, commercialised by Mt Tyson seeds. No EPR applies.

Kyabra.Φ Susceptible to Ascochyta – suited to areas where Ascochyta is not considered a major threat and experience shows that the disease can be managed in susceptible varieties; MS to Phytophthora; S to Botrytis grey mould. Larger seed size and superior grain quality for the whole seed market compared with other current varieties. Bred by DAF Qld and NSW DPI; commercial partner is Heritage Seeds. A seed royalty applies to all seed sales of Kyabra; no EPR applies.

Neelam.Φ Resistant to Ascochyta, similar to Genesis™ 509 and Genesis™ 090, superior to PBA HatTrick and PBA Boundary; S to Phytophthora root rot, so not recommended for northern NSW. Limited evaluation in southern NSW. Developed by DAFWA and UWA from germplasm bred by DEDJTR Victoria. Marketed by Heritage Seeds. An EPR of $4.40/tonne applies.

PBA Boundary.Φ Moderately resistant to Ascochyta, superior to PBA HatTrick; S to Phytophthora, less resistant than PBA HatTrick and only suitable for paddocks with a low Phytophthora risk. Highest yielding variety across chickpea growing regions of northern NSW and southern QLD. Lower yielding than PBA Slasher in southern NSW, but a suitable option if a tall, erect plant type is required. Mid-season maturity, equivalent to PBA HatTrick. Medium sized desi seed suited to the human consumption market. Developed by Pulse Breeding Australia (PBA). Marketed by Seednet with seed available through Seednet agents. An EPR of $4.40/tonne applies.

PBA HatTrick.Φ Moderately resistant to Ascochyta, superior to Flipper; MR to Phytophthora, more resistant than Jimbour, but less than Yorker. High-yielding variety across chickpea growing regions of northern NSW and southern Qld, recommended and suited to areas north of Parkes. Tall, erect plant type with mid-season maturity, equivalent to Jimbour. Medium sized desi seed suited to the human consumption market. Developed by Pulse Breeding Australia (PBA). Marketed by Seednet with seed available through Seednet agents. An EPR of $4.40/tonne applies.

Table 46. Chickpea variety characteristics

Variety	Plant height	Lodging resistance	100 seed weight (g)	Maturity	North		South	
					Yield as a % of PBA HatTrick 2011–2015		Yield as a % of PBA Slasher 2011–2015	
					East 1.94 t/ha	West 1.55 t/ha	East 1.56 t/ha	West 1.36 t/ha
Desi Types								
Ambar	MS	VG	16	E	n.d.	n.d.	93 (3)	95 (3)
Flipper	T	VG	18	M–L	n.d.	94 (5)	n.d	n.d
Howzat	M	M	21	M	n.d.	n.d.	95 (5)	95 (5)
Jimbour	T	VG	20	M	101 (13)	101 (35)	n.d.	n.d
Kyabra	T	VG	26	M	106 (10)	109 (28)	n.d.	n.d.
Neelam	MT	VG	17	M	n.d.	n.d.	99 (3)	99 (3)
PBA Boundary	T	G	19	M	102 (13)	103 (35)	94 (5)	95 (5)
PBA HatTrick	T	G	20	M	100 (13)	100 (35)	91 (5)	92 (5)
PBA Maiden	MS	M	24	M	n.d.	n.d.	97 (5)	99 (5)
PBA Slasher	MS	M	18	M	n.d.	n.d.	100 (5)	100 (5)
PBA Striker	MS	M	21	E	n.d	n.d	100 (5)	102 (5)
Yorker	M	G	21	M–L	n.d	95 (5)	n.d.	n.d
Variety	**Plant height**	**Lodging resistance**	**100 seed weight (g)**	**Maturity**	**Yield as a % of Almaz 2011–2015**		**Yield as a % of Genesis™ 090 2011–2015**	
					East 2.03 t/ha	West 1.52 t/ha	East 1.35 t/ha	West n.d.
Kabuli types								
Almaz	MT	G	41	L	100 (5)	100 (17)	93 (5)	n.d.
Genesis™ 090	M	G	30	M–L	104 (5)	109 (17)	100 (5)	n.d.
Genesis™ 114	T	VG	39	M–L	102 (5)	103 (11)	91 (5)	n.d.
Genesis™ 425	M	G	33	M–L	96 (5)	96 (14)	97 (5)	n.d.
Genesis™ Kalkee	T	VG	45	L	100 (5)	102 (17)	94 (5)	n.d.
PBA Monarch	M	F	42	E	101 (5)	101 (17)	97 (5)	n.d.

Yield results are a combined-across-sites analysis using NVT and PBA data from 2011–2015.
Number of trials in brackets ( ). n.d. = No data. **Plant height**: T – tall; MT – medium tall; M – medium; MS – medium short.
Lodging resistance: VG – very good; G – good; M – moderate; F – fair; P – poor. **Maturity**: E – early; M – medium; L – late.

Table 47. Chickpea variety ratings for common chickpea diseases in Australia

Variety	Ascochyta blight	Phytophthora root rot[1]	Botrytis grey mould[2]	Virus[3]	Root-lesion nematode (*Pratylenchus thornei*)		Root-lesion nematode (*P. neglectus*)	
					Resistance[4]	Tolerance[4]	Resistance[4]	Tolerance[4]
Desi								
Ambar	R	S	S	–	–	–	–	–
Flipper	MR–MS	MS	S	S	MS	T	MS	–
Howzat	S	MS	MS	S	S	MT	S	MI
Jimbour	S	MS–MR	S	S	S	T	MS	T
Kyabra	S	MS	S	S	VS	–	R	–
Neelam	R	S	S	–	–	–	–	–
PBA Boundary	MR	S	S	S	–	–	–	–
PBA HatTrick	MR	MR	S	S	–	–	–	–
PBA Maiden	MR	S	S	S	–	–	–	–
PBA Slasher	R	S	S	S	–	–	–	–
PBA Striker	MR	S	S	S	–	–	–	–
Yorker	S	MR	S	S	MS	MT	MR	–
Kabuli								
Almaz	MS	VS	S	S	VS	T	MR	–
Genesis™ 090	R	VS	S	S	VS	T	MR	–
Genesis™ 114	MS	VS	S	S	–	–	–	–
Genesis™ 425	R	S	S	S	MS	MI	MR	–
Genesis™ Kalkee	MS	VS	S	S	–	–	–	–
PBA Monarch	MS	VS	S	S	–	–	–	–

Source: Pulse Breeding Australia
R = Resistant, MR = Moderately resistant, MS = Moderately susceptible, S = Susceptible, VS = Very susceptible;
T = Tolerant, MI = Moderately intolerant, I = Intolerant, – = No data.

[1] Ratings a compilation of NSW (Tamworth) and Qld (Warwick) data.
[2] The risk of Botrytis grey mould (BGM) damage can be affected by the management of Ascochyta blight (AB); fungicides used to control Ascochyta can also control Botrytis. Note that if BGM risk is high, then a fungicide with greater efficacy for BGM than for AB might also be needed. BGM screening is conducted in a controlled environment and rating is independent of plant architecture.
[3] Virus ratings could change with different virus species predominating in different areas.
[4] Resistance measures the plant's ability to resist disease. Tolerance measures the plant's ability to yield at a given disease level. Tolerant varieties, while potentially yielding well, are unlikely to reduce nematode numbers for following crops. Data supplied by John Thompson, DAF Qld, Toowoomba.

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PBA Maiden.[Φ] Moderately resistant to Ascochyta, less than PBA Slasher; S to Phytophthora root rot, so not recommended for northern NSW. Semi-spreading plant type with mid-season maturity, similar to PBA Slasher. Large sized desi for southern environments with a yellow-tan seed coat suited to whole seed markets. Developed by Pulse Breeding Australia (PBA). Marketed by Seednet with seed available through Seednet agents. An EPR of $4.40/tonne applies.

PBA Slasher.[Φ] Resistant to Ascochyta, similar to Genesis™ 509 and Genesis™ 090, superior to PBA HatTrick and PBA Boundary; S to Phytophthora root rot, so not recommended for northern NSW. High-yielding variety across all southern and western Australian chickpea growing regions, recommended and suited to areas south of Parkes. Semi-spreading plant type with mid-season maturity, similar to Howzat. Medium sized desi with tan–brown seed coat suitable for the whole and split seed markets. Developed by Pulse Breeding Australia (PBA). Marketed by Seednet with seed available through Seednet agents. An EPR of $4.40/tonne applies.

PBA Striker.[Φ] Moderately resistant to Ascochyta, less than PBA Slasher; S to Phytophthora root rot, so not recommended for northern NSW. High-yielding variety in short season environments in southern and western Australian chickpea growing regions. Semi-spreading plant type with earlier flowering and maturity than PBA Slasher. Medium sized desi with tan–brown seed coat suitable for the whole and split seed markets. Developed by Pulse Breeding Australia (PBA). Marketed by Seednet with seed available through Seednet agents. An EPR of $4.40/tonne applies.

Yorker.[Φ] Moderately susceptible to Ascochyta, inferior to PBA HatTrick and PBA Boundary; MR to Phytophthora, better than PBA HatTrick. Suited to drier areas where Phytophthora rather than Ascochyta is the greater risk. Yorker is sensitive to Balance® herbicide (**see Weed control in the next column**). Bred by NSW DPI; commercial partner is Seednet with seed available through Seednet agents. An EPR of $3.30/tonne applies.

Kabuli types

Almaz.[Φ] Moderately susceptible to Ascochyta, inferior to Genesis™ 090 and Genesis™ 425; S to Phytophthora. Medium seed size, 8–9 mm. Introduced from ICARDA, Syria and selected by DAFWA. Commercial partner is COGGO Group. Contact Seednet in eastern Australia for seed orders. An EPR of $7.15/tonne applies.

Genesis™ 090. Resistant to Ascochyta, equal to Genesis™ 509; broadly adapted; VS to Phytophthora, suited only to areas with a low Phytophthora risk. Seed size is smaller than Almaz, predominantly 7–8 mm. Introduced from ICARDA, Syria and selected by DEDJTR Victoria. Marketed by Australian Agricultural Crop Technologies. An EPR of $5.00/tonne applies.

Genesis™ 114. Moderately susceptible to Ascochyta, inferior to Genesis™ 090 and Genesis™ 425; S to Phytophthora. Medium seed size similar to Almaz, predominantly 8–9 mm. Introduced from ICARDA, Syria and selected by DEDJTR Victoria. Excellent harvestability with an erect plant habit and good lodging resistance. Marketed by Australian Agricultural Crop Technologies. An EPR of $5.50/tonne applies.

Genesis™ 425. Resistant o Ascochyta, superior to Almaz, and equal to Genesis™ 090. The least susceptible kabuli variety to Phytophthora but a susceptible rating means it will sustain economic yield loss in high risk Phytophthora situations. Higher yielding than Almaz, but lower yielding than Genesis™ 090. Seed size is smaller than Almaz, but slightly larger than Genesis™ 090 (predominantly 8 mm). Genesis™ 425 has shown some sensitivity to Balance® in northern NSW trials and herbicide screening trials in South Australia. Introduced from ICARDA, Syria and selected by DEDJTR Victoria and NSW DPI. Marketed by Australian Agricultural Crop Technologies. An EPR of $5.50/tonne applies.

Genesis™ Kalkee. Moderately susceptible to Ascochyta, inferior to Genesis™ 090 and Genesis™ 425; S to Phytophthora. Larger seed size than Almaz and Genesis™ 114, predominantly 9 mm. Introduced from ICARDA, Syria and selected by DEDJTR Victoria and NSW DPI. Yield is similar to Genesis™ 114 and Almaz in northern and southern NSW. Excellent harvestability with an erect plant habit and good lodging resistance. Marketed by Australian Agricultural Crop Technologies. An EPR of $5.50/tonne applies.

PBA Monarch.[Φ] Moderately susceptible to Ascochyta, inferior to Genesis™ 090 and Genesis™ 425; S to Phytophthora. Early flowering and early maturing. Medium seed size, 8–9 mm, similar to Almaz. Highest yielding medium sized kabuli chickpea. Semispreading plant type, which can be prone to lodging. Developed by Pulse Breeding Australia (PBA). Marketed by Seednet with seed available through Seednet agents. An EPR of $7.15/tonne applies.

Weed control

Chickpeas do not compete well with weeds, and there are few options for broadleaf weed control. However, isoxaflutole (e.g. Balance®) and terbuthylazine (e.g. Terbyne®) have made weed control more effective. Plant chickpeas in paddocks with relatively low broadleaf weed seed banks. Chickpeas can be sensitive to herbicide wash in planting furrows and care needs to be taken, particularly when moisture-seeking, that seed is well covered with at least 7 cm of soil. Consult your farm adviser.

Plants weakened by herbicide injury are more susceptible to diseases. The most common problems come from residual herbicides applied to prior cereal crops, such as:

- **Sulfonylurea herbicides** (e.g. Logran®, Glean®, Ally®, Eclipse®) applied to preceding cereal crops. Take special note of label instructions concerning crop rotation, rainfall required for breakdown and plant-back periods, particularly on high pH and/or compacted soils.
- **Triazine herbicides** (e.g. simazine, cyanazine, atrazine, terbuthylazine). Seek advice as to potential crop damage when using triazine herbicides in winter cereals, sorghum or maize, as application rates on different soil types influence the extent of residual herbicide breakdown. Follow label recommendations and avoid spray overlaps.

» **Clopyralid** (e.g. Lontrel®), **2,4-D amine and some other hormone herbicides**. Under dry conditions, these herbicides breakdown more slowly and residues can also carry over in stubble and affect subsequent crops. Read labels carefully and observe plant-back periods, including rainfall requirements.

Isoxaflutole products (e.g. Balance®) can damage Yorker and is not recommended for this variety. Under certain conditions, other varieties can be damaged causing delayed growth and flowering, and nitrogen benefits in rotations might not be maximised. Damage can occur where rain follows soon after spray application and the full rate is used. However, the full rate will provide longer residual activity through the season. Ensure there is no open trench left above the seed at planting. Consult your farm adviser if unsure.

To minimise the risk of spray rig herbicide residues damaging the crop, decontaminate the main tank, mixing hopper and all spray lines, hoses and filters. Herbicide injury from residual fallow spray mixtures occurred in several crops in 2010, despite decontamination via the main tank. If this cannot be done satisfactorily, fit end taps to booms so that they can be thoroughly flushed. Be aware that some granular herbicides can accumulate in filters and in the nozzle bodies.

Be aware of plant-back periods for herbicides such as Broadstrike® if used later in the season, especially when considering double cropping.

Consult herbicide labels and the NSW DPI guide *Weed control in winter crops* for further information on current weed control and plant-back recommendations.

Insect control

The major insect pest of chickpeas is *Helicoverpa* spp. (heliothis caterpillars). They can reduce yield and cause grain quality problems. Careful crop monitoring is required from flowering until seed maturity.

DAF Qld research recommends changes to control decisions for *Helicoverpa*. The change is from a fixed threshold of 1–2 larvae/m^2, to one based on the relationship between damage potential (determined by size and number of larvae, and crop growth stage), chickpea grain price and cost of control. Full details of the monitoring protocol to determine the cost/benefit ratio of control are outlined in *Helicoverpa management in chickpea*.

Helicoverpa management must be considered in terms of area-wide management and the regional Insecticide Resistance Management Strategy. Where possible, growers should consider using products that do not increase the risk of *Helicoverpa* developing resistance to chemicals used in summer crops. This means growers are advised not to use certain chemicals such as synthetic pyrethroids and thiodicarb (Larvin®) without actively considering the benefits and disadvantages this will have to both their own crop and those of summer crop growers. Possible options are the 'softer' more selective products such as Vivus® or Gemstar®, Steward®, and Dipel®. There are many factors to consider when deciding which product to use, such as *Helicoverpa* species and risk of resistance, compatibility with fungicides, cost and harvest withholding period (WHP).

Read pesticide labels carefully before use. **See** *Insect and mite control in field crops* and *Helicoverpa management in chickpea* for more information on pest control measures and thresholds.

Diseases

Disease monitoring and management is an important aspect of chickpea production. Growers are urged to seek advice on which diseases occur in their area. Control measures include crop rotation, paddock selection, and seed and variety selection, so it is best to start planning at least one season ahead of sowing.

Disease can occur at any time, but economic losses are more likely late in the season, making pre-harvest contracts risky. The major chickpea diseases in NSW are Ascochyta blight, Phytophthora root rot, Botrytis grey mould, virus diseases, seedling disease caused by seed-borne Botrytis, and ill-thrift caused by rootlesion nematodes. Sclerotinia can also cause problems in dense canopy crops. Physiological disorders with disease-like symptoms are also significant, in particular injury from low temperature, frost, herbicides, waterlogging, sodicity and salinity. See GRDC *Chickpea disease management (Southern and Northern regions)*

Ascochyta foliar disease (Ascochyta blight)

Ascochyta first caused widespread damage in NSW in 1998. A management strategy has been successfully adopted by the chickpea industry and is updated as new information becomes available and new varieties are released. It includes paddock selection and rotation, hygiene, growing less susceptible varieties (e.g. PBA Boundary, PBA HatTrick, PBA Slasher and most Genesis™ varieties), planting low risk seed, treating seed with a thiram-based fungicide, applying an early protectant fungicide spray, routine crop inspections and a willingness to apply additional fungicide sprays. All fungicide sprays must be applied before rain and wherever possible by ground rig with a minimum of 80 L/ha water.

Foliar disease management strategy

Similar to the 2014 season, Ascochyta infection of chickpea crops was common in 2015 in some localities. Although the extent of infection was not severe and the disease was well managed, there will be carry-over of inoculum for the 2016 season. Implications for Ascochyta management in the 2016 season are that:

» Where Ascochyta **was** found on any variety on your, or a neighbouring, farm there will be inoculum present and a high Ascochyta risk. Apply a registered fungicide before the first rain event after crop emergence to all varieties with lower resistance than PBA HatTrick. PBA HatTrick will also need to be sprayed. Monitor the crop two weeks after rain and, if Ascochyta is detected, consider a second fungicide spray.

Table 48. Disease and crop injury guide – chickpea

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Fungal and oomycete diseases				
Pre-emergence diseases Many fungi	Seedlings fail to emerge.	Mainly kabuli cultivars.	Wet soils. Survives in soil.	Treat seed with a thiram-based fungicide.
Botrytis seedling disease *Botrytis cinerea* (fungus)	Seedlings wilt and die. Random distribution (not patches of plants).	Related to infected seed source.	Survives in seed after pods become infected.	Treat seed with a thiram-based fungicide (first grading out small or mouldy seed, if present).
Damping off *Pythium* (oomycete) and several fungi	Seedlings wilt and die. Patchy distribution.	Wet soils.	Survives in soil.	Treat seed with a thiram-based fungicide (might not give adequate control of Pythium).
Phytophthora root rot *Phytophthora medicaginis* (oomycete)	Rotted roots, plants easily pulled up. Patches of plants wilting; yellowing and defoliation starting from bottom leaves.	In patches with poor soil drainage, after heavy rainfall. Paddock history of medic, lucerne, or root rot in chickpea.	Survives in soil. Can persist for years. Spreads by water and soil movement.	Use the variety Yorker or PBA HatTrick, which combine improved resistances to both Phytophthora and Ascochyta. Avoid paddocks with a history of root rot in chickpea. Rotate with cereals. In high risk situations, treat seed with metalaxyl (effective against early, but not late, infection).
Ascochyta leaf, stem and pod blight *Phoma rabiei* (syn. Ascochyta rabiei) (fungus)	Lesions with concentric rings of tiny black specks, leaves, stems, pods and, when severe, whole plants and patches of plants die. Can kill entire crops of susceptible varieties if not managed properly.	Endemic in NSW. Favoured by wet, humid weather.	Seed, chickpea trash. Volunteer chickpeas.	Use NSW DPI/DAF Qld/Pulse Australia management strategy. Prevent introduction of chickpea trash, especially on equipment. Maintain machinery hygiene. Control volunteers early in the fallow. Use varieties with improved resistance.
Botrytis grey mould *Botrytis cinerea* (fungus)	Grey or dead patches on stem, collar, flowers or pods. Spore clusters evident as 'bunches of grapes' on dark brown stalks, best seen with hand lens	Warm (>15 °C), humid, overcast conditions, dense canopies.	Many sources including any crop trash, sclerotes in soil, neighbouring crops, in-crop weeds, and infected seed. Inoculum usually not limiting.	Prevention is the same as for Ascochyta blight. Current recommendations for Ascochyta have reduced effects from Botrytis grey mould. Pre-emptive spraying might be possible; check current recommendations and permits.
Sclerotinia wilt *Sclerotinia sclerotiorum*, *S. minor* (fungi)	Beige–tan lesions on stems at ground level or higher. White–grey mould in wet or humid weather. Sclerotes (1–5 mm black bodies) usually form on, or inside stems, or on tap roots.	Basal stem rot usually occurs in late winter/ early spring. Canopy stem rot favoured by dense, luxuriant growth.	Sclerotes survive in soil for at least 8 years, germinate directly and infect roots and stem bases, or indirectly to release wind-blown spores. Very wide host range in broadleaf weeds and crops.	Rotate with cereals, 4 year break between broadleaf crops. Avoid planting next to canola paddocks; control broadleaf weeds.
Virus diseases				
Beet western yellows virus (BWYV), *Alfalfa mosaic virus* (AMV), *Subterranean clover redleaf virus* (SCRLV), *Cucumber mosaic virus* (CMV), *Mastrevirus* pp., *Bean leafroll virus* (BLRV), *Tomato spotted wilt virus* (TSWV), and at least three other species	First symptoms are bunching, reddening, yellowing, or shoot tip death. Later symptoms are reddening or yellowing and early death of whole plants. Diseased plants are scattered, i.e. solitary or in small groups of 2–4 plants.	Seasons or districts with major aphid flights. Most common in crops that have a low plant density, weed infestation.	Survives in weeds and pasture legumes, especially lucerne. Spread by aphids and, to a minor extent, thrips and leafhoppers. AMV and CMV are transmitted through seed to seedlings at incidences up to 1% and 2% respectively.	Aim for optimal establishment, standing stubble, and no weeds by following best agronomic practices.
Nematodes				
Ill-thrift *Pratylenchus thornei*, *P. neglectus*	Poor plant growth in situations where nodulation and other factors are favourable. Microscope shows nematodes with stylets.	Widespread in soils with high clay content.	Survives and spreads in soil.	Crop rotation with a nematode-resistant cereal cultivar could be beneficial. Some chickpea varieties are less susceptible than others (seek advice).
Herbicide Injury				
Injury from soil residues of Group C herbicides (e.g. triazines) and sulfonylurea herbicides, and isoxaflutole (Balance®)	Discolouration, stunting, death, or leaf necrosis, especially in seedlings.	Related to pre-emergence herbicide use in current and previous seasons. Damage greatest in boom overlaps and compacted areas.	Most persistent in alkaline soils.	Observe label recommendations and avoid spray overlaps. Thoroughly decontaminate spray gear, especially auto rigs. Be aware of Group C herbicide risk when following sorghum (double crop) and triazin-tolerant (TT) canola.
Waterlogging				
Injury from saturated soil or standing water	Similar to Phytophthora root rot, but roots remain intact. Initially plants do not pull easily out of ground. Onset is more rapid (1–2 days after rain) than for Phytophthora. Leaflets show bleaching, yellowing or reddening and might not fall.	Soil saturation for one day or longer, plants most sensitive when stressed and/or podding.	Poor drainage due to compacted soils or subsoil constraints.	Ensure good paddock drainage. Avoid irrigation after podding (see Pulse Australia publication Irrigated Chickpea Management).

» Localities where Ascochyta was **not** found in 2015 are considered low Ascochyta risk and the usual management practices (described below) apply.

Apart from considering the risk from 2015 inoculum, the following strategy should reduce losses from Ascochyta in 2016:

» In north-central and northern NSW, spray all varieties with lower Ascochyta resistance than PBA HatTrick (MR) with a registered Ascochyta fungicide before the first rain event after crop emergence, three weeks after emergence, or at the 3-branch stage of crop development, whichever occurs first.

» In north-central and northern NSW, in paddocks that have not had chickpeas for at least two years, PBA Boundary, PBA HatTrick and most Genesis™ lines will not require their first Ascochyta spray until the disease is detected. Monitor these crops 2–3 weeks after each rain event from emergence onwards and spray if Ascochyta is detected in the crop or is found in the district on any variety.

» For all varieties with lower Ascochyta resistance than PBA HatTrick and for varieties with Ascochyta resistance as good as or better than PBA HatTrick but where Ascochyta has been detected, apply a second fungicide spray before the second post-emergence rain event. In 2011, crops that were sprayed on this schedule had the least Ascochyta and subsequent management was successful.

» Ground application of fungicides is preferred. Select a nozzle such as a DG TwinJet or Turbo TwinJet that will produce no smaller than medium droplets (ASAE) and deliver the equivalent of 80–100 litres water/hectare at the desired speed.

» Where aerial application is the only option (e.g. wet weather delays) ensure the aircraft is set up properly and that contractors have had their spray patterns tested to ensure full canopy coverage.

Further information on chickpea Ascochyta disease can be found at the Pulse Australia website.

Botrytis grey mould foliar disease (BGM)

This disease can be very damaging in seasons with frequent rainfall and prolonged high humidity, such as 2010. There were four reasons BGM was particularly severe in 2010, which could also apply if the same conditions occur in 2016:

1. Early planting (April–mid/late May) and narrow rows caused early canopy closure, resulting in high in-crop humidity and poor penetration of fungicide. Many crops lodged, exacerbating the situation.
2. Frequent overcast, showery weather – rainfall totals between June and December in 2010 were well above the long-term averages across the northern region and, in many cases, the number of rainy days during this period was double the long-term average. Wet paddocks limited spraying by ground rigs.
3. Lack of supply of effective fungicides – the large area of chickpeas planted in the northern region in 2010, combined with the sequence of rainfall events early in the season, resulted in a widespread and significant Ascochyta epidemic. This resulted in a severe shortage of registered fungicides when BGM started to develop. Even after Emergency Use permits were issued, supplies of BGM fungicides were limited.
4. Lack of BGM tolerant/resistant varieties – there is no useful resistance in current Australian chickpea varieties to BGM.

Fungicide sprays can reduce losses if applied early and repeatedly. The principles for fungicide application and management are the same as for Ascochyta (but the product selection differs). Check labels and permits or registration for fungicides on chickpea.

Botrytis seedling disease

The fungus that causes BGM (*Botrytis cinerea*) also causes pre- and post-emergence seedling death. In 2011, Botrytis seedling disease was common in most northern NSW crops sown with grower-retained seed. The disease came from seed infected during the 2010 BGM epidemic. In every case, this seedling disease in 2011 crops could be traced to inadequate treatment of the 2010 crop seed, due to poor coverage and/or insufficient rate. Together with poor germination and vigour, the result was a patchy crop with a low plant population and secondary infection of healthy seedlings by Botrytis via root contact. Botrytis basal collar rot appeared from September onwards. Patchy stands made weed management challenging and led to a higher risk of viruses.

Field trials in 2011 at Moree, Bellata, Breeza and Tamworth, using seed from 2010 crops affected by BGM, showed that Botrytis seedling disease is readily controlled with registered seed treatments, as long as they are applied correctly. However, it is recommended to not use Botrytis-infected grain as planting seed even if treated. The seed will have lower vigour and this will increase the risk of other seedling diseases. Also, sowing rates will need to be increased to account for the reduced vigour, which may make using grower-retained seed uneconomical.

Phytophthora root rot

Phytophthora root rot is a soil and water-borne disease whose inoculum can become established in some paddocks. Damage is greatest in seasons with above average rainfall, but only a single saturating rain event is needed for infection. Avoid high-risk paddocks such as those with a history of Phytophthora in chickpea, waterlogging, or pasture legumes, particularly medics and lucerne. Alternative Phytophthora hosts such as pasture legumes, particularly medics and lucerne must be managed to provide a clean break between chickpea crops. If considerations other than Phytophthora warrant sowing in a high-risk paddock, choose PBA HatTrick or Yorker and consider treating seed with metalaxyl. Metalaxyl can be applied in the same operation as other seed dressings, providing all conditions of permits and labels are met. Metalaxyl only provides protection for about eight weeks; crops can still become infected and die later in the season. Do not plant PBA Boundary in any paddock that has had a history of pasture legumes or chickpea Phytophthora root rot.

Root lesion nematode (RLN) (*Pratylenchus thornei, P. neglectus*)

Root lesion nematodes cause poor plant growth in situations that otherwise appear favourable. They attack cereals and pulses and are thus a threat to the whole farming system. Nematodes feed and multiply on and in the roots of chickpea plants and, in sufficient numbers, will reduce growth and yield. Chickpea varieties differ in their resistance and tolerance to RLN, but are generally considered more susceptible (allowing nematodes to multiply) than field peas, faba beans and lupins. Reduce the risk of losses from RLN by not planting chickpeas in paddocks that had susceptible or intolerant cereal varieties in 2015, and by following the recommendations in *Management of root-lesion nematodes in the northern grain region*.

Sclerotinia base rot (*Sclerotinia sclerotiorum*, *S. minor*) and Sclerotinia aerial blight (*S. sclerotiorum*)

In 2010, Sclerotinia was more common than in previous years and in some paddocks caused serious damage. There are two species that attack chickpeas, distinguishable by the size of their sclerotes (survival structures). *Sclerotinia sclerotiorum* produces large, irregular shaped sclerotes 5–10 mm in diameter and up to 20–30 mm long in chickpea stems, whereas *S. minor* sclerotes are angular and much smaller, rarely larger than 2–3 mm in diameter.

Both species of Sclerotinia have a wide host range, including many broadleaf weeds and crop plants such as canola, faba beans and sunflowers. Reduce the risk of losses from Sclerotinia by planting seed free of sclerotia and by not planting chickpeas in paddocks that have recently had alternative host crops. The resting structures (sclerotes) can survive for up to 10 years, but it is impracticable to maintain a host-free break for that period. No fungicides are registered for control of Sclerotinia in chickpea.

Virus diseases

Flying aphids spread viruses, which can cause major losses in some years, often later in the season as was the case in 2012. The Liverpool Plains, and Gilgandra and Narrabri districts have a history of virus disease. Prevention is the only technique to limit losses because there is no cure. However, prevention measures are not adequate due to limited effectiveness and practicality, and there are no immune varieties. Follow best agronomic practices including retaining standing stubble, optimising sowing rate and sowing time, and controlling in-crop and fallow weeds. Stressed crops tend to be more prone to insect attack (particularly from aphids) hence the basic principles of managing paddock selection and plant health to avoid stressed crops should apply. Other measures that can be beneficial in some cases include using virus-free seed, controlling host weeds, distancing from lucerne crops, and using narrow row spacing and a higher sowing rate. Monitoring and spraying aphids is not recommended. Virus control is different for chickpea than for other pulses, because spread is almost entirely by non-colonising aphids that visit crops only briefly. The prevention options are detailed and evaluated in *Managing viruses in pulses.*

Fungicide seed dressings

Chickpea seed should always be treated to control seed-borne Ascochyta and Botrytis and some soil-borne diseases. Research has shown P-Pickel T® (thiram plus thiabendazole), and products containing thiram only (e.g. Thiram® 600) are equally effective against Ascochyta and Botrytis. Additionally, applying metalaxyl could be warranted if there is a risk of Phytophthora in a paddock.

Table 49 Chickpea seed treatments

Active ingredient	Example product	Rate	Target disease
thiram 360 g /L + thiabendazole 200 g /L	P-Pickel T®	200 mL/100 k g seed	Seed-borne Ascochyta and Botrytis, Damping off, Fusarium
thiram 600 g /L	Thiram® 600	200 mL/100 k g seed	Damping off, seed-borne Botrytis and Ascochyta
thiram 800 g /kg	Thiragranz®	150 g /100 k g seed	Seed-borne Botrytis and Ascochyta, Damping off
metalaxyl 350 g /L	Apron® XL 350 ES	75 mL/100 k g seed	Phytophthora root rot

Injury from herbicide residues in soil

Herbicide residues can cause disease-like symptoms. Damage is greatest on alkaline soils above pH_{Ca} 7.6 and can be aggravated by compacted soil. Group B sulfonylurea herbicides (e.g. Ally®, Associate®, Glean®, Logran®, Lynx®, Nugran® and Tackle®) on preceding cereal crops are especially risky, requiring special attention to crop rotation recommendations on labels. The trend in northern NSW to double crop sorghum and include triazine tolerant (TT) canola varieties in the rotation also increases the risk of Group C herbicide damage.

Consult herbicide labels and the NSW DPI guide *Weed control in winter crops* for further information on plant back periods and rainfall requirements.

Harvesting

Chickpea plants often contain pods with various stages of maturity (i.e. first set pods can be mature whilst young green pods are still forming). Chickpea seeds are physiologically mature when yellowing from the beak of the seed begins to extend through the remainder of the seed.

Chickpea crops can be desiccated using glyphosate (540 g /L) ± metsulfuron-methyl (600 g /kg), or diquat (200 g /L), to aid harvest efficiency once the majority (90–95%) of seeds have reached physiological maturity. Ensure that the harvest WHP is observed according to the label of the product used (e.g. seven days for glyphosate products; nil for diquat products) . Desiccation allows earlier harvest, maximising both yield and grain quality. However, a crop ripening evenly under very hot conditions or with no weed problems might not require desiccation (see *Chickpea harvest and seed storage*, available from Pulse Australia). Crops desiccated with glyphosate should not be kept for planting seed as it reduces seed viability.

The receival standard for chickpea is 14% seed moisture content. Harvest should start as soon as the seeds

have dried down sufficiently to thresh. Harvesting chickpea at 14–15% moisture then drying or aerating will normally result in a higher yield, better quality, fewer harvest difficulties and less problems with late Ascochyta infection. Harvest losses and downgrading in quality (cracking) can be substantial if chickpea harvest is delayed until moisture is below 11–12%. A delayed harvest also increases the risk of lodging and late rain or hail leading to lower yields (reduced seed density and brittle seeds), and downgraded quality (observed as dark, discoloured or sprouted seeds). Significant harvest losses can occur if harvest operators are inexperienced. Make sure contractors are experienced in chickpea harvesting and that headers travel at appropriate speeds.

Marketing

The bulk of the Australian chickpea crop is exported. Most desi chickpeas go to the Indian subcontinent for human consumption as whole seed, dhal (split seed) or besan (flour). A small proportion is split in Australia or milled into flour and consumed locally or sold to expatriate Indian communities in the UK, Canada and Fiji.

Prices in the Indian subcontinent are low in their post-harvest period from April to June and Turkish imports fill the period from August to December. The Australian crop meets the off-season demand from December to March, although prices for chickpeas in Australia in October/November are often higher than in December/January.

Small seeded kabulis (up to 7 mm diameter) meet separate market requirements from large kabulis and are therefore priced accordingly. They are mainly exported to the Indian subcontinent and Middle East. Larger kabulis command a higher price, with significant premiums applying to each 1 mm increment in seed diameter. The size of these premiums varies from year to year, depending on supply from key competitors. The larger kabuli chickpeas are exported to the Indian subcontinent, Middle East and Europe. A small amount of both small and large seeded kabulis are retained in Australia for local processing and consumption.

The current marketing specifications for the different grades of chickpeas can be found on the Pulse Australia website.

Further information

NSW DPI

Weed control in winter crops

Insect and mite control in field crops

Pulse Point 7, *Reducing disease risk*

Pulse Point 20, *Germination testing and seed rate calculation*

GRDC

PBA Fact Sheet, September 2013, *Seed markings of desi chickpea*

May 2013, *Chickpea disease management (Southern and Northern regions)*

GRDC bookshop for:

Chickpea disorders: The ute guide

Field crop herbicide Injury: The ute guide

Pulse Australia

2015–16 Pulse Trading Standards

PA Bulletin, *Chickpea: High quality seed*

PA Bulletin, *Chickpea: Integrated disease management*

PA Bulletin, *Chickpea: Ascochyta blight management*

PA Bulletin, *Chickpea: Botrytis grey mould management*

PA Bulletin, *Chickpea: Phytophthora root rot management*

PA Bulletin, *Chickpea: Identifying Sclerotinia*

PA Bulletin, *Managing viruses in pulses*

PA Bulletin, *Chickpea: deep seeding strategies*

Accredited advisors

Pulse traders

Crop protection products

Chickpea harvest and seed storage

Department of Agriculture and Fisheries Qld (DAF)

2009, *Management of root-lesion nematodes in the northern grain region*

Helicoverpa *management in chickpea*

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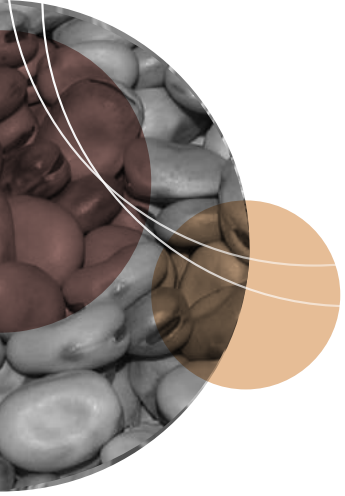

Faba bean

Crop management

Many dryland and irrigated graingrowing areas are well suited to faba bean. All varieties are suitable for stockfeed or human consumption. However, in some environments, seed size and colour could limit the potential to achieve human consumption market specifications. Faba bean is best suited to deep, neutral–alkaline, well-structured soils. Avoid shallow, acidic (less than pH_{Ca} 5.2) or very light to sandy-textured soils. In southern areas, test the pH to ensure the soil is suitable. Good drainage is preferable, however faba bean can withstand short periods of waterlogging much better than chickpea, field pea or lupin. If possible, locate crops at least 500 m from faba bean stubble. In northern NSW, faba bean should be planted on a minimum of 100 mm plant available water (PAW) at sowing.

Faba bean enhances soil nitrogen levels and breaks weed and disease cycles in cereal crop rotations. Under conditions of adequate moisture, they can be sown immediately following maize, sorghum or cotton, provided no residual herbicides that damage faba bean have been applied in the previous crop.

The optimum temperature range for growth is 15–25 °C, with flowering ideally occurring from July to late September. Flowering could start as soon as June if sown early in northern NSW and can extend to mid October in southern NSW. High temperatures and hot, dry winds during flowering will reduce yield. Severe frosts following mild weather often cause elongating stems to develop a bent stick (hockey stick) appearance, blackening leaf margins and aborting flowers and pods in some varieties. Faba bean is an open-pollinated crop, so out-crossing from one variety to another can occur. If retaining faba bean for seed, the maximum distance possible should separate crops of different varieties to reduce any out-crossing and varietal contamination.

Introducing bee hives to paddocks at flowering has been shown to benefit pod set and increase yields in areas where low naturalised honey bee or native bee populations exist.

Grain yield potential and nitrogen benefit are closely related to growth – the more dry matter produced, the higher the potential yield and the more nitrogen added to the soil.

Plant residues, particularly lost grain left after harvest, can provide valuable grazing with no stock health risks. Adhere to harvest withholding periods (WHP) for all herbicides, insecticides and fungicides applied to the crop.

Sowing

Seeds are relatively large and flat compared with cereal seed. Some equipment cannot successfully sow seed of this size and shape. It is important to test equipment before sowing using inoculated seed, as the peat increases seed bridging in planter boxes and air seeder bins. Ensure the air seeder sowing boots and hoses are large enough to handle large seeds. Ideally sow faba bean into cereal stubble for maximum nitrogen fixation, rotational benefits and to minimise aphid infestation. Wider row spacing can improve stubble flow.

Faba bean is generally sown 4–6 cm deep, depending on soil moisture, but they can be sown up to 12–13 cm if needed. Deep furrow or moisture seeking techniques can be used to ensure planting on time. The large seed size makes them very suitable for this type of planting system. Deep sowing can also reduce potential effects on crop establishment from post sowing, pre-emergent herbicides. Under furrow irrigated conditions, it is best to sow shallow (2–3 cm) and water the crop up.

Sowing time

Aim to sow in the earlier part of the sowing window to maximise yield potential. Avoid sowing earlier than the suggested sowing times, particularly under irrigation, as this can promote excessive vegetative growth and consequently increase crop lodging and foliar diseases. Sow irrigated crops in southern NSW in early to mid May.

Sowing rate

Sowing rates for faba bean vary according to seed size, sowing time and region. Over a wide range of plant populations under favourable conditions, faba bean can yield well as they have the ability to compensate and fill in plant rows. Trials conducted in northern and southern NSW under dryland conditions show that plant densities below the recommended populations reduce yield in most years. Later-sown crops require a higher plant population to minimise potential yield loss. A plant population of 20 plants/m^2 has been acceptable on a 50–100 cm row spacing in northern NSW dryland crops and southern NSW irrigated crops. Plant populations of 20–35 plants/m^2 are required for southern NSW dryland crops, depending upon sowing time.

Table 50. Suggested sowing times

Variety / Week	April 1	April 2	April 3	April 4	May 1	May 2	May 3	May 4	June 1	June 2	June 3	June 4
Northern												
Narrabri–Boggabilla			■	■	■	■	■					
Walgett–Coonamble		■	■	■	■	■						
Liverpool Plains					■	■	■	■	■	■		
Central West												
Dubbo–Warren			■	■	■	■	■					
Cowra–Forbes			■	■	■	■	■					
Central and Southern												
Temora–Wagga–Lockhart			■	■	■	■	■					
Griffith–Hillston (irrigated)					■	■	■	■				

☐ Too early, high disease pressure likely and increased risk of aphid flights and virus infection

■ Best sowing time

■ Later than desirable, yield reduction unless favourable spring conditions

Table 51. Sowing density

Plant population target	Plants/m²
North dryland	15–25
North irrigated	15–20
South dryland	20–35
South irrigated	20–30

Table 52. Sowing rates for faba bean varieties

Sowing rates	Average 100 seed weight (g)	Seed rate (kg/ha) 20 plants/m²	Seed rate (kg/ha) 30 plants/m²
Establishment %		90	90
Doza	50 (40–60)	111	166
Cairo, Fiesta VF, Farah, Nura, PBA Samira	68 (60–75)	151	227
PBA Nasma	70 (61-79)	156	233
PBA Rana, PBA Zahra	75 (65-85)	167	250
PBA Warda	64 (58–70)	142	212

Calculations based on 100% seed germination.

Your calculation

100 seed weight # (grams)		target plant population		establishment percentage* × germination percentage	
.....	×	.....	× 1000 ÷	.....	

= your sowing rate ..... kg/ha

To determine your seed weight, weigh 100 seeds in grams.

* Establishment percentage – 90% is a reasonable estimate, unless sowing into adverse conditions.

Inoculation

Inoculation is essential on all soil types. Use the commercially available faba bean inoculant (rhizobium strain WSM 1455). Faba bean rhizobia are very sensitive to soil acidity. Some products are more sensitive to drying out than others, so ensure seed is sown into good soil moisture, especially when moisture-seeking. Calibrate the planter using inoculated seed.

Nutrition

Phosphorus (P) is the main nutrient required by faba beans. Apply phosphorus fertiliser on deficient soils at equivalent rates to that used on cereals. Phosphorus is best banded close to, but not in direct contact with, the seed at planting, especially in soils that have grown rice within the last two years. Yield responses to zinc have been recorded on alkaline clay soils, but only where zinc had not been applied to other crops in the rotation. Consider molybdenum on acid soils.

Variety selection

When selecting a variety consider season length, seed size with reference to sowing machinery, disease tolerance, seed availability and suitability to markets. A number of varieties are available, differing in a range of characteristics, with most suited to specific growing regions in NSW. Carefully select varieties based on local data. For characteristics of the different varieties, refer to Table 51.

Faba bean

Cairo.ϕ Released in 2003 for the northern grains region, superior to Fiord and Barkool for yield, seed size and quality, rust resistance and tolerance to stem collapse from frost. Outclassed for yield and rust resistance by Doza and PBA Nasma. It is not generally recommended for southern NSW where Ascochyta and chocolate spot are major constraints. Licensed to Seednet, and available through local seed suppliers. An End Point Royalty (EPR) of $3.00/tonne (GST excl.) applies.

Doza.ϕ Released in 2008 by Pulse Breeding Australia's (PBA) northern faba bean breeding node at Narrabri. Doza is significantly better adapted to warmer spring temperatures than Barkool, Cairo or Fiord. Doza is higher yielding than Cairo, with improved rust resistance. Seed is smaller than Cairo, but more uniform with a light buff seed colour. It is not generally recommended for southern NSW where Ascochyta is a major constraint. Licensed to Seednet and available through local seed suppliers. An EPR of $3.30/tonne (GST excl.) applies.

Farah.ϕ Farah is a selection from Fiesta VF with improved resistance to Ascochyta. It has similar agronomic characteristics and yield to Fiesta VF. The improved Ascochyta resistance will result in a lower level of Ascochyta-stained seed compared with Fiesta VF. Selection was also undertaken for reduced environmentally stained seed and improved seed size uniformity. Licensed to Heritage Seeds and available through local seed suppliers. An EPR of $3.00/tonne (GST excl.) applies.

Nura.[Φ] Released in 2005 from the southern node of the National Faba Bean Breeding Program, Nura was produced from a cross between Icarus and Ascot and selected for improved resistance over Fiesta VF to both chocolate spot and Ascochyta. It also has moderate resistance to rust. Nura is later flowering than Fiesta VF, however is of similar maturity. Suited to the medium to high rainfall areas of southern NSW and is not recommended for northern NSW. Shorter in height than Farah and Fiesta VF and is less likely to lodge. Seed is slightly smaller than Farah and light buff in colour. Licensed to Seednet and available through local seed suppliers. An EPR of $3.00/tonne (GST excl.) applies.

PBA Nasma.[Φ] New release (breeding code IX220d/2-5). Released in spring 2015. A new variety for northern NSW and southern Queensland with higher yield than PBA Warda. PBA Nasma has a larger and more uniform seed than Cairo and PBA Warda, which will make it readily acceptable into the human consumption market. Its flowering and maturity time is similar to PBA Warda. PBA Nasma is similar to PBA Warda for resistance to chocolate spot and tolerance to frost and *Bean leafroll virus*. Its rust resistance is slightly inferior to Doza, but far superior to Cairo. It is susceptible to Ascochyta and is therefore not recommended for southern NSW. Licensed to Seednet. An EPR of $3.50/tonne (GST excl.) applies.

PBA Rana.[Φ] Released in 2011 from the southern node of the PBA faba bean breeding program. PBA Rana is suited to the higher rainfall, longer season growing areas. It is mid to late flowering, with improved resistance to chocolate spot compared Farah and resistant to Ascochyta. It has large, plump, light brown seed that is bigger than current varieties. In NSW, PBA Rana has performed well at longer season or high rainfall sites. Before considering growing PBA Rana, growers should investigate marketing options as it needs to be segregated to achieve a premium for its larger seed size. Licensed to Seednet. An EPR of $3.50/tonne (GST excl.) applies.

PBA Samira.[Φ] Released in spring 2014 from the southern node of the PBA faba bean breeding program. PBA Samira is adapted to a wide range of environments in the southern region. It is mid to late flowering, but matures at the same time as Farah and Fiesta VF. PBA Samira is resistant to Ascochyta, including the new strain that was recently identified in the mid-north of South Australia. Its seed is slightly larger than Farah and Fiesta VF, but of the same colour and should be suitable to be comingled with other varieties for the human consumption market. Licensed to Seednet. An EPR of $3.50/tonne (GST excl.) applies.

PBA Warda.[Φ] Released in late 2012 from the northern node of the PBA faba bean breeding program. PBA Warda is higher yielding than Doza and best adapted to the northern region's higher rainfall. It is similar to Doza for earliness, and chocolate spot and rust resistance, but has better tolerance to frost and *Bean leafroll virus*. Its seed is more uniform and bigger than Doza, making it suitable for the human consumption market. Licensed to Seednet. An EPR of $3.50 /tonne (GST excl.) applies.

PBA Zahra.[Φ] New release (breeding code AF05095-1). Released in spring 2015. A variety selected for the southern region where it has shown very high yield potential and is particularly responsive to high-yielding situations. It is resistant to Ascochyta blight in most districts in the southern region, although MS–MR to a new pathotype in the mid-north of South Australia. It is less susceptible to chocolate spot and rust than Fiesta and Farah. PBA Zahra flowers at the same time as Nura and PBA Samira, but can mature slightly later under conducive seasonal conditions. PBA Zahra has large, plump seed, similar to PBA Rana. The two varieties could be co-mingled for a large-seeded category in the Middle East market. Licensed to Seednet. An EPR of $3.50/tonne (GST excl.) applies.

Table 53. Variety characteristics and reaction to diseases

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

Yield results are a combined across sites analysis using PBA and NVT yield trials from 2008–2015.

– = Insufficient data; VS = Very susceptible; S = Susceptible; MS = Moderately susceptible; MR = Moderately resistant; R = Resistant.

Broadbean

PBA Kareema.(D) Released in 2010 from the southern node of the PBA faba bean breeding program. PBA Kareema is a broadbean that is adapted to the higher rainfall zones of south-eastern South Australia and southern Victoria. PBA Kareema maintains the adaptation of Aquadulce, but with more uniform, larger seed, no evergreen seed and improved resistance to Ascochyta. Similar maturity to Aquadulce and requires a long pod-filling period to achieve maximum yield and large seed. Licensed to PGG Wrightson Seeds. An EPR of $4.40 /tonne (GST incl.) applies.

Irrigation

Faba bean is grown in rotation with irrigated summer crops such as cotton, rice, maize or sorghum. Faba bean is a safe crop to sow dry and water up on either beds or hills. To increase rhizobium inoculum survival, dry-sown beans should be watered immediately after sowing. Always ensure good seed–soil contact. Plant populations can be lowered to 15 plants/m^2 in the north and 20 plants/m^2 in the south without yield penalties, provided plant establishment is even.

In short season northern areas, one irrigation at early pod-fill (early–mid August) might be all that is required. Avoid irrigating before flowering as often tall, vegetative, low yielding crops can result. In southern areas, apply the first spring irrigation early to avoid stress during flowering and early pod-filling as delays will reduce yield potential. Followup irrigations can be scheduled according to plant water use. Although the crop tolerates some waterlogging, a good layout is essential and irrigation times should be kept as short as possible for high yields.

In southern NSW, furrow irrigation is preferred over spray irrigation as overhead watering encourages more foliar disease. Border check layouts increase the risk of waterlogging during and after irrigation. In these layouts, irrigation and drainage should be complete within eight hours.

Weed control

To maximise rotational benefits, effective weed control is essential. Herbicides can damage faba bean, so use only registered products according to the label directions.

Plants weakened by herbicide injury are more susceptible to diseases, especially chocolate spot. The most common problems come from residual herbicides applied to prior cereal crops, but non-residual herbicides have also been implicated.

1. **Sulfonylurea herbicides** (triasulfuron, chlorsulfuron, metsulfuron methyl, metosulam) applied to preceding cereal crops. Take special note of label instructions concerning crop rotation and plantback periods, particularly on high pH and/or compacted soils where rainfall has been limited.
2. **Clopyralid** applied to preceding cereal crops and summer fallows. Clopyralid can carry over in straw and affect subsequent crops.
3. **Atrazine** applied at full rates to preceding maize and sorghum crops. Check the label for crop rotation guidelines.
4. **Picloram and aminopyralid** formulations e.g. Grazon Extra and Tordon 75D, applied to previous summer fallows. Under dry conditions the breakdown of these fallow herbicides is reduced and subsequent crops can suffer herbicide injury.

Triazine herbicides (simazine, cyanazine, terbuthylazine) applied in-crop can potentially cause crop damage in some circumstances – application rates influence herbicide action on different soil types. Follow label recommendations and avoid spray overlaps.

In addition, some spray oils used with post-emergent selective grass herbicides can cause minor leaf spotting and/or burning, which should not be confused with disease symptoms.

Correct boomspray decontamination procedures must be followed to avoid the potential for herbicide injury.

Be aware of the plantback periods for the post-sowing pre-emergent herbicides (e.g. imazethapyr – Spinnaker®) used in faba bean crops as these can affect subsequent crops, especially other non-pulse broadleaf crops such as sunflowers and canola.

Read pesticide labels and the NSW DPI guide *Weed control in winter crops* for further information on current weed control recommendations, plantback periods and correct spray unit decontamination procedures.

Table 54. Disease and crop injury guide – faba bean

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Foliar diseases				
Ascochyta blight *Ascochyta fabae*	Small, grey, circular leaf spots, showing through both sides of the leaf, developing light brown centres with age. Under humid conditions lesions become dotted with black specks. The disease also causes stem breakage and pod lesions which result in seed discolouration.	Wet conditions in mid to late winter or when late rains occur before harvest and cause pod infection.	Spores spread by wind and rain splash. Infected seed, faba bean residues and volunteer plants are sources of initial infection.	Disease-free seed. Crop rotation. Destroy or incorporate infected stubble. Locate crops at least 500 m from last year's faba bean crop. Control volunteer plants. Use resistant varieties. Foliar fungicides.
Chocolate spot *Botrytis fabae*	Leaf spots are initially reddish-brown, pin-head sized and on one side of the leaf only. Under suitable conditions spots expand into large, irregular, black, dead areas, expanding onto the stem. Flowers and pods can also be affected.	Extended (>1 day) periods of leaf wetness. Favoured by mild temperatures 15–20 °C, which can rapidly spread the disease.	Infected faba bean residues. Infected volunteer plants. Spores spread by wind and rain.	Use resistant varieties, foliar fungicides, crop rotation and good crop hygiene. Locate crops at least 500 m from last years faba bean crop or from wind-blown stubble residues. Control volunteer faba bean.
Rust *Uromyces viciae-fabae*	Several spore stages can appear on leaves, stems and sometimes pods at the same time. Early on, creamy-yellow pustules form on leaves. These are soon replaced by orange-brown pustules. Later, black spore masses develop on stems.	Only a short period of leaf wetness during the night (like a heavy morning dew) is needed for infection to occur. Infection can occur under a wide range of temperatures, but disease development is favoured by high (>20 °C) temperatures and therefore of more importance in northern NSW and towards the end of the season in southern NSW.	Infected volunteer plants are very important. Infected faba bean residues.	Use resistant varieties. Foliar fungicides. Locate crops at least 500 m from last year's faba bean crop. Control volunteer faba bean. Crop rotation.
Viral diseases				
Virus yellowing diseases: *Bean leafroll virus* (BLRV), *Soybean dwarf virus* (SbDV, synonym, *Subterranean clover redleaf virus*), *Subterranean clover stunt virus* (SCSV)	Yellowing, interveinal at first, and often prominent at shoot tips. Leaves are stiffer than normal and often rolled upwards at the edges, pointing upwards. Infected plants are usually stunted and often die prematurely.	Seasons or districts with major aphid flights.	These viruses survive in weeds and pastures, particularly in forage legumes. All are spread by aphids and are persistent (aphids remaining infective for four days or longer).	Follow best management recommendations including: retaining standing cereal stubble (deters aphids), using recommended sowing rates, sowing on time, and controlling weeds. The systemic seed-applied insecticide imidacloprid will provide early control against these viruses. Poorly established, weedy crops suffer most from viruses. If it is detected early, controlling aphids with a registered aphicide can be beneficial for limiting the spread of the virus. Seek advice from your agronomist.
Virus mosaic diseases: *Bean yellow mosaic virus* (BYMV), *Alfalfa mosaic virus* (AMV)	Leaves show mosaic, dark green colour against a pale green or yellow background. Leaf texture is abnormal, ranging from uneven to crinkled. Early infection by BYMV can lead to reduced pod set and to pod discolouration. Late infection is unlikely to lead to yield loss.	Seasons or districts with major aphid flights.	These viruses survive in weeds and pastures, particularly in forage legumes. BYMV is spread by aphids and is non-persistent, lasting no more than four hours in aphids and usually less.	Follow best management recommendations including: retaining standing cereal stubble (deters aphids), using recommended sowing rates, sowing on time, and controlling weeds. Poorly established, weedy crops suffer most from viruses. Foliar or seed-applied insecticides are not reliable for controlling virus mosaic diseases.
Necrosis: *Tomato spotted wilt virus* (TSWV)	Large dark lesions are formed on the leaves and later dark brown streaks develop on the upper stem, often on one side. The growing point of the shoot is often killed. Seed production from affected plants is severely reduced.	Locally common in some years in northern NSW, but incidence is yet to exceed 5% of infected plants.	TSWV survives in weeds and is spread by thrips.	No proven control.
Herbicide injury				
Group A such as fops and dims	Grey or brown spotting or burning on the upper sides of leaves, which can be confused with diseases such as chocolate spot.	More common where cheap oil adjuvants are added to post-emergent grass herbicides.		Follow label recommendations and only use adjuvants specified on the label.
Group B such as sulfonylureas (SUs)	Seedlings become stunted, stem and leaf margins blackened, leaflets cupped and lateral root growth reduced. Plants often die.	Related to use of pre- and post-emergent herbicides. Alkaline soils increase risk of injury.		Follow label recommendations especially plant-back periods, soil pH and minimum rainfall requirements. Avoid spray overlaps and drift.
Group C such as triazines	Leaves blackened and die back from edges and tips.	Alkaline soils or sandy soils, low in organic matter. Shallow sowing. Wet conditions following application to dry soil.		Follow label recommendations especially plant-back periods. Avoid spray overlaps and drift.
Group I such as phenoxys	'Hormone-type' injury including abnormal leaves.	Related to herbicide use in previous crops and fallows, also drift from neighbouring crops.		Follow label recommendations and be aware of rainfall and soil pH requirements in plant-back periods.

Insects

Early detection of insect damage and appropriate control measures are important in improving crop health and vigour, and in reducing the crop's susceptibility to foliar disease. The two critical times that pests need to be monitored are at establishment and from flowering to harvest.

Redlegged earth mite and blue oat mite – large populations can cause distorted early growth and can kill seedlings. The rasping of the leaf surface during feeding results in a distinctive silvering on the leaves. Areas can redden and be confused with early disease infection.

Lucerne flea – damage is characterised by clear membranous windows chewed into leaf surfaces. It is a sporadic pest in the paddock, so not all the crop will be infested. Hot spots can occur along weedy fence lines and around trees and rocky outcrops in paddocks.

Early detection of mite and flea damage and control improves crop health and vigour, reducing the crop's susceptibility to foliar diseases.

Aphids – monitor from early establishment. Dense colonies of cowpea aphid (*Aphis craccivora*), consisting of shiny black adults and dull grey juveniles, often damage shoot tips early in the season and can reduce yield. Cowpea aphid is a vector of several virus diseases. Pea aphid (*Acyrthosiphon pisum*) and blue green aphid (*Acyrthosiphon kondoi*) are large green aphids that are less conspicuous on plants. They are not known to cause major feeding damage. However, out of all the colonising and visiting aphids, pea aphid is the most damaging as it is an important vector of virus diseases of faba bean.

Thrips – monitor from early establishment. Thrips feeding can damage seedlings and high populations can cause seedling death. Fields sown close to cotton often have high populations. Thrips can cause flower and early pod abortion and should be monitored regularly during this period. Thrips can also spread *Tomato spotted wilt virus* in faba bean.

Mirids – Green mirids are pod-sucking insects. Monitor crops from early pod-fill for nymphs and adults. Mirids have been shown to cause spotting on the seed coat and, in high populations, reduce seed size. Mirids are quite mobile within the crop and currently there are no spray thresholds.

Helicoverpa spp. (Heliothis) – base control decisions on regular monitoring. Crops should be monitored twice weekly from flowering onwards. Larvae feed on leaves, stems and pods. Once they are of sufficient size, larvae burrow into pods and feed on the developing seed. Human consumption markets have strict limits on *Helicoverpa*-damaged seeds, so spray thresholds of one larva per m^2 warrants control. Early-sown crops can mature before *Helicoverpa* moth infestion, avoiding the need for control.

Helicoverpa spp. can develop resistance to certain insecticides, so research the resistance status for your region. The recommended strategy for limiting resistance is:

- check crops regularly to detect eggs and small caterpillars
- correctly identify the species present
- spray caterpillars when they are less than 10 mm long
- rotate insecticides from different chemical groups according to the *Helicoverpa* strategy for each region.

See the NSW DPI guide *Insect and mite control in field crops* for more detailed information on pest control measures and thresholds.

Disease management

Proactive decisions will help to manage disease risks. Monitoring from emergence for disease, especially during favourable conditions, is crucial. Effective disease control depends on strategic fungicide use, but careful attention to other management practices can reduce disease pressure, making the fungicide program more effective. These include:

- growing faba bean no more than once in four years in the same paddock
- separation of crops by 500 m from previous faba bean crops
- reduction of disease infected stubble load by grazing and/or incorporating
- control of volunteer faba bean
- use of clean Ascochyta blight lesion-free seed, and
- growing locally adapted varieties that are the most tolerant to the major regional diseases.

Fungicide control

Six fungicides – mancozeb, carbendazim, chlorothalonil, copper, metiram, tebuconazole and procymidone are all registered. Tebuconazole is available under permit (PER13752, expiry 30/06/16). Check pesticide permits and registrations for any changes in use patterns before using fungicides. Mancozeb, chlorothalonil, metiram and copper are protectants and have no curative action on existing infections. Newly grown, untreated foliage will not be protected. Carbendazim and procymidone have protectant and limited curative action and work best when applied before an infection event. These fungicides are not translocated from sprayed leaves so foliage that grows after spraying is not protected.

Spray on time. Organise spraying ahead of schedule so that fungicides can be applied as soon as a decision is made. Frequent viewing of four-day weather forecasts can help decision making. Do not compromise a fungicide spray to wait for a herbicide application. Plan to spray one or two days before a significant rain period, but do not delay spraying because of the threat of rain. Light rain (less than 12 mm) can actually increase the efficacy of mancozeb. For ground application, aim for 100 L water/ha. If the label or permit specifies a minimum water rate, the fungicide must be applied at that specified water rate. Correctly timing fungicide application is essential for good disease control.

Ascochyta blight, chocolate spot and rust management (southern NSW)

Research and commercial evaluation have shown that strategic spraying with mancozeb, carbendazim, chlorothalonil or procymidone are effective for disease management.

The recommended program includes an application of mancozeb four to six weeks after emergence to control Ascochyta and early chocolate spot. Mancozeb, carbendazim, chlorothalonil or procymidone is then applied for chocolate spot control throughout the growing season. Under registration restrictions, carbendazim must not be applied for more than two consecutive sprays and should be rotated with other fungicides. The number of sprays depends on the number of infection periods (i.e. rainfall events). Monitor crops regularly in spring for development of chocolate spot, which can be rapid under favourable conditions (i.e. mild temperatures and frequent rainfall events).

Fungicides are effective for up to 14 days. Severe disease pressure will reduce the protection period, as will rapid growth, which will be unprotected. A final spray of mancozeb should be considered for rust and late control of Ascochyta, which can cause blemishes on the seed. Use mancozeb or chlorothalonil earlier if rust becomes a problem as carbendazim has no activity against this disease.

Mancozeb or chlorothalonil are broad spectrum fungicides and might need to be used through the season on varieties that are susceptible to Ascochyta. This is particularly important when producing grain for whole-seed markets, as Ascochyta staining will cause downgrading.

Be aware of the critical spray application times as part of an overall fungicide program. This includes;

» **1st critical period** is four-six weeks after emergence
» **2nd critical period** is during early flowering just before canopy closure. This is the last opportunity to apply fungicides that will penetrate into the crop canopy and protect potential infection sites from disease establishment and spread.
» **3rd critical period** is at the end of flowering and early pod fill. Applications of fungicide at this time should be aimed at protecting developing pods and preventing any further disease spread. The target diseases at this time are Ascochyta blight, chocolate spot and rust.

Rust and chocolate spot management (northern NSW). To manage rust and chocolate spot:

» Control volunteer faba bean over summer.
» Select paddocks as far from previous faba bean crops as possible (preferably at least 500 m).
» Apply a spray of mancozeb 4–6 weeks after crop emergence or before a significant rain event or canopy closure. This can be combined with a grass herbicide spray if the timing is correct for both products. This early spray is critical and will help to control early infection of both chocolate spot and rust in the crop.
» Monitor crops for signs of rust and chocolate spot. It is very important to protect the crop during flowering and early pod set.

Spraying just before canopy closure is particularly effective as the fungicide can still reach the lower parts of the plant. Mancozeb is the preferred fungicide for disease control in northern NSW because of its proven effectiveness against rust.

At late crop stages, consult your agronomist, as the economics of spraying is determined by disease levels, seasonal conditions and outlook, stage of crop development, yield potential and grain prices. In Doza, PBA Warda and PBA Nasma crops it is likely that chocolate spot will be the main disease present, in which case carbendazim or procymidone are the most effective fungicides when a second fungicide spray is necessary. In Cairo crops, rust is likely to be the main problem, in which case mancozeb will be more effective. Identify the disease correctly before choosing a product.

In wet seasons, chocolate spot can become a problem in its own right and additional sprays could be warranted. Consult your agronomist.

Virus disease management

Virus diseases in faba bean crops can be a problem throughout NSW, even though varieties released for the north have greatly improved resistance compared with older varieties. Disease management still depends on reducing aphids entering the crop and spreading viruses that they have picked up from other host plants.

Crop management techniques to reduce aphids entering faba bean crops include retaining cereal stubble to deter aphids; sowing at the recommended times for your district but, where possible, avoiding autumn flights of aphids; and sowing at recommended sowing rates for early canopy closure. Also, separate faba bean crops from lucerne pastures, which act as reservoirs for aphid species that transmit viruses to faba bean.

Research on controlling aphids in crops and reducing virus transmission through insecticide application is continuing, however, no clear thresholds have been determined for the different viruses and the type or number of aphids infesting faba bean crops. The systemic seed-applied insecticide imidacloprid is registered for faba bean and will provide early control of aphids. Growers should consult their agronomist if either a seed dressing and/or a foliar insecticide are being considered. Ensure that the viral disease is correctly identified before deciding to apply any insecticides.

Harvesting

Faba bean should be harvested to give 14% moisture at delivery into storage. At this stage, the crop will be black, although some top growth could still be green. If the pod splits and the seeds become exposed, they can be discoloured by sunlight or stained by rainfall. It is preferable to harvest the crop before the seed changes colour, is stained, becomes brittle or splits, particularly for human consumption markets.

Faba bean can be windrowed, potentially allowing an earlier harvest and to reduce harvest problems from crop lodging and late maturing weeds.

Harvest efficiency surveys in northern NSW in 2008 and 2009 showed windrowed crops had less grain losses than direct heading, but were not always more profitable due to the extra costs of windrowing. In both 2010 and 2011, windrowing faba bean crops in north western NSW was beneficial, as it quickened crop dry-down and allowed crops to be harvested before rainfall. Consider windrowing for higher yielding crops.

Windrowed faba bean samples can contain more dirt, especially if rain falls on the windrow. Where possible avoid placing windrows onto deepened wheel tracks where controlled traffic farming systems are used. Swath width might need to be adjusted according to crop biomass. Large bulky windrows will result in slower dry down time, delaying harvest. In seasons with low crop biomass, windrowing should be avoided as small windrows might not pick up well and the extra cost will not be recouped. Crops can appear green at the correct windrow timing; determining windrow timing is relatively simple. See Pulse Point 9 *Windrowing faba bean* for more detailed information.

Faba bean pods thresh easily so drum speed should be reduced to 400–600 rpm and concave clearance set at 15–35 mm to reduce mechanical damage to the grain. Blanking plates and alternative wires should be removed from the concave so that the grain is not cracked as separation can occur at the concave.

Grain damaged during harvest and subsequent movement using augers can be downgraded and have a lower germination percentage and lower seedling vigour. Rotary harvesters and belt conveyers are gentler on the grain and generally cause less grain damage than conventional augers.

Marketing

The majority of the Australian faba bean crop is exported for human consumption, mostly to Egypt, but also to Italy, Sudan and the United Arab Emirates. Around 10% is retained domestically for stockfeed and some is split for human consumption. There are developing markets in the aquaculture industry. It is difficult to achieve food quality standards where disease or insects have not been controlled, or after prolonged storage.

Australia cannot compete on a price basis with other exporters but has other advantages. We are reliable shippers, have low moisture content grain, and harvest in the offseason to the northern hemisphere. Northern NSW- and southern Queensland-grown crops often have smaller seed than the main growing areas in southern Australia. It is expected that with the release of the larger seeded variety, PBA Nasma, the situation will improve. Small seed is a marketing disadvantage, however, good quality grain marketed before the southern harvest can achieve human consumption export grade. After this window of opportunity, northern beans will normally be traded domestically at reduced prices.

Domestically, faba bean is used in the aquaculture, pig, poultry and horse industries, being a source of protein and hence competes with field pea, fishmeal, lupin, soybean meal and other protein supplements.

The current marketing specifications for the different grades of faba beans can be found on the Pulse Australia website.

Further information

Weed control in winter crops (NSW DPI, 2016)

Insect and mite control in field crops (NSW DPI, 2013)

Winter pulse disorders: The ute guide (GRDC)

NSW DPI website for

Agfact P4.2.7 *Faba bean*

Agnote DAI 128 *Honey bees in faba bean pollination*

Pulse Point 7, *Reducing your disease risk*

Pulse Point 9, *Windrowing faba bean*

Pulse Point 12, *Seeding equipment problems with faba beans*

Pulse Point 20, *Germination testing and seed rate calculation*

Primefact 1163 *Nitrogen benefits of chickpea and faba bean*

Pulse Australia website for:

» *Faba bean production: Southern and western region*

» *2015–16 Australian Pulse Trading Standards*.

Contributing authors

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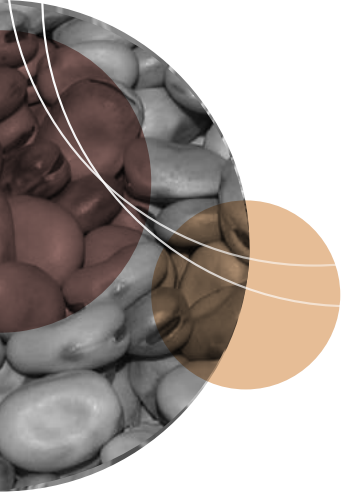

Field pea

Field pea is a valuable pulse crop rotation option in cereal farming systems. The crop fixes nitrogen from the atmosphere and conserves soil mineral nitrogen. It uses less subsoil water because of its shallower root system and earlier maturity. Growing field pea also increases flexibility for weed control and provides a break for cereal disease cycles. Wheat yields after field pea are well above those of wheat after wheat, and increased wheat protein is common.

Field pea is suited to a wide range of soils from light to heavy textured and from pH_{Ca} 4.5–8.0. The crop is sensitive to high soil-exchangeable aluminium levels and does not tolerate extended periods of waterlogging. Grain can be used for both stockfeed and human consumption. The critical management factors for producing high yields and good quality seed are optimising plant density, effective nodulation, post-sowing rolling to flatten clods and stones, weed control, insect control and timely harvest.

Sowing time

Field pea is one of the few crops that can tolerate a later sowing window relative to other pulse crops, giving it the edge in dry autumns. plus an extended presowing weed control period. However, yield potential will be maximised by sowing as early as possible within the recommended window for each region. Sowing too early increases the risk of disease and frost damage; delayed sowing increases the risk of moisture stress and high temperatures during the critical grain filling stage. Suggested sowing times shown in Table 53 apply to average to wet years. Grower experience and research trials over the past decade clearly show yield responses from sowing up to two weeks earlier in dry seasons when disease in spring has not been a problem.

Table 55. Field pea sowing times

Region	May				June			
	1	2	3	4	1	2	3	4
Western Zone								
Eastern Zone								

Only suggested for the lower rainfall areas of zones or for hay crops

Preferred sowing time

Later than recommended, yield reduction likely

There is now a wider range of varieties available, with differing maturities and some with shatter resistant pods. Growers should consider their preferred sowing window and select a variety that has a maturity to match. Any variety intended as a brown or green manure crop, or for hay, should be sown as early as possible within the recommended sowing window, to maximise dry matter production.

Figure 7. Map of NSW showing field pea growing zones

Sowing rate

Optimum plant populations vary depending on the height and vigour of the specific variety and on sowing time. Populations for tall, vigorous, scrambling types such as Morgan, Parafield, PBA Percy, or Sturt can be as low as 30 plants/m^2 when sown early, or as high as 40 plants/m^2 when sown late. For hay/manure types such as PBA Coogee and PBA Hayman, establish at least 40–50 plants/m^2 to maximise biomass. For the shorter, less vigorous group of varieties (**see Table 57 Field pea variety characteristics**) such as Excell, Maki, PBA Pearl, PBA Oura, Yarrum, and SW Celine, target 40 plants/m^2 with early sowing, increasing up to 60 plants/m^2 when sowing late. Kaspa type varieties with intermediate growth characteristics such as Kaspa, PBA Gunyah,

PBA Twilight and PBA Wharton should be sown to establish 35–50 plants/m^2.

These establishment targets can only be achieved by accounting for seed size, germination and sowing conditions when calculating sowing rates. Also, consider the seedbed condition and adjust accordingly. Use **Table 56 Field pea sowing rate** to calculate the desired sowing rate based on target density, seed size, germination and potential establishment percentage of your seed.

Air seeders can reduce germination and establishment, particularly with weather-damaged seed or seed low in moisture content. Larger round seeded varieties such as Excell, PBA Pearl, Maki and SW Celine are particularly susceptible to damage from impact on distributor heads and other hard surfaces, as their seed coats are less tightly attached to the cotyledons. Lowering the air speed of the seeder reduces the impact of seed on the seed distributor heads and other hard surfaces. Adjust ground speed to avoid problems of seed and fertiliser blockages. Lowering the seeder's ground speed and air flow at sowing also reduces seed bounce and improves seed placement in the furrow, aiding establishment.

Table 56. Sowing rate (kg/ha) based on 100% germination and 80% establishment

Field pea type	Variety	Average 100 seed weight (g)	Target plant density/m2			
			30	40	50	60
Tall scrambling	PBA Hayman	13	–	65	81	–
	Morgan	18	68	90	–	–
	Sturt	19	71	95	–	–
	PBA Coogee	20	–	100	125	–
	Parafield, PBA Percy	23	86	115	–	–
Medium–tall semi-leafless	Excell, Maki, PBA Pearl, PBA Oura, SW Celine, Yarrum	22	–	110	138	165
Kaspa types	Kaspa, PBA Gunyah, PBA Twilight, PBA Wharton	22	–	110	138	–

Your calculation

100 seed weight # (grams)		target plant population		establishment percentage* × germination percentage
.....	×	.....	× 1000 ÷	.....

= your sowing rate ..... kg/ha

To determine your seed weight, weigh 100 seeds in grams.

* Establishment percentage – 90% is a reasonable estimate, unless sowing into adverse conditions.*

Sowing depth

Field pea should be sown under most conditions 3–5 cm deep. They will emerge from deeper sowing (up to 7 cm) provided moisture is adequate for consistent germination. Do not sow dry or moisture seek field pea at depth if uneven moisture is present, as crops will germinate unevenly, causing management difficulties (such as herbicide timing) for the crop. Crops sown later in the sowing window (for example due to a delay in sowing rainfall) should be sown shallower to improve germination under cold conditions.

Inoculation

Inoculation each season is essential on all soil types. Use the commercially available Group E field pea inoculant. Check for effective nodulation 6–10 weeks after sowing to ensure nodulation has been effective. Take care with seed inoculation. If seed is to be treated with a fungicide, carry out this operation first and apply inoculant separately just before sowing. Avoid inoculating directly into airseeder bins as the seed will need to dry in the short period before being sown. Newly inoculated seed is often sticky and does not flow properly, leading to uneven seed flow and patchy establishment across the paddock.

A number of new inoculant products are available for field pea, such as freeze-dried and dry granular products. Read and follow the instructions carefully to avoid inoculation problems.

Nutrition

Apply phosphorus (P) fertiliser at rates equivalent to those used with cereals (10–25 kg P/ha). Adjust the P rate according to paddock cropping history and potential crop yield for your area. A long history of phosphorus use can build soil P levels and at high levels little or no additional P will be required.

Aim to select paddocks with a low level of residual nitrogen, to encourage nodulation and hence nitrogen fixation. Very low levels of nitrogen can be supplied as part of the starter fertiliser component. Consider applying molybdenum on acid soils.

Paddock rolling

Rolling paddocks after sowing levels the ground and presses loose stones and sticks into the soil, avoiding header damage and grain contamination at harvest. Rolling can be carried out either directly after sowing or at the 2–3 node stage. Rolling after crop emergence has the advantage of avoiding crusting on soils prone to this condition, but can increase the chance of bacterial blight disease infection.

Variety selection

When selecting a variety consider seed type (white, dun, blue), varietal maturity and sowing date, disease resistance, standing ability, seed shattering resistance, ease of harvest, yield in your region, market outlets and seed availability. A large number of varieties are available, with a wide range of characteristics; some are only suited to specific growing regions of NSW and growers should select varieties carefully based on local data. For characteristics and yield of the different varieties, refer to **Table 57 Variety characteristics and reaction to diseases**.

There are no new variety releases for the 2016 season.

CRC Walana.(Þ) Released in 2010 by the Pork CRC field pea breeding program; licensed to Waratah Seeds. White seeded, semi-leafless field pea with yellow cotyledons and white flowers. Very erect growth habit, medium height and quick, early maturity. Selected for improved yield potential and quicker flowering in the warmer, short season environments of northern NSW and southern Queensland, combined with complete resistance to powdery mildew and good levels of resistance to *Bean leafroll virus* (BLRV) and *Pea seedborne mosaic virus* (PSbMV). Suitable for human consumption or stockfeed. An EPR of $4.50/tonne applies.

Excell. Released in 1998 from the Australian Coordinated Field Pea Improvement Program. Public variety with no marketing restrictions, now largely outclassed. A semi-leafless, blue-seeded type, medium height and excellent standing ability, up to 20% lower yielding than newer commercial varieties. Moderately resistant (MR) to downy mildew; Susceptible (S) to black spot, bacterial blight, PSbMV and powdery mildew. Pods susceptible to shattering and blue seed is prone to bleaching. No EPR applies.

Kaspa.(Þ) Released in 2002 from the Australian Coordinated Field Pea Improvement Program; licensed to Seednet. High yield potential in average to good seasons, but due to its late flowering, has performed poorly across southern Australia in harsh finishes. Dun seed type but, unlike other varieties in this category, seeds are round (no dimples) and light brown–red in colour (not green–brown). Distinctive pink flowers, semi-leafless, medium in height, erect vigorous growth. Flowers seven days later than Parafield, and 10–14 days later than Excell. Non-shattering pods (sugar pod) a distinct advantage at maturity, reducing or totally eliminating any seed losses. Susceptible to new Kaspa strain of downy mildew; very susceptible (VS) to bacterial blight, S to powdery mildew, PSbMV and blackspot. An EPR of $2.20/tonne applies.

Table 57. Variety characteristics and reaction to diseases

Variety	PBR	Standing at maturity	Leaf type	Height	Maturity	Shatter resistance	Disease			Seed size (g/100 seeds)	North		South	
							Bacterial blight[#] (*Pseudomonas syringae* pv *syringae*)	Downy mildew (Parafield strain)	Powdery mildew		Yield as a % of Yarrum 2011–2015		Yield as a % of Kaspa 2011–2015	
											East 1.33 t/ha	West 1.78 t/ha	East 2.00 t/ha	West 1.45 t/ha
Kaspa type dun field peas														
Kaspa	Yes	4	SL	M	8	R	S	MR	S	22	77 (3)	88 (14)	**100 (22)**	**100 (25)**
PBA Gunyah	Yes	4	SL	M	5	R	S	R	S	22	87 (3)	97 (12)	104 (18)	108 (21)
PBA Twilight	Yes	4	SL	M	4	R	S	R	S	22	88 (3)	98 (12)	102 (18)	107 (21)
PBA Wharton	Yes	4	SL	M	5	R	S	R	R	23	108 (3)	107 (14)	105 (22)	114 (25)
Dimpled type dun field peas														
Morgan	Yes	3	SL	T	9	MR	MR	R	S	18	n.d.	85 (11)	95 (17)	100 (13)
Parafield	No	2	C	T	7	MR	MR–MS	S	S	23	n.d.	n.d.	92 (7)	97 (9)
PBA Coogee	Yes	2	C	T	8	MR	MS–MR	–	R	20	n.d.	n.d.	n.d.	n.d.
PBA Oura	Yes	4	SL	M	5	MR	MR	MR	S	22	94 (3)	101 (14)	106 (22)	115 (25)
PBA Percy	Yes	2	C	T	5	MR	R	S	S	23	83 (3)	96 (14)	106 (20)	114 (19)
Yarrum	Yes	4	SL	M–S	5	MR	MR–MS	S	R	22	**100 (3)**	**100 (10)**	102 (11)	103 (9)
Blue field peas														
Excell	No	6	SL	M	6	S	S	MR	S	22	n.d.	n.d.	n.d.	94 (4)
Maki	Yes	4	SL	M	3	MS	S	MR–MS	R	22	103 (3)	99 (6)	97 (5)	103 (5)
White field peas														
CRC Walana	Yes	4	SL	M	3	MS	–	–	R	18	109 (3)	109 (6)	103 (5)	110 (5)
PBA Hayman	Yes	3	C	T	9	MR	MR	MR–R	R	13	n.d.	n.d.	n.d.	n.d.
PBA Pearl	Yes	5	SL	M	4	MR	MS	R	S	22	96 (3)	102 (14)	112 (22)	119 (25)
Sturt	Yes	2	C	T	5	MR	MR–MS	MS	S	19	n.d.	93 (8)	106 (17)	115 (17)
SW Celine	Yes	5	SL	M	4	MR–MS	S	MR–MS	S	22	n.d.	98 (4)	107 (8)	108 (7)

Yield results are a combined-across-sites analysis using NSW DPI, PBA and NVT yield trials from 2011–2015.

Number of trials in brackets ( ). n.d. = no data

[#] Resistance only demonstrated to the bacterial blight pathovar *Pseudomonas syringae* pv *syringae*.

Standing: 1–9 (1 = flat on ground, 9 = erect)
Leaf type: C = Conventional; SL = Semi-leafless
Height: T = Tall; M = Medium; S = Short.
– = Unknown or no data available.

Shatter resistance and disease resistance ratings: R = Resistant; MR = Moderately resistant; MS = Moderately susceptible; S = Susceptible

Maturity: 1 to 9 (1 = early, 9 = late); less than 5 best for crop-topping.

Maki.[Φ] Released in 2008 by the University of Sydney, Narrabri; licensed to Australian Grain Technologies (AGT Seeds). Blue pea with green cotyledons, white flowered, semi-leafless and short–medium plant height. Good resistance to seed bleaching and mid maturity. Resistant (R) to powdery mildew and PSbMV, tolerant (T) to downy mildew and MR–R to BLRV; S to black spot, bacterial blight and downy mildew in disease-prone areas. Potential for niche human consumption blue pea market. An EPR of $4.40/tonne applies.

Morgan.[Φ] Released in 1998 by NSW DPI; licensed to Hart Bros Seeds. Original cross made in Victoria, selected in NSW. Tall semi-leafless dun type with excellent vigour and bulky upright growth habit. Late flowering, purple flowered with dimpled, dun-coloured seed. Seed size approximately 25% smaller than PBA Percy. Moderately resistant to bacterial blight; S to black spot, PSbMV, powdery mildew and downy mildew. Very competitive with weeds; best choice for hay, forage, silage and green/brown manure; lodges at maturity. Holds up well in dry seasons and tight finishes because of its height. No EPR applies.

Parafield. Released in 1998 by SARDI. Public variety with no marketing restrictions. Now largely outclassed and very little if any grown. Conventional tall, scrambling dun type, high yield potential with broad adaptation, but has largely been replaced by Kaspa. Seed and plant appearance similar to the older variety Dundale, but flowers later and seed size larger and more dimpled. Moderately susceptible to bacterial blight; S to black spot, PSbMV, powdery mildew and downy mildew. No EPR applies.

PBA Coogee.[Φ] Released in 2013 by Pulse Breeding Australia; licensed to Seednet. Conventional, trailing-type dun pea similar to PBA Percy and Parafield. It has not performed any better than these varieties in NSW and is unlikely to be widely grown. Long season variety that flowers mid to late season. Pod set is rapid and maturity time is significantly later than PBA Percy. Resistant to powdery mildew. Higher tolerance to soil boron and salinity compared with Kaspa and Parafield. Moderate resistance to bacterial blight; moderately susceptible (MS) to blackspot and BLRV. Ratings for downy mildew (both strains) and PSbMV unknown at time of publication. Produces a medium size, dimpled dun type grain with a greenish brown seed coat. Grain is marketed as 'Australian dun type' which is suited to human consumption markets (e.g. dhal or roasted snack food). It can also be marketed for pea sprouting as tendrils have leaflets present, or as stockfeed. An EPR of $2.86/tonne applies.

PBA Gunyah.[Φ] Released in 2010 by Pulse Breeding Australia; licensed to Seednet. Higher yielding Kaspa type adapted to the low and medium rainfall zones of southern and central west NSW. Similar plant type to Kaspa with distinctive pink–white flowers, semi-dwarf and semi-leafless plant habit, medium height and early vigour. Starts flowering about five days earlier than Kaspa. Longer flowering duration than PBA Twilight or Kaspa, particularly in shorter growing seasons. Matures earlier than Kaspa. Sugarpod trait, resistant to pod shattering at maturity. Disease resistance similar to Kaspa. Resistant to Parafield strain of downy mildew but S to Kaspa strain of downy mildew, powdery mildew, bacterial blight, PSbMV and blackspot. Produces a dun seed with spherical (nondimpled) grain, marketed as a 'Kaspa type' to suit Indian subcontinent human consumption requirements. An EPR of $2.75/tonne applies.

PBA Hayman[Φ] Released in 2013 by Pulse Breeding Australia; licensed to Seednet. Very late forage type of field pea for hay or silage production or for green or brown manuring. Adapted across all cropping zones but not recommended for grain production because of very low yields. High biomass production in spring similar to Morgan. Semi-erect growth habit with multi branched long vines. Very late flowering and maturity – later than Morgan; as such it should be sown earlier than optimal times for other grain varieties. There could also be an increased risk of insect pests and disease due to later maturity. Resistant to powdery mildew; MR to bacterial blight and Parafield strain of downy mildew; MS to blackspot. Produces small pods and very small, white-soft seeded grain. Grain is suitable for stockfeed if harvested, but yields are likely to be 30–80% of a normal field pea crop. No EPR applies; a breeder royalty is included in the price of the seed.

PBA Oura.[Φ] Released in 2011 by Pulse Breeding Australia; licensed to Seednet. Broadly adapted across all major field pea production regions; performs relatively well in short growing seasons and low-rainfall climates. Recommended for bacterial blight prone regions. Erect semi-dwarf, semi-leafless type with vigorous early growth, medium height and purple flowers. Early–mid flowering (earlier than Kaspa) and early maturing. Suitable for crop-topping in long seasons. Fair to good lodging resistance and moderate pod shatter resistance at maturity. Moderately resistant to bacterial blight (*P. syringae* pv *syringae*) and the Parafield strain of downy mildew but S to Kaspa strain of downy mildew, powdery mildew, blackspot and PSbMV. Produces a medium size, dimpled dun-type grain, light green in colour, similar in size to Kaspa. Grain is marketed as 'Australian dun type', which is exported to the Asian subcontinent to produce dhal (splits) and pea flour, and also sold for stockfeed. An EPR of $2.86/tonne applies.

PBA Pearl.[Φ] Released in 2012 by Pulse Breeding Australia; licensed to Seednet. Broadly adapted across all major field pea production regions and is the highest yielding variety in the south-eastern and south-western production regions of NSW. Semi-leafless, semi-dwarf erect growing variety with white flowers. Early to mid-season flowering (10 days earlier than Kaspa and similar to Sturt) and early maturing (earlier than Sturt). Ideally suited to crop-topping due to early maturity. Superior lodging resistance compared with other semi-dwarf varieties, moderate resistance to pod shattering. Resistant to the Parafield strain of downy mildew and BLRV; MS to bacterial blight and blackspot; S to powdery mildew and PSbMV. Produces medium–large spherical white pea seed (larger than Sturt) suitable for human consumption or stockfeed markets. Recommended for regions where growers can deliver white pea seed for export or for domestic sale. An EPR of $2.97/tonne applies.

PBA Percy.[Φ] Released in 2011 by Pulse Breeding Australia; licensed to Seednet. Broadly adapted across all major field pea production regions; performs relatively well in short growing seasons and low-rainfall zones. Recommended for bacterial blight-prone regions. Conventional type with vigorous early growth, tall height and purple flowers. Very early flowering (about a week earlier than PBA Oura) and early maturing. Suitable for crop-topping in long seasons. Lodges at maturity but moderate pod shatter resistance at maturity. Excellent R (better than PBA Oura) to bacterial blight (*P. syringae* pv *syringae*) but S to both the Parafield and Kaspa strain of downy mildew, powdery mildew, blackspot and PSbMV. Produces a very large, dimpled dun type grain, tan–green in colour similar to Parafield. Grain is marketed as 'Australian dun type', which is exported to the Asian subcontinent for dhal production (splits) and pea flour, and also sold for stockfeed. An EPR of $2.86/tonne applies.

PBA Twilight.[Φ] Released in 2010 by Pulse Breeding Australia; licensed to Seednet. Higher yielding Kaspa type adapted to the lower rainfall, short season climates of southern and central west NSW. Similar plant type to Kaspa with distinctive pink–white flowers, semi-dwarf and semi-leafless plant habit, medium height and early vigour. Starts flowering about a week earlier than Kaspa. Shorter flowering duration than PBA Gunyah but longer than Kaspa, particularly in shorter growing seasons. Matures earlier than Kaspa. Sugarpod trait, resistant to pod shattering at maturity. Disease resistance similar to Kaspa: R to the Parafield strain of downy mildew but S to the Kaspa strain of downy mildew, powdery mildew, bacterial blight, PSbMV and blackspot. Produces a dun seed with spherical (non-dimpled) grain, marketed as a 'Kaspa type' to suit Indian subcontinent human consumption requirements. An EPR of $2.75/tonne applies.

PBA Wharton.[Φ] Released in by Pulse Breeding Australia in 2013; licensed to Seednet. Kaspa-type pea, well suited to all field pea production regions of NSW, including central and northern NSW, due to both powdery mildew and virus resistance. This variety is well positioned to replace Kaspa, PBA Gunyah and PBA Twilight across all production regions of NSW. Similar plant type to Kaspa with a semi-leafless erect growth habit and distinctive pink–white flowers. Early to mid-season flowering (similar to PBA Gunyah but flowers five days earlier than Kaspa) and early maturing. Sugar-pod trait, resistant to pod shattering at maturity. Has broader disease resistance than Kaspa by combining disease resistance to powdery mildew and the viruses PSbMV and BLRV with higher soil boron toxicity tolerance; R to the Parafield strain of downy mildew but S to the Kaspa strain of downy mildew and blackspot. Like Kaspa, is VS to bacterial blight. Produces a medium size, non-dimpled, tan coloured seed. Grain is marketed as a 'Kaspa type' to suit Asian subcontinent human consumption requirements (dhal, flour and roasted snack foods). An EPR of $2.86/tonne applies.

Sturt.[Φ] Released in 2005 from the Australian Coordinated Field Pea Improvement Program. Conventional tall plant type, scrambling growth habit, early to mid-season flowering; small, smooth white seeds. Still one of the most adapted and highest yielding peas in the drier production areas of south western NSW. MR–MS to bacterial blight; S to black spot, PSbMV, powdery mildew and downy mildew. No EPR applies.

SW Celine.[Φ] Released in 2007 by Access Genetics; commercialised under licence to Nuseed. Semi-leafless white pea with medium height, white flowers and a short–medium upright growth habit. Early flowering, similar to PBA Oura but two weeks earlier than Kaspa. It is the earliest maturing of the current commercial pea varieties, making it ideally suited to quick finishing seasons and crop-topping. SW Celine does not carry the shatter resistant sugar-pod character of Kaspat ype varieties, therefore care is needed at harvest. Medium/large white round seed. Susceptible to powdery mildew; MR–MS to downy mildew. An EPR of $3.30/tonne applies.

Yarrum.[Φ] Released in 2003 by University of Sydney, Narrabri; licensed to AGT Seeds. Extensive testing has shown Yarrum to be a consistently high yielding commercial line across both northern and southern NSW. Dimpled dun pea, purple flowered, semi-leafless, medium height. Late flowering but fills pods and finishes quickly. Erect growth but tends to lodge at maturity. Resistant to powdery mildew; R to PSbMV; good level of R to BLRV; MR–MS to bacterial blight; S to black spot and downy mildew. An EPR of $4.40/tonne applies.

Weed control

Field pea provides valuable management strategies for integrated weed management and has unique features to assist weed control in the cropping rotation. These include a relatively late sowing window compared with other crops; the availability of competitive varieties such as Morgan; and the availability of earlier maturing varieties such as Maki, PBA Oura, PBA Twilight and SW Celine that enable crop-topping to be synchronised with maturity. Field pea has the widest range of herbicides available for broadleaf weed control of any pulse crop. There is a number of soil-applied residual herbicides registered, which provide an excellent opportunity to use alternative herbicides as part of a herbicide resistance management program. They might also be more cost effective than post-emergent herbicide options for weed control.

As residual herbicides applied to the previous cereal crop can affect field pea establishment and growth, refer to current pesticide labels for information on plantback periods.

For detailed information on registered herbicides, refer to the NSW DPI guide *Weed control in winter crops* and pesticide labels.

Insect control

Redlegged earth mite, blue oat mite and lucerne flea – Monitor these pests closely from emergence up to the 4 node stage. If crop damage becomes apparent, undertake appropriate control measures.

Aphids – Monitor for aphids from the early establishment stage. High numbers of aphids, particularly pea aphids (*Acyrthosiphon pisum*) can cause feeding damage and yield loss. Controlling aphids could be more important for reducing certain viruses that are persistently transmitted than actual feeding damage.

Pea weevil – This pest is a continuing problem in most areas. Be careful not to introduce it onto the farm as an impurity in purchased seed or any other seed containing field pea. Monitor crops at least weekly from flowering through to early pod set for pea weevil adults. Apply a border spray of insecticide if pea weevils are found, or if you know that you are in a pea weevil area. Fumigate all seed with phosphine in a sealed silo soon after harvest to destroy any pea weevil that might be present or developing in the grain.

On farm problems can be reduced by:

» harvesting promptly
» fumigating carry over seed soon after harvest
» controlling all self-sown field pea in following crops.

For further information, see **Pulse Point 4 –** *Managing Pea Weevil*.

Helicoverpa spp. (Heliothis) – Most crops require spraying during late flowering and pod filling and should be checked at least twice a week during this time. The spray threshold for human consumption grade is 1–2 larvae per 10 sweeps, and for stockfeed, 4 or more larvae per 10 sweeps. One well-timed early spray before larvae get too large (10 mm) is generally adequate. However, control can be very difficult once larvae enter the pods if not detected early. Monitor crops after spraying to determine effectiveness.

For detailed information on insecticides, refer to the **NSW DPI guide** *Insect and mite control in field crops.*

Disease management

The impact of disease on field pea production can be minimised by sowing disease- and virus-free seed; by planning sensible crop rotations (not growing field pea in the same paddock more than once every five years); eliminating volunteer field pea plants; and not sowing near, or immediately downwind of, the previous season's field pea paddock. The following diseases have the potential to cause severe yield losses.

Bacterial blight – This disease is very sporadic and often unpredictable. It is caused by the bacterium *Pseudomonas syringae*. There are two pathovars (pv) of *P. syringae* found in NSW, *P. syringae* pv *pisi* and *P. syringae* pv *syringae*. Frost damage followed by wind and frequent rain encourages the disease to develop and spread. This highly infectious disease can be easily spread by movement of machinery, people and animals through the crop. There are currently no post-emergence control options available to manage bacterial blight outbreaks.

P. syringae bacterium can survive on both seed and infected plant material; the main means of disease transmission to new crops. Therefore, seed harvested from infected crops should not be used for sowing. Also note that wind and water can move pea stubble to adjacent paddocks and should be closely monitored, as should movement through stubble baled for hay, as these are a ready source of infective bacteria. Finally, note that crops having no obvious signs of disease can still carry the bacteria at low levels.

Bacterial blight will often develop in frost-prone, low-lying areas first. Be aware that frost events can trigger development of this disease and check these areas first for symptoms. Avoid sowing field pea crops in paddocks prone to frequent frost events.

Operations favouring rapid breakdown of pea trash can greatly reduce the bacterium's length of survival. Controlling volunteer pea plants is equally important to control this disease between seasons. Survival can be up to three years on seed in storage.

Field pea variety screening for bacterial blight is regularly undertaken at Wagga Wagga in NSW for the Pulse Breeding Australia – Field Pea Breeding Program. Field pea breeding lines showing good field tolerance to *Pseudomonas syringae* pv *syringae* have been identified as part of this screening program under conditions of high disease pressure. The varieties PBA Oura and PBA Percy were released in 2011 with significantly improved resistance to *Pseudomonas syringae* pv *syringae*. In the older varieties, Morgan, Parafield, Sturt and Yarrum display the best field tolerance.

Reports were received of isolated outbreaks of bacterial blight in central and southern NSW in 2015. Despite cool daytime winter temperatures, there were few severe frost events. Frost events in July and August triggered disease outbreaks in some commercial crops. Crops sown into heavy cereal straw and/or low lying paddocks appeared to be the worst affected. Growers should be aware that field peas sown early for green or brown manuring are prone to develop bacterial blight.

Traditionally, major outbreaks of bacterial blight in NSW result from early frosting coinciding with wet conditions. Management factors that favour a bacterial blight outbreak include sowing field pea crops early, sowing infected seed, and new season crops coming into contact with infected pea straw. More recently it appears that crops sown into a thick covering of cereal straw under the crop (not standing cereal stubble) and into heavy textured soils can develop bacterial blight more readily.

Kaspa, one of the most popular varieties, is also one of the most susceptible to bacterial blight. The safest strategy is to only grow the more resistant varieties and only use seed from crops inspected to be visibly free of symptoms. A seed test is available to detect for presence of the bacteria. Under conditions favouring disease development, even very low levels of seedborne bacterial blight can lead to the development of an epidemic.

Blackspot and Septoria blotch – These two fungal diseases regularly infect pea crops in southern and central NSW. In wetter years and in high rainfall production zones, yield losses of 10–30% are common. Drier growing conditions may have reduced the impact of these diseases in recent years, but under ideal conditions these diseases can develop quickly,

even from very low levels of disease in the previous year. Cool winter conditions, with frequent rainfall events help blackspot to build up and disperse. Winter conditions in 2015 were ideal for this disease, but the drier spring kept potential disease levels low. The impact of blackspot and Septoria blotch can vary with proximity to old field pea stubble and paddock rotation history. Using a fungicidal seed dressing, crop rotation and separation from last year's field pea stubble by at least 500 m will reduce disease potential. In recent years, blackspot has been observed at high levels in some districts, mainly in field pea crops sown early for manuring. Dry summer conditions in combination with early sowing opportunities and wet winter conditions favour a disease epidemic developing.

Downy mildew – This disease can develop quickly when conditions are cool (5–15 °C) and wet for 4–5 days, often when field pea crops are emerging and in the early vegetative stage. Winter conditions in 2015 were ideal for this diseas to develop. Heavy dews will promote spore production, and rain splash is the main means of disease dispersal within a crop. The disease is caused by the fungus *Peronospora viciae*, which can survive in soil, on old field pea trash and also on seed. The most notable symptom of downy mildew is the appearance of stunted, yellowish pale-green seedlings within a crop, which have fluffy grey spore masses on the underside of infected leaves. Heavy infection can stunt plants early and kill seedlings if favourable conditions continue. Warm, dry weather is unfavourable for disease development. Downy mildew can impair wax formation on leaves, rendering field pea plants more susceptible to post emergent herbicides. The most effective means of managing the disease is by growing resistant varieties. Varieties such as Morgan, Excell and Kaspa have useful resistance. However, a new strain of downy mildew was identified in South Australia in 2008 that can overcome the resistance contained in many field pea varieties. This strain has not yet been detected in NSW. Other methods of managing downy mildew include using fungicide seed dressing containing metalaxyl, crop rotation (at least four years between field pea crops) and separating this year's field pea crop from last year's field pea paddock.

Powdery mildew – This disease can cause yield losses and occurs more frequently in the drier areas of the central and northern wheat belt, generally towards the end of the season. Mild day temperatures and cool nights with dew formation favour the disease. Varietal resistance is the best method of control. All three newer varieties: PBA Coogee, PBA Hayman and PBA Wharton, as well as the older varieties CRC Walana, Maki and Yarrum, carry a powdery mildew resistance gene that provides complete protection against this disease. Other currently commercially available varieties are susceptible to varying degrees. Foliar fungicides can be used to manage the disease in more susceptible varieties.

Virus diseases

Several virus species cause disease in field pea and other pulses. As symptoms caused by virus infection can be easily confused with those caused by environmental stresses, expert advice should be sought to correctly identify the virus. All the important pulse viruses are aphid transmitted and most need to survive in living plants between cropping seasons. Control strategies for virus diseases can only be preventive as infected plants cannot be cured. Not enough is known about virus and vector epidemiology in NSW to recommend economic control of aphid vectors. Following the recommended crop management guidelines will reduce the risk of virus infections, as poorly growing crops and plants are more prone to infection. Aphid vectors are most active during the warmer periods of autumn and spring. Sowing crops early in virus-prone areas should be avoided so that plants can escape autumn infections. Plant resistance is the best defence against virus infection and Pulse Breeding Australia's field pea breeding program is making rapid progress in developing varieties with adequate resistance to the most important field pea viruses.

Pea seedborne mosaic virus (PSbMV) – PSbMV survives between seasons in infected seed. The virus is found wherever susceptible pea varieties are grown and infected seed has been sown. PSbMV reduces yields and can, depending on the plant's growing environment, cause markings on the seed. Seed lots with high levels of seed infection have lower levels of plant emergence and seedling vigour. Evaluation of commercial seed lots harvested in 2005 and 2007 in southern NSW showed infection levels of up to 30% in some lots sown with Kaspa and Excell. A field survey in 2006 highlighted the importance of seed infection; crops sown with clean seed had low levels of PSbMV, while neighbouring paddocks sown with infected seed showed severe infection. Growers are advised to have their seed tested and not to use seed lots with infection levels greater than 1%. Among the currently available varieties, PBA Wharton, CRC Walana, Maki and Yarrum have resistance to PSbMV.

Bean leafroll virus (BLRV) – BLRV infection results in leaves yellowing and stiffening. BLRV can cause severe yield losses and, with early infection, stunting and plant death. The virus survives between seasons on pasture legumes and lucerne. Higher levels of infection are generally found in the higher rainfall cropping zones or in the vicinity of irrigated lucerne paddocks. The varieties Kaspa and Excell are highly susceptible to BLRV and should not be grown in virus-prone areas. Of the current varieties, PBA Pearl, PBA Wharton and Yarrum have good resistance, and CRC Walana and Maki have adequate BLRV resistance, whilst a number of other breeding lines with good BLRV resistance are in advanced testing.

Table 58. Field pea variety disease guide

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Seedling Disease				
Damping off *Pythium* spp., *Rhizoctonia* spp.	Seedlings collapse within a few days of emergence. Stem/taproot near ground level sunken, water soaked.	Cool, wet, poorly drained soils. Late sowing leading to slow germination.	Spores survive in soil for extended periods. Wide host range among other broadleaf crops.	Sow on time into well-drained soils. Treat seed with fungicide seed dressing. Cultivate below seed sowing depth.
Root diseases				
Foot rot *Phoma medicaginis* var. *pinodella* *Mycosphaerella pinodes*	Purplish-black rot of lower stem. Black rot of upper tap root.	Cool, damp weather. Paddocks with a recent field pea history or adjacent paddocks.	Survives on infected pea trash and as spores in soil for several years. Also seed-borne at low levels.	Crop rotation – 4 years between pea crops and avoid sowing into paddocks adjacent to last year's field pea crop.
Root rots *Pythium*, *Rhizoctonia* and *Fusarium* spp.	Dark brown, girdling lesions on taproot and lateral roots. Patches of stunted plants within crops.	Wet, poorly drained conditions. Variable moisture.	Survives in soil and on plant debris.	Crop rotation – 4 years between field pea crops. Aim to sow on time. Avoid poorly-drained paddocks.
Foliar diseases				
Black spot complex *Mycosphaerella pinodes*, *Ascochyta pisi*, *Phoma medicaginis* var. *pinodella*	Dark brown to black spots on leaves, with reddish/purplish margin, often with an irregular outline. Girdling of lower stem and tendrils with a dark lesion. Bluish-black sunken spots on pods.	Cool, wet conditions. More severe on early-sown crops.	Spores survive in soil and plant debris. Spread by rain splash and wind-blown rain.	Avoid early sowing. Crop rotation – 4 years between field pea crops and avoid sowing into paddocks adjacent to last year's field pea crop.
Septoria blotch *Septoria pisi*	Spreading, light brown, angular leaf lesions containing very small, dark brown to black spots. Tends to appear on moisture-stressed crops in spring.	Cool, wet weather. More severe on early-sown crops.	The fungus survives on infected plant debris and can be seed-borne at low levels.	Avoid early sowing. Crop rotation – at least four years between pea crops and avoid sowing into paddocks adjacent to last year's field pea crop.
Sclerotinia wilt *Sclerotinia sclerotiorum*	White, cottony fungal growth on aerial parts of plants. Plants wilt. Sclerotia of fungus form on plant surfaces and inside stems.	Cool–mild humid conditions following rain in spring. Worse in dense crops.	Survives as resting sclerotia in soil. Sclerotia germinate in spring and infect with airborne spores.	Difficult because of wide host range and long survival in soil – 10 years. Avoid sowing consecutive broadleaf crops.
Downy mildew Peronospora viciae	Thick, grey–brown fungal growth on lower leaf surface. Upper leaf surface turns yellow above growth on lower surface. Leaf death.	Favoured by cool, moist conditions. Rarely causes economic damage.	Survives on plant debris and soil. Spores spread by wind.	Crop rotation. Grow resistant varieties.
Powdery mildew *Erysiphe polygoni*	White, powdery growth on upper leaf surface. Leaf withering. Poor seed-set in late pods.	Warm, humid (but not wet) weather. More likely when sowing is late or on late-maturing varieties.	Over-summers on infected pea trash or volunteer plants. Spores blown by wind into new crops.	Crop rotation. Grow resistant varieties. Foliar fungicides in susceptible varieties. Burn or incorporate infected crop residue after harvest.
Bacterial disease				
Bacterial blight *Pseudomonas syringae* pv *pisi* *Pseudomonas syringae* pv *syringae*	Fan-shaped, water-soaked lesion spreading into the leaf from the base. Dark brown, spreading stem lesions. Sometimes a sheen on the lesion when dry.	Frost events followed by cool, wet weather.	Infected seed. Infected crop debris. Easily spread in crop by machinery, people and animals.	Crop rotation. Seed testing. Do not keep seed from infected crops for sowing. Use newer resistant varieties.
Major virus diseases				
Bean leafroll virus (BLRV), **Soybean dwarf virus** (SbDV, syn *Subterranean clover redleaf virus*).	Yellowing or sometimes reddening, stunting, leaf stiffening, premature death.	Areas prone to aphid flights. Can be very damaging, occasionally causing complete crop loss.	Survives in legumes including lucerne, subterranean clover and medic. Spread by aphids.	Follow best management recommendations including retaining standing stubble to deter aphids from landing in the crop.
Pea seed-borne mosaic virus (PSbMV)	Commonly symptomless. Can show leaf mosaic, stunting, pod abortion, seed markings.	Has the potential to reach high incidence in all districts.	Source is usually infected seed. Spread within crops by aphids.	Use seed that has been tested and found to be free of PSbMV. Grow resistant varieties.
Cucumber mosaic virus (CMV), *Alfalfa mosaic virus* (AMV)	Mosaic, mottle or yellowing along leaf veins. Early infection can results in stunting, stem necrosis and premature death.	Uncommon in the major pea growing areas.	Range of weed and pasture spp. AMV also in lucerne. Spread by aphids.	Follow best management recommendations including retaining standing stubble to deter aphids from landing in the crop.

Desiccation and harvest

Desiccation – This harvest aid is the early chemical termination of plant growth strategically timed when field pea pod and seed development has physiologically finished so as not to compromise grain yield. Desiccation advances pea maturity and harvest by up to 10 days, reducing problems caused by uneven ripening and/or late weed growth. Earlier harvest improves both yield and quality, particularly when starting at a higher seed moisture content. Soil and weed seed contamination in the grain sample can be reduced. Desiccation also doubles up as a spray-topping operation to prevent seed set in weeds, provided timing is targeted at the correct stage of the weed.

Field pea crops can be desiccated using glyphosate (540 g/L) or diquat (200 g/L). Ensure that harvest WHP is observed according to the label of the product used (e.g. seven days for glyphosate products; nil for diquat products). Crops desiccated with glyphosate should not be kept for planting seed as it reduces seed viability.

Timing of desiccation – Note and record the end-of-flowering date and, from then on, start regular monitoring every few days for changes in pod colour, and particularly seed developmental and colour changes within the pod. From the end of flowering, days to desiccate vary enormously depending on the length of the spring and finishing conditions, but should occur within 3–4 weeks. Desiccate when the lower three quarters of pods along the stem are brown; seeds are firm, rubbery, and split, rather than squash, when squeezed; and the shells are thin and leathery. Pea pods mature from the lowest flowering node upwards. Many plants at this stage can still have green tips.

Seed moisture changes can also be monitored. Desiccate when seed moisture drops to around 30%. To collect seed for this, randomly pick 10–20 stems or more across the paddock. Further information on desiccation timing can be found in **Pulse Point 5,** *Desiccation & harvest of field pea*.

Harvest – Normally occurs well before wheat is ready and should start as soon as seed moisture falls to 14% to maximise yield. Delayed harvest leads to seed quality loss; harvest clashes with other crops; greater soil contamination; increased pod shattering; pea weevil emergence in the field; problems with late weed growth; more severe crop lodging; and increased vulnerability to late rain and hail damage. The important message is to plan to start harvest early.

Rolling after sowing reduces rock and clod pick up at harvest. Crops sown into cereal straw have considerably less soil contamination in the grain sample. Use contour-following crop lifters. Seed to be kept for sowing should be harvested first, when moisture content is higher and header damage is least. Minimise subsequent handling to reduce seed cracking and splitting.

Marketing

The domestic stockfeed industry continues to be the main user of field pea produced in NSW, as supply and grain quality over the last few years has been erratic from drought conditions or wet weather at harvest reducing yields. Dun field pea continues to be the most robust of the pea types, with both food- and feed-market opportunities. They still remain the preferred field pea type to be exported to Asia and the Indian subcontinent. The smooth, nondimpled Kaspa-type varieties PBA Gunyah, PBA Twilight and PBA Wharton can attract a small premium in human consumption export markets, but quality is an ongoing issue, particularly with damage from pea weevil and heliothis grubs, and the amount of dirt in samples.

The recent erratic supply of Australian white field pea has hampered the development of overseas markets, with the main competitor, Canada, producing large quantities of quality white field pea. The domestic stockfeed industry has been the major consumer of white field pea and this is expected to continue until more stable production occurs to allow export markets to be supplied on a continuing basis.

The Australian blue pea crop supplies a small niche domestic market and a few niche export markets. Quality is vital. Colour bleaching, pea weevil, heliothis grub damage and contamination from other pea types are major problems that need to be carefully managed by growers.

The current marketing specifications for the different grades of field peas can be found on the Pulse Australia website.

Further information

NSW DPI

Weed control in winter crops (NSW DPI, 2015)

Insect and mite control in field crops (NSW DPI, 2013)

Pulse Point 4, *Managing pea weevil* (3rd edition)

Pulse Point 5, *Desiccation & harvest of field pea* (2nd edition)

Pulse Point 7, *Reducing disease risk*

Pulse Point 13, *Strategies to minimise bacterial blight in field pea*

Pulse Point 14, *Powdery mildew in field peas: A growers guide to management*

Pulse Point 20, *Germination testing and seed rate calculation*

Field pea: Western NSW planting guide

Pulse Australia

2015–16 Pulse Trading Standards

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NVT apps

National Variety Trials
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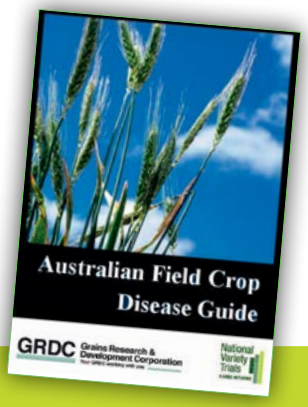

The NVT LONG-TERM YIELD REPORTS provide Australian growers and advisers with the best available tool for making variety selection decisions based on crop yield. Information is available for all cropping regions in Australia for 10 crops: wheat, barley, canola, oats, triticale, chickpeas, field peas, faba beans, lentils and lupins.

The CROP DISEASE AU application has been developed by the Australian National Variety Trials program (NVT) and funded by the GRDC. It provides access to up-to-date variety information from the NVT database, as well as current disease-resistance ratings, disease information and an extensive disease image library.

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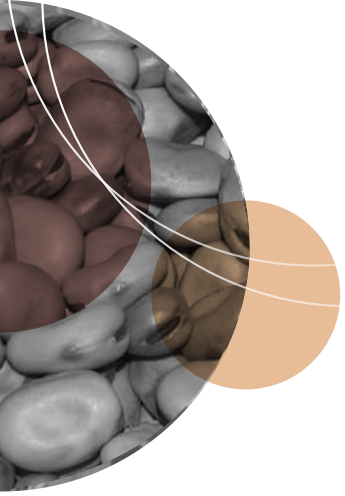

Lupin

Lupin is a profitable pulse crop well suited to lighter soil types in central and southern NSW. Lupin has many advantages in both cropping and mixed cropping-livestock farming systems. It can be used to extend cereal crop rotations by acting as a break crop (non-host) for cereal diseases. Other benefits include significant nitrogen contribution for subsequent crops, improved soil structure, and alternate weed control options to delay or reduce the incidence of herbicide resistance. Lupin also provides a high protein grain that can be valuable as part of a profitable livestock enterprise.

Two species of lupin, narrow-leaf (*Lupinus angustifolius*) and albus (*L. albus*), are widely grown. Narrow-leaf lupin tolerates moderately acid soils (pH_{Ca} 4.2–6.0) and high levels of exchangeable aluminium (up to 20%) and manganese. However, its growth and development (and survival of rhizobia) can be affected when soil pH_{Ca} drops below 5.0. Albus lupin is less tolerant of acid soils than narrow-leaf lupin (but more so than canola or wheat) and can accumulate high manganese levels in the grain when grown in high manganese soils. Both species are sensitive to soils containing free lime (bicarbonate). High pH soils can be tolerated provided free lime is not present. High pH soils can reduce nodulation as symbiosis with rhizobia is impaired. Albus lupin is more susceptible to waterlogging than narrow-leaf lupin.

Albus lupin averages 5–15% higher yields than narrowleaf lupin under high rainfall conditions.

Be aware of seed import quarantine restrictions into NSW due to the foliar disease Anthracnose. This disease has not been identified in commercial crops in NSW.

Sowing

Direct drilling lupin into cereal stubble is a successful crop establishment method. Stubble conserves soil moisture, reduces brown leaf spot incidence and also reduces aphid infestations, minimising virus infection and transfer.

Dry sowing lupin is an option with grower experience showing it to be successful in establishing crops on time (**see Pulse Point 6**, *Dry sowing*). Dry sowing can be difficult on virgin lupin paddocks where inoculation will be required and rhizobia survival could be poor. New granular inoculants might help in this regard.

Aim to sow at a depth of up to 5 cm. Albus lupin have a much larger seed than narrow-leaf types – if the soil moisture is marginal then albus seeds are at greater risk of not imbibing enough water, resulting in false germination. Deeper sowing into warmer soils (moisture seeking) can be a successful method to allow earlier sowing, but is risky, especially with larger-seeded albus. Low vigour seed and sowing late into soils with low temperatures results in poor establishment and often crop failure, especially in albus lupin.

Sowing time

All current lupin varieties are susceptible to frost damage. Lupins are most vulnerable during the reproductive phase, which occurs once they initiate stem elongation. Frost damage risk can be reduced by not sowing varieties earlier than the recommended sowing window to avoid flowering in July to early August. For most lupin-growing areas in southern NSW, sowing before late April with early flowering varieties such as Mandelup increases the risk of frost damage.

Seed quality

Always do a germination test on seed and adjust the sowing rate accordingly. Good seed quality is critical to achieve adequate plant density and high yields. In trials, yields increased by 20% when using high-germination seed (more than 80%) compared with low-germination seed (50%), even when the seed rate was doubled to compensate.

Headers easily damage seed as does excessive handling during harvest, grading and sowing. Rotary headers cause less damage. Seed that is to be kept for sowing should be harvested as soon as seed moisture content reaches 14%. Use a low header drum speed and open the concave; and minimise subsequent handling.

Test germination in a laboratory or at home, counting only healthy seedlings – those with both cotyledons (seed leaves) present. Test narrow-leaf lupin seed for *Cucumber mosaic virus* (CMV) and obtain documentation of germination, seeds/kg and CMV status when purchasing seed. For further details **see Pulse Point 20**, *Germination testing and seed rate calculation*.

Table 59. Suggested sowing times for narrow-leaf and albus lupin

Week	April				May			
	1	2	3	4	1	2	3	4
Low rainfall			■	■	■	■		
High rainfall				■	■	■	■	

■ Preferred sowing time

■ Later than recommended, yield reduction likely depending on spring conditions

Bitterness in albus lupin seed

To maintain the seed quality standards for the sweet (low seed alkaloid) albus lupin industry, growers should test all sowing seed for possible bitter (high alkaloid) contamination. Bitterness seed testing for albus lupin is available through Futari Grain Technology Services, 34 Francis Street, Narrabri 2390 (phone 02 6792 4588).

The albus industry has set a zero bitter contamination level for seed to be used for sowing.

Avoid growing lupini bean (100% bitter, large seeded albus) in sweet albus production areas. These measures are to protect the most recently released 100% sweet albus varieties Luxor and Rosetta from bitter pollen contamination. Bitterness prevention in these new varieties is crucial to maintain the threshold standards set for albus for both human consumption and stockfeed use.

Only grow one albus lupin variety on the farm – discard old varieties – and keep a minimum one kilometre isolation from all other albus crops. Check with neighbours about their albus sowing intentions. If growing a small quantity of albus for seed increase, surround it with a narrow-leaf lupin crop – the agronomy is similar and the albus crop will be protected from pollen contamination by foraging honey bees. Test all sowing seed for bitterness every year, including new varieties. Do not buy any albus seed without a testing certificate showing that the seed is free from bitterness.

Sowing rate

Aim to establish 35 plants/m^2 for early sowing and up to 45 plants/m^2 for later sowings. Sowing rates will vary depending on seed size and germination percentage. Albus lupin seed rates are much higher than narrow-leaf varieties due to their large seed size. For further detail see Pulse Point 20, *Germination testing and seed rate calculation*.

Table 60. Sowing rates (kg/ha) based on 80% establishment and 100% germination

Lupin type	100 seed weight (g)	Target plant density	
		35 plants/m^2	45 plants/m^2
Narrow-leaf lupin	13	56	73
Albus lupin	35	153	197

Your calculation

100 seed weight # (grams)		target plant population		establishment percentage* × germination percentage
.....	×	.....	× 1000 ÷	.....

= your sowing rate ..... kg/ha

To determine your seed weight, weigh 100 seeds in grams.

* Establishment percentage – 90% is a reasonable estimate, unless sowing into adverse conditions.

Table 61. Variety characteristics and reaction to diseases

Variety	Flowering time	Pod loss, shatter resistance	Lodging resistance	Seed size (g/100 seeds)	Disease						North		South	
					Brown leaf spot	Pleiochaeta root rot	Phomopsis stem infection	CMV # seed transmission	BYMV #	Anthracnose resistance	Yield as a % of Mandelup 2009–2015		Yield as a % of Mandelup 2009–2015	
											East 2.01 t/ha	West 2.35 t/ha	East 2.47 t/ha	West 1.37 t/ha
Narrow-leaf														
Jenabillup	early	G	MG	14	MR	R	MS	MR	MR	MS	96 (6)	94 (16)	98 (57)	99 (8)
Jindalee	mid–late	G	G	13	MR	MR	R	MS	S	MS	87 (6)	82 (16)	84 (57)	87 (8)
Mandelup	very early	G	MP	14	MS	R	R	MR	MS	MR	**100 (6)**	**100 (16)**	**100 (57)**	**100 (8)**
PBA Barlock	early	VG	G	13	MS	R	MR	MR–R	MS	R	102 (5)	97 (13)	98 (44)	98 (7)
PBA Gunyidi	very early	VG	G	13	MS	R	R	MR–R	MS-MR	MR–R	100 (6)	93 (16)	100 (54)	99 (8)
Quilinock	early	G	MP	16	MS	R	MR–MS	MR	–	VS	91 (6)	93 (16)	94 (56)	95 (8)
Wonga	early–mid	G	MG	13	MS	S	R	R	MS	R	95 (6)	91 (16)	89 (57)	90 (7)

Albus											Yield as a % of Luxor 2008–2015		Yield as a % of Luxor 2008–2015	
											East 2.17 t/ha	West 2.21 t/ha	East 2.3 t/ha	West 1.47 t/ha
Kiev Mutant	very early	G	G	35	R	VS	R	Immune	n.d.	VS	91 (8)	96 (18)	94 (57)	91 (10)
Luxor	early	G	G	35	R	R	R	Immune	n.d.	VS	**100 (8)**	**100 (18)**	**100 (57)**	**100 (10)**
Rosetta	mid	G	G	35	R	MR	R	Immune	n.d.	VS	100 (8)	97 (18)	99 (57)	98 (10)
Ultra	very early	G	G	35	R	S	R	Immune	n.d.	VS	92 (8)	96 (18)	96 (57)	92 (10)

Yield results are a combined across sites analysis using NVT, NSW DPI and PBA yield trials from 2009–2015 (Narrow-leaf) and 2008–2015 (Albus).

Number of trials in brackets ( ). n.d. = No data.

Lodging, pod loss and shattering resistance: MP = Moderately poor; MG = Moderately good; G = Good; VG = Very good.

Disease resistance: VS = Very susceptible; S = Susceptible; MS = Moderately susceptible; MR = Moderately resistant; R = Resistant; n.d. = No data.

Data from Pulse Breeding Australia

Inoculation

Lupin requires specific rhizobium (Group G) to form active root nodules. Take care with seed inoculation techniques, especially into paddocks where lupin has not previously been grown. Adequate inoculum can persist for more than five years once established, but survival is reduced with increasing soil acidity or prolonged periods of low rainfall or drought. If the sowing seed is to be treated with a fungicide, treat first and allow the seed to dry thoroughly. Apply inoculant immediately before sowing. A number of new inoculant products are available for lupin such as freeze-dried and dry granular products – read the instructions and follow them carefully to avoid inoculation failure.

Nutrition

Phosphorus – Application rates on responsive soils should be similar to cereals to achieve optimum yields and maintain soil phosphorus (P) levels, usually 15–25 kg/ha. Responses in albus lupins are often very low or negligible to these rates of applied P. Be careful when using higher rates of high-analysis fertilisers as lupin seed is sensitive to fertiliser burn.

Wider rows and narrow tynes, which can concentrate the seed and fertiliser together in a narrow band, exacerbate the risk of fertiliser burn. Sowing into marginal moisture conditions can also increase this risk. Consider separating the seed and fertiliser by banding fertiliser below the seed where possible.

Sulfur – Fertilisers blended with a sulfur component are recommended.

Molybdenum – If soils are acid or likely to be deficient, an application every five years promotes rhizobial activity. Sodium molybdate is relatively cheap and is compatible in mixes with most herbicides.

Variety selection

Select lupin varieties depending on yield potential for your environment and resistance to diseases that cause regular problems in your area.

For characteristics and yield potential of different varieties, **refer to Table 59 Variety characteristics and reaction to diseases** in this chapter.

Narrow-leaf lupin

Jenabillup.[Φ] Released in 2007 by the Western Australian Department of Agriculture and Food (DAFWA). High yielding, medium-tall, early flowering variety. Resistant to black pod syndrome (BPS), which is a problem in cool, higher-rainfall areas of southern Western Australia. This resistance also appears to be beneficial in the eastern states when conditions favour high levels of *Bean yellow mosaic virus* (BYMV). Commercialised by Seednet, protected by PBR. An End point royalty (EPR) of $2.53/tonne applies.

Jindalee.[Φ] Released in 2000 by NSW DPI. Mid flowering, later maturing lupin variety, well suited to the medium to high rainfall areas of NSW. Improved Phomopsis stem infection resistance. Jindalee is susceptible to *Cucumber mosaic virus* and can be severely affected when sown early in seasons with high aphid populations. Marketed by Seednet, protected by PBR. An EPR of $1.38/tonne applies.

Mandelup.[Φ] Released in 2004 by DAFWA. High yielding, early maturing variety with good early vigour. Suited to the low–medium rainfall zones of NSW. Has a tendency to lodge in very high productivity situations and not generally recommended for the higher rainfall zones. Mandelup is the earliest maturing variety currently available and therefore the most suitable for crop topping. Marketed by Heritage Seeds, protected by PBR. An EPR of $2.53/tonne applies.

PBA Barlock.[Φ] Released in 2013 by Pulse Breeding Australia (PBA) in Western Australia only, to replace Mandelup and Tanjil in all WA lupin-growing zones. Compared with Mandelup, PBA Barlock is slightly later flowering and maturing, but has a shorter harvest height. It is moderately resistant to lodging in high rainfall regions and is more resistant to pod shattering than Mandelup. Resistant (R) to anthracnose. Tolerant to metribuzin (equal to Mandelup). Moderately resistant (MR) to phomopsis stem blight. Commercialised by Seednet, protected by PBR. An EPR of $2.75/tonne applies.

PBA Gunyidi.[Φ] Released in 2011 by PBA in Western Australia only, as a replacement for all varieties in the medium and low rainfall zones of WA. In NSW PBA Gunyidi yields have been marginally lower than Mandelup based on long term trial results. PBA Gunyidi has superior resistance to pod shatter and good lodging resistance, allowing later harvest without incurring significant shatter losses. Moderately resistant (MR) to anthracnose. Tolerance to the herbicide metribuzin is equivalent to Mandelup but is more susceptible to damage from Eclipse®. Commercialised by Seednet, protected by PBR. An EPR of $2.75/tonne applies.

PBA Jurien.[Φ] Released in 2015 by PBA in Western Australia. PBA Jurien is a broadly adapted high-yielding variety that is R to anthracnose, phomopsis and grey spot. It is tolerant to metribuzin (superior to PBA Barlock) with early flowering and maturity similar to other current varieties. NSW trials have shown it to be more susceptible to plant lodging than other current varieties in high rainfall areas, particularly in an early sowing and high crop biomass situations. A release decision for the eastern states will be made in March 2016. Commercialised by Seednet, protected by PBR. An EPR of $2.75/tonne applies.

Albus lupin

Luxor.[Φ] Released in 2005 by NSW DPI. Higher yielding than Kiev Mutant and Ultra. Resistant to Pleiochaeta root rot (the cause of many seedling deaths in older varieties). Luxor is 7 days later flowering than Ultra, but earlier flowering than its companion line Rosetta. Suited to the medium–low rainfall zones of NSW. Commercialised by Seednet, protected by PBR. An EPR of $3.08/tonne applies.

Rosetta.[Φ] Released in 2005 by NSW DPI. Higher yielding than Kiev Mutant and Ultra in longer season environments. Moderately resistant to Pleiochaeta root

rot. Later flowering and taller than Luxor, it is especially suited to higher rainfall areas. Commercialised by Seednet, protected by PBR. An EPR of $3.08/tonne applies.

Weed control

There is a range of herbicides to control both broadleaf and grass/cereal weeds in lupin. Sowing early with good crop establishment is essential to achieve more effective results from herbicides.

Herbicide damage causing yield losses in lupin crops has been observed from both residual herbicides applied before cereal crops and from in-crop herbicides. Plants weakened by herbicides are more susceptible to root and foliar diseases such as Phytophthora root rot, Pleiochaeta root rot and brown leaf spot.

1. **Sulfonylurea herbicides** (e.g. Glean® or Logran®) applied to preceding cereal crops. Take special note of label instructions concerning crop rotation and plant-back periods, particularly on high pH and/or compacted soils, and after prolonged periods of low rainfall or drought.
2. **Triazine herbicides** (e.g. simazine). Be aware that application rates vary significantly on different soil types. Follow label recommendations and avoid spray overlaps. Albus lupin is more sensitive to triazine damage.
3. **Clopyralid** (e.g. Lontrel®) applied to preceding cereal crops. Clopyralid can carry over in straw and affect subsequent crops.
4. **Metosulam** (e.g. Eclipse®). Damage can occur in-crop if applied beyond the recommended growth stage. Some varieties are sensitive and have narrow safety margins. Follow label recommendations.

For more detailed information on current weed control and plant-back recommendations, **refer to pesticide labels and NSW DPI guide** *Weed control in winter crops*.

Insect control

Redlegged earth mite and blue oat mite. Large mite populations are common and can cause distorted early growth and kill seedlings. The rasping of the cotyledon and leaf surface during feeding results in a distinctive silvering on the leaves. Mite damage can be confused with brown leaf spot lesions so correct identification is required before control measures are used. Early detection and control improves crop health and vigour.

Lucerne flea. Damage is common and is characterised by clear membranous windows chewed into cotyledons and leaf surfaces. Early detection and control improves crop health and vigour.

Cutworms, armyworms and pasture cockchafers. These caterpillar pests can cause sporadic damage to seedlings and young plants. Monitor crops regularly during the establishment phase and control if required.

Aphids. These insects rarely cause significant feeding damage on lupin in NSW, but can transmit viruses. Aphids are vectors of two potentially serious lupin viruses: *Cucumber mosaic virus* (CMV) and *Bean yellow mosaic virus* (BYMV). Yield losses are greatest when aphids arrive early in the season, usually following wet seasonal conditions that provide a 'green bridge' of weed hosts over the summer months. BYMV is not seed-borne whereas CMV can be. Lupin varieties differ in their susceptibility to viruses (see disease section on *Cucumber mosaic virus*). Wonga and Jenabillup appear to have more resistance to aphid attack than other varieties. Uniform plant density, early canopy closure and keeping cereal stubble can reduce aphid visitation.

Thrips. Monitor for thrips from early flowering. Thrips can cause reduced vigour, and flower and early pod abortion. Thrips can be particularly damaging to albus lupin. Critical control decisions should be made at early flowering. Control threshold is 1–2 thrips per open flower, **not** 1–2 per flowering spike.

Heliothis (*Helicoverpa* spp.). Occurrence is common and control decisions should be based on regular monitoring. Crops should be monitored twice weekly once flowering has started. Larvae feed on leaves, stems and pods and, when big enough, they burrow into pods and feed on the developing seed. Human consumption markets have strict limits on insect-damaged seeds, so populations of 1–2 larvae per square metre warrant control. Aerial insecticide application is often required.

Refer to the NSW DPI guide *Insect and mite control in field crops* for more detailed information on pest control measures and thresholds.

Diseases

Anthracnose. This destructive disease remains confined to commercial lupin crops in South Australia and Western Australia. Wonga and PBA Barlock are resistant (R) whilst PBA Gunyidi (MR–R) and Mandelup (MR) are slightly more susceptible. All other narrow-leaf and albus lupin varieties are susceptible. Fungicide seed dressing will provide some early protection. Be sure to report suspicious crop symptoms, which include twisted stems and shepherds crook appearance (**see Table 60 – Disease guide: lupin** in this chapter for further detail). If it is detected early in NSW, the disease could be eradicated. Restrictions apply on the movement of lupin material into NSW from South Australia and Western Australia.

Brown leaf spot (BLS). This can potentially be a damaging disease affecting narrow-leaf lupin. It is more likely to occur in crops that are sown into a paddock with a bare surface and in paddocks with a recent lupin history. This disease was widespread in 2015 due to favourable winter conditions. Albus lupin is less affected by this disease where it is not usually a significant problem – some lesions might develop on pods but do not cause any yield loss. The disease is favoured by cool, wet conditions during seedling emergence when soil-borne spores are splashed onto leaves and cause infection. Seedlings can rapidly become defoliated and die. Good crop management can prevent losses from BLS. Preventive measures are necessary to protect crops in high disease risk situations, particularly in areas with intensive lupin production. Crop rotation (at least four years between lupin crops), paddock separation from last year's lupin crop, cereal stubble cover and minimum

tillage, and fungicide seed dressing all used together, provide the maximum protection. There are no foliar fungicides currently registered to manage the disease.

Pleiochaeta root rot (PRR). Albus lupin is reasonably tolerant to BLS when grown on red-brown loamy soils. However, older varieties are susceptible to PRR caused by the same fungus, *Pleiochaeta setosa*. Soil-borne spores can infect the taproot of albus plants causing stunting and premature death. Luxor is rated R and Rosetta rated MR to the disease. Disease management is the same as for BLS. Treat seed at sowing with a fungicide seed dressing, separate this year's crop from last year's lupin paddock and avoid growing lupin for at least four years in the same paddock.

***Cucumber mosaic virus* (CMV)**. This disease tends to be more prevalent in central and northern NSW but only in narrow-leaf lupin. Albus lupin is immune to the disease. It is spread through infected seed and by aphid movement. Narrow-leaf lupin seed should be tested for CMV infection. Wonga is the most resistant narrow-leaf lupin to CMV seed transmission. CMV can cause symptoms in all narrow-leaf lupin varieties but it is the seed transmission from infected plants that causes problems for growers. The infected seed then carries over the disease into next year's lupin crop. Infected plants are most commonly seen around crop margins and in areas of low plant density or in gaps. Best management practices including retaining standing cereal stubble and weed control (to deter aphids) will reduce disease incidence.

***Bean yellow mosaic virus* (BYMV)**. This is a common virus infection in both narrow-leaf and albus lupin. The disease causes yellowing, wilting and plant death. It is most common on crop margins and near gaps in the crop where aphids land more often. BYMV infection in narrow-leaf lupin can cause three types of symptoms. **1.** When infected before pod set, the most common symptom is necrotic that kills the infected plant. **2.** The less common non-necrotic symptom causes stunting without killing the plant. **3.** Plants can be infected after pod set where black pods develop (black pod syndrome). There are no seed-borne BYMV strains in Australia. Best management practices including retaining standing cereal stubble and weed control (to deter aphids) will reduce disease incidence.

Phomopsis and lupinosis. Be aware of the potential danger to stock grazing stubble and seed infected with the phomopsis stem blight fungus. Outbreaks of this disease were detected in spring 2015 due to a combination of wet winter conditions and moisture-stressed crops in spring (which can trigger the disease in green plants). Summer rain also often stimulates fungal growth and toxin production on stubble. Strategies to avoid lupinosis in stock involve careful grazing management in the first few months after harvest and growing a narrow-leaf lupin variety with the best available phomopsis resistance. Current albus lupin varieties have a good level of resistance to stem infection by the phomopsis pathogen, but are susceptible to pod and seed infection especially after heavy rain, wind, or hail close to harvest. In 2015, outbreaks of the disease were mainly found on albus lupin varieties, particularly Rosetta, in southern NSW. Look for pink, tan or brown discoloured or mouldy seed. Do not feed grain to stock or deliver for human consumption if Phomopsis-infected seed is suspected. Manage the disease through separating this year's crop from last year's paddock and avoid growing lupin for at least four years in the same paddock. For further information **see NSW DPI Primefact 1308**, *Reducing the risk of lupinosis and the incidence of phomopsis*.

Phytophthora root rot 'Sudden death'. A serious disease in years when late winter and early spring are wet, and plants suddenly wilt and die around pod set stage. Outbreaks of this disease occurred in 2015 in southern NSW. The disease can occur as individual plants or patches within a crop. Occurrence is associated with soil hard pans or perched water tables as the disease initiation requires a brief period of waterlogging to infect lupin roots. In narrow-leaf lupin, an undescribed species of Phytophthora causes the disease. In albus lupin the disease is caused by *Phytophthora cryptogea*. The latter fungus is also highly pathogenic to lentil. Disease management is difficult because of the extended period of survival of the fungus in the soil. Methods to minimise the occurrence of the disease include crop rotation and avoiding paddocks with a known water-logging problem.

Sclerotinia stem rot. This disease is caused by the same fungus that infects canola. Disease development is favoured by prolonged wet conditions in late winter followed by periods of prolonged leaf wetness during flowering. Districts with reliable spring rainfall and long flowering periods for lupin appear to develop the disease more frequently. The environmental conditions for Sclerotinia to develop are very specific and will not occur every year, so even when the fungus is present the disease could fail to develop in dry conditions. Dry spring conditions in 2015 did not favour disease development in commercial crops, despite some petal infection. Be aware of crop rotations that include lupin and canola in close rotation as this can increase soil-borne sclerotia. Burning canola or lupin stubble will not effectively control Sclerotinia as sclerotia survive mainly on, or in, the soil. Crop rotation with cereals, following recommended sowing times and ensuring crops do not develop heavy vegetative growth, which are likely to reduce air circulation, are the best means of managing the disease. There are currently no foliar fungicides registered to manage Sclerotinia stem rot in lupin.

Table 62. Disease guide: lupin

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Root diseases				
Damping off *Pythium* spp., *Rhizoctonia* spp.	Seedlings collapse within a few days of emergence. Stem/taproot near ground-level sunken, water soaked.	Cool, wet, poorly drained soils. Late sowing leading to slow germination and emergence.	Spores survive in soil for long periods. Wide host range among other broadleaf crops.	Sow on time into well drained soils.
Pleiochaeta root rot *Pleiochaeta setosa* (mainly in albus lupin, rare in narrow-leaf lupin)	Dark brown, girdling lesions on taproot and lateral root spots.	Winter/spring. More severe in older albus varieties. Paddocks with a recent lupin history.	Survives in soil and on infected plant debris.	Crop rotation, four years or more between crops. Avoid growing near last year's lupin stubble. Grow resistant albus varieties Luxor or Rosetta.
Rhizoctonia root rot *Rhizoctonia* spp.	Dark brown, girdling lesions on taproot, fine roots rotted with 'spear point' effect. Patches of stunted plants within crops.	Favoured by minimum tillage, marginal soil moisture, mild conditions and some herbicide residues. Survives as fungal fragments in soil.	Host range depends on strain, but can include cereals and other broadleaf crops.	Suppressed by frequent cultivation. Cultivate below seed sowing depth.
Phytophthora root rot *Phytophthora* spp.	Plants wilt, turn yellow and die suddenly between flowering and pod set. Roots are completely rotted with a blackish, sunken lesion extending up to 5 cm up the stem base.	Favoured by wet, late winters and early springs on poorly drained heavier soils, especially with hard pans.	Resting spores survive for extended periods in soil.	Avoid hard pans and poorly drained sites.
Foliar diseases				
Anthracnose *Colletotrichum lupini*	Twisting of stems and 'Shepherds Crook' syndrome. Dark lesions with pale pink centres on stems, leaves and pods.	Not found on narrow-leaf or albus lupin crops in NSW. Found on Russell ornamental lupin.	Seed-borne and on trash. Spread by rain splash, machinery and animal movement.	Varieties with improved resistance are available. Crop rotation; use fungicide seed dressings and foliar fungicides.
Brown leaf spot *Pleiochaeta setosa* (mainly in narrow-leaf lupin, rare in albus lupin)	Initially dark brown spots on cotyledons, which die and drop off. Dark brown spots on leaves. Leaves distorted, can be shed. Lesions might girdle stems in extreme cases.	Cool, wet conditions. Worse on late sown crops, low pH soils and exacerbated by wetting agents used with herbicides. Only a problem in narrow-leaf lupin.	Spores survive in soil and on infected plant debris. Spread by rain splash and wind-blown rain.	Crop rotation, four years between crops. Early sowing. Retain cereal stubble. Minimum tillage and soil disturbance at sowing. Avoid growing near last year's lupin stubble. Use fungicide seed dressings.
Grey mould *Botrytis cinerea*	Dead areas on stem, covered with fluffy, greyishbrown fungal growth, usually near ground level. Stem girdling leads to wilting and death.	The disease is worse in dense crops. The fungus can survive in infected trash for extended periods as resting mycelium and is favoured by cool to mild, wet conditions in spring.	Survives on many alternative hosts. Aerial spores blown considerable distances.	Consider wider rows and/or lower plant populations to reduce dense canopies and increase air movement in the canopy. Use foliar fungicides.
Phomopsis stem blight *Diaporthe toxica*	Generally few symptoms on living plants. Black fruiting bodies of the fungus form on the surface of dead stems after harvest. Infected seeds discoloured, especially visible in albus. Fungal toxin poisons stock causing lupinosis.	Plants can be infected at any time during growth. Infection usually during cool, moist conditions in autumn, winter or spring.	Survives on infected stubble. Spores spread by rain splash and in wind-blown rain. Infected seed can spread disease.	Resistant varieties. Safe grazing practices reduce lupinosis.
Sclerotinia stem rot *Sclerotinia sclerotiorum*	White cottony fungal growth on stem at ground level and sometimes in upper canopy. Plants wilt. Sclerotia of the fungus develop on plant surfaces and inside stems. Can sometimes cause a basal rot.	Cool to mild humid conditions following rain in spring. Worse in dense crops.	Survives as resting sclerotia in soil. Sclerotia germinate in late winter and early spring and infect with airborne spores.	Difficult because of wide host range and long survival in soil (10 years). Canola is a major host of Sclerotinia and should not be sown too close to lupin in the crop rotation. Consider wider rows in high rainfall areas to increase air movement in the canopy.
Virus diseases				
Bean yellow mosaic virus (BYMV)	Plants yellow with blackened, flat pods. Plants wilt and die. The non-necrotic strain causes downturned leaflets.	Mainly in mild conditions during spring. Often seen at crop margins.	Survives in many legume and weed species. Spread by several aphid species.	Follow best management practices including retaining standing cereal stubble and weed control.
Cucumber mosaic virus (CMV) (narrow-leaf lupin only)	Plants stunted. Foliage distorted, bunchy leaves with upturned leaflets. Persistent green plants at harvest. Infected narrow-leaf lupin seeds smaller.	Occurs early in the season from infected seed; at any other time from aphid transmission.	Survives in many legume and weed species. Infected seed of narrow-leaf lupin only. Spread by several aphid species.	Grow narrow-leaf lupin varieties resistant to seed transmission e.g. Wonga. Use virus tested narrowleaf lupin seed. Follow best management practices including retaining standing cereal stubble and weed control. In high risk areas grow albus lupin.

Harvest

Lupin seed can be harvested and delivered as soon as seed moisture content is below 14% (maximum receival standard). Timing is critical to maximise yields. Pods are prone to shattering if left too long after maturing, especially albus lupin. If harvest is delayed or dry conditions prevail, harvest at night or in the early morning with dew to minimise shattering and pod drop. Use extended fingers to help trap pods. Grower reports suggest pod loss is reduced if draper fronts are used. Windrowing and crop desiccation are viable options, particularly for crops with variable maturity or high weed burdens. For further details see Pulse Point 10, *Windrowing lupin*. Registered products for desiccation are listed in NSW DPI guide *Weed control in winter crops*. As desiccation timing is similar to windrowing, seek advice from your local agronomist if unsure.

Marketing

Narrow-leaf lupin is a readily marketable, high protein stockfeed and is sold domestically for use in pig, poultry, dairy and feedlot rations. A small quantity is exported, but the price is driven by competition with soymeal.

Albus varieties are suitable to export for human consumption provided grain quality parameters are met. The principal export market for Australian albus is Egypt. Albus lupin is also suitable for dairy and cattle feedlot rations, but is not readily accepted into pig rations at high inclusion rates. Albus lupin is commonly de-hulled, concentrating the protein content for use in feed mixes, while the hulls provide a fibre source.

Further information

NSW DPI website**:**

Primefact 1308 *Reducing the risk of lupinosis and the incidence of phomopsis*

Weed control in winter crops

Insect and mite control in field crops

Pulse Point 6, *Dry sowing*

Pulse Point 10, *Windrowing lupin*

Pulse Point 17, *Phytophthora root rot of lupin*

Pulse Point 18, *Cucumber mosaic virus in lupin*

Pulse Point 20, *Germination testing and seed rate calculation*

Pulse Australia (PA) website for:

Variety Management Packages (VMP) for all new varieties

2015–16 Australian Pulse Trading Standards

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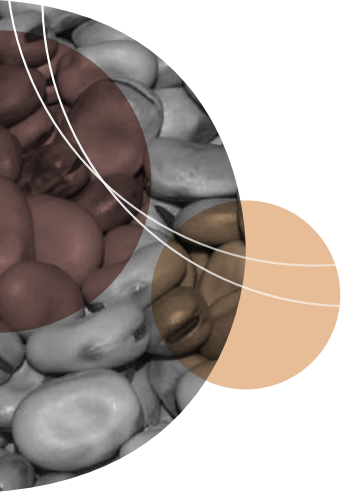

Grain insects – options for control

Most cereal grains in storage provide ideal conditions for infestation by a range of grain insects at harvest temperature. Warm grain temperatures result in most species multiplying rapidly, with the potential to seriously damage grain. Grain can be protected with either chemical or residue-free technologies as described below. Grain must also be dry to prevent moulds or fungus developing. Maximum delivery moisture contents are: 12.5% for wheat, barley, oats and 12% for triticale;, 8% for canola; 9% for sunflower; 13% for feed soybeans; 13.5% for sorghum; and 14% for maize. Grain below these moisture limits still needs protection from insect infestation.

Storage hygiene

Empty silos should be cleaned promptly. Mid-winter is ideal for a major storage facility clean up before the warmer weather of early spring leads to increased grain insect activity and movement. Silos for cereal grain can be treated with a number of products (Table 63. Insecticides for disinfesting empty grain storages and grain handling equipment). Desiccant dusts are the preferred option due to some grain insects developing resistance to some of these insecticides. Silos for organic grain, canola, pulses and other non-cereal grains can only be treated with a desiccant dust to avoid any possibility of transferring chemical residues to the grain. Avoid placing fresh grain on top of carry-over grain. If carry-over grain must be stored in the same silo, it should all be fumigated or chemically treated before the new grain is added to the silo.

Chemical protectants

These insecticides (Table 64. Protectants for treating cereal grain in storage) are sprayed directly onto the grain stream while augering into storage. They protect uninfested cereals from insects during storage periods of 3–9 months, but are not intended to control infestations that have already developed. Some full rate treatments have withholding periods (WHP) of up to three months before the grain may be used. This is to ensure that residues meet domestic and export limits. Always check with end users before treatment with any contact insecticide, as buyers might specify nil residues on grain for particular markets, despite the protectant having full registration. Where possible, use alternative chemicals for repeated treatments. This will prevent resistance building up through overusing the same chemical. Some planting seed dressings can also contain an insecticide to help protect grain against stored insect pests (refer to pesticide labels). Regular checking for pests is still advised.

Protectants are not registered for use on canola, other oilseeds or pulses. These grains must be protected by residue-free methods such as fumigation and aeration cooling. Some insecticide treatments on grain, including carbaryl and desiccant dusts, are not accepted by bulk handlers and many other grain buyers. Malting barley may only be treated with a limited range of protectants, see Table 64. Protectants for treating cereal grain in storage.

Sealed silo fumigation

Phosphine and sulfuryl fluoride (Profume®) use is restricted to sealed, gas-tight storages. Sulfuryl fluoride (SF) use is restricted to licensed fumigators that have undergone a specific SF fumigation training program.

For phosphine fumigations, cereals, pulses and oilseeds are best fumigated by hanging bag chains or blankets of aluminium phosphide in the headspace of a sealed silo. If tablets are used, they should not be mixed with the grain, but spread out on a tray. A disposable aluminium tray is generally adequate. This tray can either be placed on the surface of the grain or suspended in the headspace. Do not add water to the tablets. Phosphine gas is generated in the headspace and gradually diffuses down through the grain. This method leaves no powdery residue in the grain, and minimises insect resistance.

Before fumigation, sealable silos should be tested to confirm gas-tightness by pressurising the silo to an oil level difference of 25 mm at the silo relief valve. The oil level difference should hold above 12.5 mm for at least three minutes after the air supply is shut off. This is important, as phosphine is unlikely to kill pupae and eggs in poorly sealed silos, resulting in re-infestation and resistance. For new sealable silos, the Australian standard (AS2628) specifies a pressure test result of at least five minutes from 25 – 12.5 mm.

Conduct the silo pressure test during the morning, before the sun starts heating and expanding the air inside the silo. It is often best to conduct the test with grain in the silo to put pressure on outlets and walls.

Do you know what is eating at your profits?
– common stored grain insect pests of NSW

Lesser grain borer – *Rhyzopertha dominica*

Key features: dark brown, pellet shaped, 3 mm long, eyes and mouth parts tucked underneath A

Rust-red flour beetle – *Tribolium castaneum*

Key features: red brown, 3–4 mm long, three larger segments at end of antennae A

Rice weevil – *Sitophilus oryzae*

Key features: dark brown to black, 2–4 mm long, long weevil snout A

Saw-toothed grain beetle – *Oryzaephilus surinamensis*

Key features: dark brown, 3 mm long, fast moving, saw tooth pattern on side of body behind head A

Flat grain beetle or rusty grain beetle – *Cryptolestes ferrugineus*

Key features: brown, small, 2 mm long, fast moving, keen to hide, long thin antennae A

India meal moth – *Plodia interpunctella*

Key features: distinctive bicoloured wings, 5–7 mm long, larvae create webbing on grain surface B

A – Images courtesy Department of Agriculture, Fisheries and Forestry, Queensland.

B – Image courtesy K Walker, PaDIL www.padil.gov.au

Aeration cooling

Grain aeration is a very effective way of cooling grain, thereby reducing stored grain insect feeding activity and reproduction rate. It also helps maintain grain quality. A typical system consists of an externally-mounted fan and motor that directs air into perforated ducting on the inside cone or base of the silo. The fan must be matched to silo size; a small 0.37 kW motor (0.5 HP) is usually adequate to cool up to 80 tonnes of wheat. Multiple fans or larger capacity units are needed for larger tonnages or smaller, compact seed like canola. Seek advice as to the appropriate fan size and design.

An aeration controller will automatically turn on fans to select the most appropriate cooling air available at any time. Depending on the control unit, one controller can manage multiple silo fans. Begin aerating as soon as the ducting is covered. Manual systems using time switches and other means produce less reliable results. After the initial longer fan run times in the first two weeks of storage, manual operations should then aim for the best 100 hours of cool, dry air per month.

Monitoring grain temperatures in aerated storages is a worthwhile practice. In general, during summer we should be aiming for grain temperatures of 23 °C or less. In winter we should achieve grain temperatures of less than 15 °C. Achieving both of these cool grain temperatures will significantly slow, or even stop, insect breeding lifecycles. A grain temperature probe of 1.2 m should be pushed 1 m into grain and left for a minimum of three minutes before taking the grain temperature reading.

Monitoring

It is most important to check the condition of the stored grain regularly, at least every month, and be prepared to take remedial action if required. If possible, check the top surface as well as a sample from the base, as different insect species prefer different locations within the grain bulk. Check for insects by using an insect sieve and/or pitfall traps. Also look for damage caused by insects and moisture. Keep a monthly storage record of insects found, plus any grain treatments and fumigations applied.

WARNING – Dichlorvos products are no longer allowed to be applied to grain

The APVMA cancelled the following registrations and label approvals of agricultural chemical products containing dichlorvos identified in the table below for use on grain.

Cancelled products

Product Name	Company
Divap 1140 Insecticide	United Phosphorus Ltd
Barmac Dichlorvos 500 Insecticide	Amgrow Pty Ltd
Barmac Dichlorvos 1140 Insecticide	Amgrow Pty Ltd

The product registrations and label approvals were cancelled on 20 January 2015.

The period for using cancelled dichlorvos products for grain protection use, in line with the expiry of permit PER14075 version 5, **ENDED on 2 March 2015**.

NOTE: Insectigas-D DDVP insecticide, remains registered for treating empty stored grain facilities, empty silos, farm machinery, greenhouses, factories and warehouses. Growers should ensure they have a copy of the new registration label and are aware of the changes regarding its use. Always read the product label.

Table 63: Insecticides for disinfesting empty grain storages and grain handling equipment

Purpose	Insecticide	Mixing rate per L	Summary notes: READ THE LABEL BEFORE USING
Desiccant dust treatments (activated amorphous silica or diatomaceous earth) **for treating grain storage surfaces and equipment such as headers, augers, mobile bins**.	Dryacide® Perma-Guard® D-10 Absorba-cide® Cut 'N Dry® Abrade®	120 g (1 L/20 m^2) 200 g (1 L/33 m^2) 120 g (1 L/20 m^2) 120 g (1 L/20 m^2) 240 mL (1 L/20 m^2)	Apply dust to empty silos and bins (2 g/m^2) using a hand- or power-operated duster (a venturi blower is effective). Avoid heavy deposits of dust that can dislodge. Wear a dust mask and goggles for safety. Alternatively, a slurry (10–20%) can be applied with a centrifugal pump or venturi-type sand blaster with continuous agitation. Header harvesters can be treated with 2.5 kg of dry dust. Refer to label for instructions. **Please note**: Some desiccant dust products are ineffective against rust red flour beetle (*Tribolium* spp.), studies have shown Dryacide® to be most efficacious.
Disinfesting empty silos, storage areas and equipment such as headers, augers, mobile bins.	Carbaryl 500	10 mL	Ensure silos are cleaned thoroughly before any treatment. Carbaryl is registered only to control lesser grain borers. Mixtures of carbaryl with any of the other components listed here can be used to control all species. Follow label precautions about mixing. Do not premix. Agitate thoroughly and clean equipment after use. Refer to label for spraying rates.
	Actellic® 900 Reldan® 500 Fenitrothion 1000 Reldan® PluS IGR*	11 or 22 mL 20 mL 10 mL 20 mL	Actellic®, Reldan® and Fenitrothion are not effective against lesser grain borer. Can be mixed with carbaryl (above), or methoprene (IGR). However, methoprene will not kill any live adult lesser grain borers that are present. * A premixed formulation of Reldan® and methoprene. **NOTE**: None of these chemicals are to be used in storages where canola and other oilseeds or pulses are to be stored.

Table 64: Protectants for treating cereal grain in storage

Grain situation	Insecticide rate per 100 L		Summary notes: READ THE LABEL BEFORE TREATING for limitations and full instructions.
Protect cereal grain except malting barley, rice and maize	ConserveTM On-Farm, Part A 1 L & Part B 400 ml per 50 L of water (Part A – 500 g/L Chlorpyrifos-methyl, 30 g/L S-Methoprene, Part B 120 g/l Spinosad)		Ensure treatment is acceptable to buyer. K-Obiol® and ConserveTM can be used against all the major stored grain insect pests. However, they are both restricted to one application per parcel of grain. They are also only available through stewardship programs with Bayer (K-Obiol®) or Dow (Conserve TM) Make up ONE Group A insecticide to strength before adding the required amount of ONE Group B insecticide to the spray mix. Mixtures are needed to control the whole range of grain insects. Apply 1 L of diluted spray per tonne of grain entering storage. Ensure an even coverage of the grain. Treat only non-infested grain with protectants. Check labels for WHP Different twin packs are available containing one Group A and one Group B insecticide. Twin pack premixed formulation might be available and can be used to control all stored grain insect pests. **Please note**: Resistance in lesser grain borer to IGR is widespread. * A premixed formulation of Reldan® and methoprene.
Protect cereal grain except malt barley	K-Obiol® Combi (Deltamethrin) 2.0 L		
	GROUP A	Actellic® 0.45 L Reldan® 2.0 L Fenitrothion 1.2 L	
	GROUP B	Rizacon-S® 0.2 L IGR grain protectant (methoprene) various rates	
	TWIN PACK PRE-MIXED	Two-component packs Reldan® PluS IGR 2.0 L*	
Protect malting barley	K-Obiol® Combi 2.0 L Fenitrothion 1.2 L, PLUS ONE Group B insecticide at rates indicated above		
Protect cereal grain (for treating cereal grain to be retained and used on farm only)	Dryacide® 1 kg/1 t Perma-Guard® D-10 1 kg/1 t Absorba-cide® 1 kg/1t Cut 'N Dry® 1 kg/1 t Carbaryl 500, 1.6 L PLUS ONE Group A insecticide at rates indicated above		Apply dusts evenly, and reduce auger rate to prevent choking. Follow label directions when mixing carbaryl with the Group A insecticide. Do not pre-mix concentrates. Agitate thoroughly and clean equipment after use. Vat mix can lose compatibility if left overnight. Withholding period three months. Not accepted off-farm by most traders.
Protect organic cereal grain	Dryacide® 1 kg/1 t Perma-Guard® D-10 1 kg/1 t Absorba-cide® 1 kg/1 t Cut 'N Dry® 1 kg/1 t		Dusted grain can retain protection for more than 12 months if grain moisture is low. Higher rates can be used for dirty or infested grain, but not where grain is for human consumption. Apply dusts evenly, and reduce auger rate to prevent choking. Check with buyers before application.

Table 65: Fumigants for treating cereal grain in storage

Grain situation	Fumigant	Summary notes: READ THE LABEL BEFORE TREATING for limitations and full instructions.
Disinfest cereals, pulses, oilseeds and malting barley by fumigation	Aluminium phosphide (150 tablets/100 m^3) producing phosphine gas	Ensure silo is gas-tight. Calculate fumigant as if the silo is full. Fumigate for 7–20 days, withholding period two days after ventilation. Do not mix tablets in with the grain. Other phosphine formulations are available, including bag chains, belts, blankets and cylinder gas. Refer to labels for rates and methods of use.
Disinfest cereals only by fumigation	Sulfuryl fluoride (Profume®)	Requires a licensed fumigator trained to use Profume and a gas-tight storage.

Registered insecticides as at February 2016

The product names are supplied on the understanding that no preference between equivalent products is intended, and that including a product does not imply endorsement by NSW DPI over any other equivalent product from another manufacturer.

ALWAYS READ THE LABEL. Users of agricultural chemical products must always read the label and any permit before using the product, and strictly comply with the directions on the label and the conditions of any permit. Users are not absolved from any compliance with the directions on the label or the conditions of the permit by reason of any statement made or omitted to be made in this publication.

Cereal grains include wheat, barley, oats, maize, sorghum, triticale, paddy rice and millet. Canola and other oilseeds may only be treated with phosphine. Withholding periods listed on some labels ensure that residues decay to acceptable levels before grain is sold. Any queries, please seek information from Joanne Holloway, NSW DPI Grain Storage Unit WAGGA WAGGA t: 02 6938 1605.

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Table 66. Cereal seed dressings – 2016: Control of seed-borne disease

Cereal seed dressings control smuts and bunt, and some can suppress certain leaf and root diseases. Outbreaks of bunt and flag smut in wheat emphasise the need for annual seed treatment.

If such grain is not treated the levels will quickly build up to unacceptable levels.

Recommendations for controlling smuts are:

- discard grain carrying the disease
- avoid sowing wheat for at least two seasons into land where flag smut or bunt have occurred
- treat all seed for sowing

Some fungicides only control one or two of the three smuts.

Use a product controlling all three diseases. Some dressings can reduce the coleoptile length and emergence of some varieties. The risk of emergence failure is increased when some fungicides are used on varieties with short coleoptiles, or when seed is sown deeply or into a poor seedbed.

Active ingredient of fungicide or insecticide	Examples of seed treatment trade name and manufacturer	Rate to apply to each 100 kg	Approx. cost to treat 100 kg of seed ($)##	Smuts controlled B – bunt C – covered smut L – loose smut				F – wheat flag smut		Diseases suppressed								
				Wheat	Barley	Oats	Triti-cale	Wheat	Wheat	Wheat				Wheat/ Barley	Barley			Grazing withhold-ing period (weeks)
								Seed-borne flag smut	Soil-borne flag smut	Septoria tritici	Stripe rust	Leaf rust	Take-All	Rhizoc-tonia	Scald	Powdery mildew	Seed-borne Net blotch	
Powders – various trade names sometimes available under these active ingredients, concentrations and formulations. See specific labels for details.																		
Carboxin 750 g/kg + cypermethrin 6.4 g/kg	Vitavax® 750 C ST – Arysta LifeScience*	70 g 125 g	3.17 5.66	B BL	C CL	CL –	– L	F F*	– –	– –	– –	– –	– –	– –	– –	– –	– –	7
Flutriafol 100 g/kg + cypermethrin 4 g/kg	Armour® C SD – Cheminova	100 g	2.59	BL	CL	–	–	F	F	✓	✓	–	–	–	✓	✓	–	4
Flutriafol 25 g/kg + cypermethrin 4 g/kg	Veteran™ C SD – Crop Care	100 g	2.48	BL	CL	CL	L	F	F	–	–	–	–	–	–	–	–	4
Tebuconazole 25 g/kg + triflumuron 4 g/kg	Raxil® T SD – Bayer CropScience	100 g	2.29	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	4
Triadimenol 150 g/kg + triflumuron 4 g/kg	Baytan® T SD – Bayer CropScience*****	100 g 150 g	2.53 3.79	BL BL	CL CL	CL CL	– –	F F	F F	– ✓	✓ ✓✓	– –	– –	– –	✓ ✓✓	✓ ✓✓	– –	5 5
Triadimenol 150 g/kg + cypermethrin 4 g/kg	Triadimenol 150+® SD – 4 Farmers	100 g 150 g	2.82 4.22	BL BL	CL CL	CL CL	– –	F F	F F	– –	✓ ✓✓	– –	– –	– –	✓ ✓✓	✓ ✓✓	– –	5 5
Flowable Liquids – water based – various trade names sometimes available under these active ingredients, concentrations and formulations. See specific labels for details.																		
Carboxin 400 g/L + cypermethrin 3.2 g/L	Vitaflo® C ST – Arysta LifeScience *	125 mL 250 mL	3.66 7.33	B BL	C CL	CL CL	– L	F* F	– –	– –	– –	– –	– –	– –	– –	– –	– –	7 7
Carboxin 200 g/L + thiram 200 g/L	Vitavax® 200 FF ST –Arysta LifeScience *	250 mL 375 mL 500 mL	7.98 11.96 15.95	B B BL	C C CL	CL – –	– – L	F* F F	– – F	– – –	– – –	– – –	– – –	– – –	– – –	– – –	✓ ✓✓ ✓✓✓✓	7 7 7
Difenoconazole 92 g/L + metalaxyl-M 23 g/L	Dividend® FSD – Syngenta****	100 mL 130 mL 260 mL	4.50 5.85 11.70	B BL BL	C CL(s) CL	– – –	– – –	F F F	F F F	– – –	– – –	– – –	– – –	– – ✓	– – –	– – –	– ✓ ✓✓	6 6 6
Difenoconazole 66.2 g/L + metalaxyl-M 16.5 g/L + 13.8 g/L Sedaxane	Vibrance® – Syngenta	180 mL 360 mL	6.78 13.56	BL BL	CL CL	L L	BL BL	F F	F F	– –	– –	– –	– –	– ✓^^^	– –	– –	✓ ✓✓	6 6
Difenoconazole 36.9 g/L + thiamethoxam 30.7 + metalaxyl-M 9.5 g/L + 8 g/L Sedaxane	Vibrance® Extreme– Syngenta	325 mL 650 mL	10.19 20.38	BL BL	CL CL	L L	BL BL	F F	F F	– –	– –	– –	– –	– ✓^^^	– –	– –	✓ ✓✓	6 6
Fluquinconazole 167 g/L	Jockey® Stayer® – Bayer CropScience###	300 mL 450 mL	19.12 28.68	BL BL	CL*** –	– –	– –	F F	F F	✓ ✓✓	✓✓✓ ✓✓✓✓	✓ ✓✓	– ✓	– –	✓✓✓*** –	✓✓*** –	– –	6, 12^^ 6, 12^^
Flutriafol 6.25 g/L	Vincit® C Zinc FSD – Cheminova	400 mL	7.81	BL	CL	CL	L	F	F	–	–	–	–	–	–	–	–	4
Flutriafol 25 g/L + cypermethrin 4 g/L	Vincit® C FSD – Cheminova Veteran® C – Crop Care	100 mL	2.35	BL	CL	CL	L	F	F	–	–	–	–	–	–	–	–	4
Flutriafol 100 g/L + cypermethrin 4 g/L	Arrow® C FSD – Crop Care	100 mL	2.64	BL	CL	–	–	F	F	–	✓	–	–	–	✓	✓	–	4
Flutriafol 6.25 g/L + imidacloprid 180 g/L	Veteran® Plus – Crop Care	400 mL	9.70	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	9
Flutriafol 6.25 g/L + imidacloprid 180 g/L	Arrow® Plus – Crop Care	400 mL	10.25	–	CL	–	–	–	–	–	–	–	–	–	✓	✓	✓^^^^	9
Fluxapryroxad 333g/L	Systiva – BASF	150 mL	32.84	B	L	–	–	–	–	–	–	–	–	✓	✓✓	✓✓	✓✓	4
Ipconazole 20 g/L + cypermethrin 4 g/L	Rancona® C – Arysta LifeScience	100 mL	3.40	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	6
Ipconazole 25 g/L + metalaxyl 20 g/L	Rancona® Dimension – Arysta LifeScience	80 mL 320 mL	3.37 13.47	BL BL	CL CL	CL CL	– –	F F	F F	– –	– –	– –	– –	– ✓	– –	– –	– –	10 10

Table 66. Cereal seed dressings – 2016: Control of seed-borne disease (continued)

Active ingredient of fungicide or insecticide	Examples of seed treatment trade name and manufacturer	Rate to apply to each 100 kg	Approx. cost to treat 100 kg of seed ($)##	Smuts controlled B – bunt C – covered smut L – loose smut				F – wheat flag smut		Diseases suppressed								
				Wheat	Barley	Oats	Triti-cale	Wheat	Wheat	Wheat				Wheat/ Barley	Barley			Grazing withhold-ing period (weeks)
								Seed-borne flag smut	Soil-borne flag smut	Septoria tritici	Stripe rust	Leaf rust	Take-All	Rhizoc-tonia	Scald	Powdery mildew	Seed-borne Net blotch	
Penflufen 240 g/L	EverGol® Prime – Bayer CropScience	40 mL	6.53	BL	CL	–	–	F	F	–	–	–	–	✓	–	–	–	5
		80 mL	13.05	BL	CL	–	–	F	F	–	–	–	–	✓✓	–	–	–	5
Tebuconazole 25 g/L + cypermethrin 4 g/L	Innova® Tebuconazole 25 C FSD – Syngenta	100 mL	2.59	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	0
Tebuconazole 6.25 g/L + imidacloprid 180 g/L	Hombre® – Bayer CropScience**	400 mL	7.46	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	9
Tebuconazole 12.5 g/L + imidacloprid 360 g/L	Hombre® Ultra – Bayer CropScience**	200 mL	7.70	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	9
Tebuconazole 150 g/L + prothioconazole 250 g/L	Raxil® Pro – Bayer CropScience	15 mL	2.58	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	5
Tebuconazole 25 g/L + triflumuron 4 g/L	Raxil® T FSD – Bayer CropScience	100 mL	2.00	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	4
Triadimenol 150 g/L + cypermethrin 4 g/L	Foliarflo® C ST – Arysta LifeScience	100 mL	2.70	BL	CL	CL	–	F	F	–	✓	–	–	–	✓	✓	–	5
		150 mL	4.04	BL	CL	–	–	F	F	✓	✓✓	–	–	–	✓✓	✓✓	–	5
Triadimenol 56 g/L + imidacloprid 180 g/L	Zorro® – Bayer CropScience** ProLeaf Plus® – Arysta LifeScience **	400 mL	8.83	BL	CL	CL	–	F	F	✓	✓✓	✓	–	–	✓✓	✓✓	–	9
Triadimenol 150 g/L + triflumuron 4 g/L	Baytan® T FSD – Bayer CropScience	100 mL	2.41	BL	CL	CL	–	F	F	–	✓	–	–	–	✓	✓	–	5
		150 mL	3.61	BL	CL	–	–	F	F	✓	✓✓	–	–	–	✓✓	✓✓	–	5
Triticonazole 25 g/L + cypermethrin 4 g/L	Premis® Pro C – BASF	100 mL	3.38	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	Nil
In furrow treatments – various trade names sometimes available under these active ingredients, concentrations and formulations. See specific labels for details.																		
		Rate and approx. cost /ha																
Azoxystrobin 322 g/L + metalaxyl-m 124 g/L	Uniform®– Syngenta*****	200 mL/ha	12.66	–	–	–	–	–	–	–	✓✓	–	–	✓	–	–	–	6
		300 mL/ha	18.99	–	–	–	–	–	–	–	–	–	–	✓✓	–	–	–	–
		400 mL/ha	25.32	–	–	–	–	–	–	–	✓✓✓✓	–	–	✓✓✓	–	–	–	–
Flutriafol 250 g/L	Innova® Flutriafol 250 – Syngenta	200 mL/ha	4.85	–	–	–	–	–	–	–	✓✓	–	–	–	✓	✓	–	4
		400 mL/ha	9.70	–	–	–	–	–	–	✓	✓✓✓✓	–	✓	–	✓✓	✓✓	–	4
Flutriafol 250 g/L	Intake® Combi – Crop Care ###	200 mL/ha	3.50	–	–	–	–	–	–	–	✓✓	–	–	–	✓	✓	–	4
		400 mL/ha	7.00	–	–	–	–	–	–	✓	✓✓✓	–	✓	–	✓✓	✓✓	–	4
		800 mL/ha	13.99	–	–	–	–	–	–	✓	✓✓✓✓	–	✓	–	✓✓	✓✓	–	4
Flutriafol 500 g/L	Intake® Hiload Gold – Crop Care ###	100 mL/ha	2.42	–	–	–	–	–	–	–	✓✓✓	–	–	–	✓	✓	–	4
		200 mL/ha	4.84	–	–	–	–	–	–	✓	✓✓✓✓	–	✓	–	✓	✓	–	4
		400 mL/ha	9.68	–	–	–	–	–	–	✓	✓✓✓✓	–	✓	–	✓✓	✓✓	–	4
Triadimefon 500 g/kg	Triad® 500 WP – Adama	200 g/ha	4.07	–	–	–	–	–	–	–	–	✓	–	–	–	–	–	Not stated$
Triadimefon 500 g/kg	Triadimefon 500 WG – Cheminova	200 g/ha	3.90	–	–	–	–	–	–	–	✓✓	✓	–	–	–	✓	–	Not stated@
Triadimefon 500 g/kg	Triadimefon 500 DRY – 4 Farmers	200 g/ha	3.60	–	–	–	–	–	–	–	✓✓	✓	✓	–	–	✓	–	Not stated@

Prices quoted are GST inclusive at February 2016 and approximate only. Prices will vary depending on pack size purchased and special marketing arrangements. ### Rate of product varies for disease controlled, check label.
✓ Affords useful suppression in early crop growth stages. ✓✓, ✓✓✓ and ✓✓✓✓ Affords extended suppression. * Also controls seed-borne flag smut in triticale. There are no registered seed treatments for cereal rye.

* Also controls seed-borne flag smut in triticale. There is no registered seed treatments for cereal rye. ** Barley yellow dwarf virus. Hombre®, ProGuard® Plus, ProLeaf® Plus and Zorro® provide early season control of BYDV. *** Plus Raxil® T with Jockey® Stayer® at 100 mL/100 kg seed. ****Also provides control of pythium root rot. *****Also provides control of pythium root rot and suppression of Yellow spot. ^^^ Suppresses Rhizoctonia root rot in oats. ^^^^ Suppression only.

Caution: Observe stock withholding periods on crops produced from treated seed.
^^ Withholding period – Livestock producing milk for human consumption 12 weeks.
Treated seed must not be used for animal or human consumption.
Read Label before using pesticides. @ – Do not mix leaves treated with this product with feed intended for animal consumption.
$ – Feed treated with this product must not be used for animal consumption, poultry feed or mixed with animal feed.

Table 67. Cereal insecticide seed dressings for aphid and *Barley yellow dwarf virus* (BYDV) control 2016

Active ingredient of insecticide and fungicide – various trade names sometimes available under these active ingredients, concentrations and formulations. See specific labels for details.	Examples of seed treatment trade name and manufacturer	Rate to apply to each 100 kg[###]	Approx. cost to treat 100 kg of seed ($)[##]	Aphid feeding damage suppression (wheat aphid and corn aphid)	Reduces spread of BYDV	Grazing withholding period (weeks)
Imidacloprid 180 g/L + tebuconazole 6.25 g/L	Hombre® – Bayer CropScience	400 mL	7.46	✓	✓	9
Imidacloprid 360 g/L + tebuconazole 12.5 g/L	Hombre® Ultra– Bayer CropScience	200 mL	7.70	✓	✓	9
Imidacloprid 180 g/L + triadimenol 56 g/L	Zorro® – Bayer CropScience	400 mL	8.90	✓	✓	9
Imidacloprid 180 g/L + flutriafol 6.25 g/L	Veteran® Plus – Crop Care	400 mL	9.70	✓	✓	9
Imidacloprid 180 g/L + flutriafol 25 g/L	Arrow® Plus – Crop Care (registered for barley only)	400 mL	10.25	✓	✓	9
Imidacloprid – 350 g/L	Gaucho® 350 – Bayer CropScience	200 mL–400 mL	7.37–14.74	✓	✓	9
Imidacloprid – 600 g/L	Gaucho® 600 – Bayer CropScience	120 mL–240 mL	5.00–9.99	✓	✓	9
Lambda-cyhalothrin 37.5 g/L +Thiamethoxam 210 g/L	Cruiser® Opti – Syngenta	165–330 mL	22.60–45.19	✓	✓	8

[##] Prices quoted are GST inclusive at February 2016 and approximate only. Prices will vary depending on pack size purchased and special marketing arrangements.

[###] Rate of product varies for length of disease control and risk level, check label. ✓ Affords useful suppression in early crop growth stages.

Table 68. Canola and pulse seed dressings – 2016, Seed dressings for canola, chickpea, field pea, faba bean and lupin

Example seed treatment, trade name and manufacturer	Active ingredient of fungicide or insecticide	Rate to apply to each 100 kg of seed	Approximate cost to treat 100 kg ($) ##	Range of pack sizes (kg or L)	Canola	Chickpea	Field pea	Faba bean	Lupin
Powders									
Thiragranz* – Crop Care	thiram (800 g/kg)	150 g	1.95	20 kg	–	Seed-borne Botrytis Ascochyta blight	–	–	Seed-borne Anthracnose
Flowable liquids									
Danadim® – Cheminova Dimethoate 400–- Adama	dimethoate (400 g/L)	150 mL (field pea) 150 mL (lupin) 330 mL (canola)	1.55 1.55 3.40	10–110 L 5–200 L	Redlegged earth mite, Lucerne flea	–	Redlegged earth mite Lucerne flea	–	Redlegged earth mite Lucerne flea
Gaucho® 600 – Bayer CropScience	imidacloprid (600 g/L)	300 mL (lupin) 400 mL (canola) 120 mL (faba bean) 60 mL (field pea)	12.25 16.20 4.90 2.45	1–200 L	Redlegged earth mite, Blue oat mite, Aphids	–	Aphids	Aphids	Redlegged earth mite Blue oat mite
Gaucho® 350 – Bayer CropScience	imidacloprid (350 g/L)	100 mL (field pea) 200 mL (faba bean) 500 mL (lupin)	3.70 7.35 18.45	5–175 L	–	–	Aphids	Aphids	Redlegged earth mite Blue oat mite
Emerge ™ Flowable Seed Treatment – Syngenta	imidacloprid (600 g/L)	300 mL (lupin) 400 mL (canola)	12.15 16.20	1 & 10 L	Redlegged earth mite, Blue oat mite, Aphids	–	–	–	Redlegged earth mite Blue oat mite
Cosmos® – Agriphar Crop Solutions	fipronil (500 g/L)	400 mL	329.00	5–1000 L	Redlegged earth mite	–	–	–	–
Cruiser® Opti - Syngenta	thiamethoxam (240 g/L) + lambda-cyhalothrin (37.5 g/L)	500–1000 mL	68.50–136.95	–	Green peach aphid	–	–	–	–
		1000 mL	136.95		Suppression of: Redlegged earth mite, Lucerne flea				
Jockey® Stayer® – Bayer CropScience	fluquinconazole (167 g/L)	2 L	127.45	5–1000 L	Blackleg (suppression)	–	–	–	–
Apron® XL 350 ES – Syngenta	metalaxyl-M (350 g/L)	75 mL	32.50	1–1000 L	–	Phytophthora root rot	Damping-off, Downy mildew	–	–
Maxim® XL – Syngenta	fludioxonil (25 g/L) + metalaxyl-M (10 g/L)	200–400 mL	60.50–121.00	1–1000 L	Damping-off (*Pythium* spp.) Rhizoctonia solani, Blackleg (suppression)	–	–	–	–
P-Pickel T® – Crop Care	thiram (360 g/L) + thiabendazole (200 g/L)	200 mL	8.58	10 & 200 L	–	Ascochyta blight, Botrytis seed rot Seedling root rots (*Pythium* spp., *Fusarium* spp.)	Black spot, (Leaf and Pod Spot and Collar Rot), Seedling root rots (*Pythium* spp., *Fusarium* spp.) *Macrophomina phaseolina*	Seedling root rots (*Pythium* spp., *Fusarium* spp.)	–
Poncho® Plus# – Bayer CropScience	clothianidin (360 g/L) + imidacloprid (240 g/L)	500 mL	NA	5–1000 L	Wireworm, Cutworm Lucerne flea, Redledgged earth mite, Blue oat mite	–	–	–	–
Thiram 600 Flowable Fungicide – Crop Care	thiram (600 g/L)	200 mL (chickpea) 170–200 mL (lupin)	3.05 2.60–3.05	10–200 L	–	Damping-off (*Pythium* spp.) Seed-borne Botrytis and Ascochyta blight	–	–	Seed-borne Anthracnose
Rovral® Liquid Seed Dressing – FMC	iprodione (250 g/L)	100–500 mL	2.50–12.45	5–1000 L	–	–	–	–	Brown leaf spot
Sumisclex® Broadacre – Sumitomo	procymidone (500 g/L)	100 or 200 mL	4.15 or 8.30	20 L	–	–	–	–	Brown leaf spot
In furrow treatments		**Rate per hectare**	**Cost per hectare ($)**						
Intake® Hiload Gold – Crop Care	flutriafol (500 g/L)	200 mL	4.85	5–1000 L	Blackleg				

* Wettable granule formulation. ## Prices quoted are GST Inclusive at 15 January 2016 and approximate only. Prices will vary depending on pack size purchased, seed treatment services i.e. imidacloprid + fluquinconazole or Poncho Plus + fluquinconazole, and special marketing arrangements.

Price of Poncho Plus is included in the cost of the seed. Poncho plus can only be applied by accredited applicators. NA = not available.

Table 69. Cereal foliar fungicides – 2016 currently registered products (NSW) – winter cereals

Various trade names sometimes available under these active ingredients and concentrations. See specific labels for details.

Active and Concentration	Examples of commercial trade names		WHP (weeks) W – wheat B – barley		Cost/L[1]	Adjuvant (as per Label)	Diseases controlled[2]										Registered for aerial application
	Product	Manufacturer	Grazing	Harvest			Stripe rust	Stem rust	Leaf rust	Crown (leaf) rust	*Septoria tritici* blotch	*Septoria nodorum* blotch	Yellow spot	Barley scald	Net blotch	Powdery mildew	
Azoxystrobin 200 g/L + cyproconazole 80 g/L	Amistar® Xtra	Syngenta	3	6	$40.94	Barley – addition of Adigor® at 200 mL/100 L improves disease control at lower rates	400–800 mL (wheat) $16.38–$32.75	–	200–800 mL (wheat & barley[7]) $8.19–$32.75	–	–	–	400–800 mL (wheat) $16.38–$32.75	–	200–800 mL (barley) $8.19–$32.75	400–800 mL (wheat & barley) $16.38–$32.75	Yes
Azoxystrobin 75 g/L + Epoxiconazole 75 g/L	Radial®	Adama Australia	6 + ESI	6	$36.30	–	420–840 mL (wheat) $15.25–$30.49	420–840 mL (wheat) $15.25–$30.49	420–840 mL (wheat & barley) $15.25–$30.49	–	420–840 mL (wheat) $15.25–$30.49	420–840 mL (wheat) $15.25–$30.49	420–840 mL (wheat) $15.25–$30.49	420–840 mL (barley) $15.25–$30.49	420–840 mL (barley) $15.25–$30.49	420–840 mL (wheat & barley) $15.25–$30.49	Yes
Azoxystrobin 120 g/L + tebuconazole 200 g/L	Custodia®	Adama Australia	3 +ESI	6	$57.20	–	315–630 mL (wheat) $18.02–$36.04	315–630 mL (wheat) $18.02–$36.04	315–630 mL (wheat & barley[7]) $18.02–$36.04	–	630 mL (wheat) $36.04	315–630 mL (wheat) $18.02–$36.04	315–630 mL (wheat) $18.02–$36.04	315 mL (barley) $18.02	315–630 mL (barley[8]) $18.02–$36.04	315–630 mL (barley) $18.02–$36.04	Yes
Epoxiconazole 125 g/L	Opus® 125	Nufarm	6 + ESI	6	$23.67	200 mL/100 L Chemwet may assist in certain conditions	250–500 mL (wheat) $5.92–$11.84	–	500 mL (wheat) 250–500 mL (barley) $5.92–$11.84	–	–	250–500 mL (wheat) $5.92–$11.84	–	250 mL (barley) $5.92	250–500 mL (barley[6]) $5.92–$11.84	250 mL (wheat & barley) $5.92	Yes
Fenbuconazole 240 g/L	Indar®	Dow AgroSciences	2 + ESI	NR	$25.85	500 mL/100 L Uptake Spraying Oil	150–300 mL (wheat) $3.88–$7.76	–	–	–	–	–	–	–	–	–	No
Flutriafol 250 g/L	Intake® Combi	Crop Care	7-W 10-B	7-W 10-B	$17.49	200 mL/100 L BS1000®	250–500 mL (wheat) $4.37–$8.75	–	250–500 mL (wheat) $4.37–$8.75	–	250–500 mL (wheat) $4.37–$8.75	250–500 mL (wheat) $4.37–$8.75	–	–	–	250–500 mL (barley) $4.37–$8.75	Yes
Flutriafol 500 g/L	Jubilee® Loaded	Adama Australia	7-W 10-B	7-W 10-B	$34.65	200 mL/100 L BS1000®	125–250 mL (wheat) $4.33–$8.66	–	125–250 mL (wheat) $4.33–$8.66	–	125–250 mL (wheat) $4.33–$8.66	125–250 mL (wheat) $4.33–$8.66	–	–	–	125–250 mL (barley) $4.33–$8.66	Yes
Propiconazole 250 g/L[##]	Tilt®	Syngenta	1	4	$15.06	Not required	250–500 mL (wheat)^^^ $3.77–$7.53	500 mL (wheat & oats) $7.53	150–500 mL (wheat) $2.26–$7.53	250–500 mL (oats) $3.77–$7.53	250–500 mL (wheat & oats[4]) $3.77–$7.53	150–500 mL (wheat) $2.26–$7.53	250–500 mL (wheat) $3.77–$7.53	500 mL (barley) $7.53	250–500 mL (barley) $3.77–$7.53	150–500 mL (wheat & barley) $2.26–$7.53	Yes
Propiconazole 435 g/L	PropiMax®	Dow AgroSciences	1	4	$30.36	Not required	145 mL or 285 mL (wheat) $4.40–$8.65	285 mL (wheat & oats) $8.65	85–285 mL (wheat) $2.58–$8.65	145–285 mL (oats) $4.40–$8.65	145–285 mL (wheat & oats[4]) $4.40–$8.65	145–285 mL (wheat) $4.40–$8.65	145–285 mL (wheat) $4.40–$8.65	285 mL (barley) $8.65	285 mL (barley[5]) $8.65	85–285 mL (wheat & barley) $2.58–$8.65	Yes
Propiconazole 500 g/L	Throttle®500	Nufarm	1	4	$32.45	Not required	125 mL or 250 mL (wheat) $4.06–$8.11	250 mL (wheat & oats) $8.11	75–250 mL (wheat) 125–250 mL (barley) $2.43–$8.11	125–250 mL (oats) $4.06–$8.11	125–250 mL (wheat & oats[4]) $4.06–$8.11	75–250 mL (wheat) $2.43–$8.11	125–250 mL (wheat) $4.06–$8.11	250 mL (barley) $8.11	125–250 mL (barley) $4.06–$8.11	75–250 mL (wheat & barley) $2.43–$8.11	Yes
Propiconazole 250 g/L + cyproconazole 80 g/L	Tilt® Xtra	Syngenta	3 + ESI	6	$41.11	Not required	250–500 mL (wheat) $10.28–$20.56	500 mL (wheat) $20.56	150–500 mL (wheat & barley[3]) $6.17–$20.56	–	250–500 mL (wheat) $10.28–$20.56	150–500 mL (wheat) $6.17–$20.56	250–500 mL (wheat) $10.28–$20.56	500 mL (barley) $20.56	250–500 mL (barley) $10.28–$20.56	150–500 mL (wheat & barley) $6.17–$20.56	Yes
Propiconazole 250 g/L + Tebuconazole 250 g/L	Cogito™	Syngenta	2	5	$30.15		125 mL or 250 mL (wheat) $3.77–$7.54	125–250 mL (wheat) 250 mL (oats) $3.77–$7.54	125–250 mL (wheat & barley) $3.77–$7.54	125–250 mL (oats) $3.77–$7.54	125–250 mL (wheat & oats[4]) $3.77–$7.54	125–250 mL (wheat) $3.77–$7.54	125–250 mL (wheat) $3.77–$7.54	250 mL (barley) $7.54	125–250 mL (barley) $3.77–$7.54	125–250 mL (wheat & barley) $3.77–$7.54	Yes

Table 69. Cereal foliar fungicides – 2016 currently registered products (NSW) – winter cereals (continued)

Active and Concentration	Examples of commercial trade names		WHP (weeks) W – wheat B – barley		Cost/L[1]	Adjuvant (as per Label)	Diseases controlled[2]										Registered for aerial application
	Product	Manufacturer	Grazing	Harvest			Stripe rust	Stem rust	Leaf rust	Crown (leaf) rust	*Septoria tritici* blotch	*Septoria nodorum* blotch	Yellow spot	Barley scald	Net blotch	Powdery mildew	
Prothioconazole 210 g/L + tebuconazole 210 g/L	Prosaro® 420 [8]	Bayer CropScience	2	5	$77.15	Various(adjuvants required for some diseases) – As per label directions	150–300 mL (wheat & triticale) $11.57–$23.15	150–300 mL (wheat) 300 mL (oats) $11.57–$23.15	150–300 mL (wheat & barley) $11.57–$23.15	300 mL(oats) $23.15	–	150–300 mL (wheat) $11.57–$23.15	150–300 mL (wheat) $11.57–$23.15	150–300 mL (barley) $11.57–$23.15	150–300 mL (barley) $11.57–$23.15	150–300 mL (wheat & barley) $11.57–$23.15	Yes
Pyraclostrobin 85 g/L + epoxiconazole 62.5 g/L	Opera®	BASF	3 + ESI	NR	$31.98	Non-ionic surfactant (not specified)	500 mL (wheat) $15.99	500 mL (wheat) $15.99	500–1000 mL (wheat) 500 mL (barley) $15.99–$31.98	–	500 mL (oats) $15.99	500 mL (wheat) $15.99	–	500 mL (barley) $15.99	500–1000 mL (barley) $15.99–$31.98	500 mL (wheat) 500–1000 mL (barley) $15.99–$31.98	Yes
Tebuconazole 430 g/L[##]	Folicur®	Bayer CropScience	2	5	$13.75	1% D-C-Trate or equivalent may improve results	145–290 mL (wheat)^^^ $1.99–$3.99	145–290 mL (wheat & oats) $1.99–$3.99	145–290 mL (wheat) $1.99–$3.99	145–290 mL (oats) $1.99–$3.99	290 mL (wheat) $3.99	145–290 mL (wheat) $1.99–$3.99	145–290 mL (wheat) $1.99–$3.99	145 mL (barley) $3.99	–	145–290 mL (barley) $1.99–$3.99	Yes
Tebuconazole 225 g/L + flutriafol 75 g/L	Impact Topguard®	Cheminova	2-W 10-B	7-W 10-B	$16.50	100 mL/100 L of Ospray 1000 or 1 L/100 L D-C-Trate	200 mL or 400 mL (wheat) $3.30–$6.60	–	200 mL or 400 mL (wheat) $3.30–$6.60	–	200 mL or 400 mL (wheat) $3.30–$6.60	200 mL or 400 mL (wheat) $3.30–$6.60	–	–	–	200 mL or 400 mL (barley) $3.30–$6.60	Yes
Tebuconazole 45 g/kg + sulfur 700 g/kg	Unicorn 745 WG	Sulphur Mills Aust. Limited	2	5	–	–	1.37 kg/ha or 2.75 kg/ha (wheat)	1.37 kg/ha or 2.75 kg/ha (wheat & oats)	1.37 kg/ha or 2.75 kg/ha (wheat)	1.37 kg/ha or 2.75 kg/ha (wheat & oats)	2.75 kg/ha (wheat)	1.37 kg/ha or 2.75 kg/ha (wheat)	1.37 kg/ha or 2.75 kg/ha (wheat)	1.37 kg/ha (barley)		1.37 kg/ha or 2.75 kg/ha (barley)	No
Triadimefon 125 g/L	Triadimefon 125 EC	Genfarm	Not stated, see footnote $	4	$6.55	Not required	500 mL or 1000 mL (wheat)^^^ $3.28–$6.55	–	–	–	–	–	–	1,000 mL (barley) $6.55	–	1,000 mL (barley) $6.55	Yes
Triadimefon 500 g/kg	Triadimefon 500WG	Cheminova	Not stated, see footnote@	4	$19.76	Not required	125–250 g (wheat) $2.47–$4.94	–	125–250 g (wheat) $2.47–$4.94	–	125–250 g (wheat) $2.47–$4.94	–	–	–	–	250 g (barley) 125–250 g (wheat) $2.47–$4.94	Yes

Notes:

1 Indicative costs only: significantly Lower prices are often obtained for bulk purchases of commonly used products.

2 Body of table shows rate mL/ha, g/ha and associated cost $/ha for registered products.

3 Rate on barley is 250–500 mL.

4 Propiconazole and propiconazole + tebuconazole is registered for suppression of Septoria leaf blotch in oats.

5 Spot form of net blotch.

6 Net form of net blotch only.

7 Rate on barley is 200–800 mL.

8 Prosaro® 420 is registered for the control of Fusarium head blight.

9 Suppression only.

Various formulations and active ingredient concentrations of propiconazole and tebuconazle are available.

@ Do not mix leaves treated with this product with feed intended for animal consumption.

$ Feed treated with this product must not be used for animal consumption, poultry feed or mixed with animal feed.

+ ESI Export slaughter interval applies. Do not slaughter animals destined for export within 7 days of consumption of treated cereal forage or straw.

NR Not required when used as directed.

^^^ i.e. Permit PER 12654, expiry 31/03/17 – Stripe rust control in triticale – use under permit, tebuconazole 430 g/L, tebuconazole 500 g/L, propiconazole 250 g/L, tridimefon 125 g/L based products, see permit for full use patterns. www.ampva.gov.au

Growers applying a foliar fungicide to control rust or other diseases need to observe the withholding period (WHP). Fungicides applied late, closer to harvest, may produce an excessive, illegal residue if applied within the WHP. For most of the fungicides registered to control diseases in winter cereals, the maximum residue Limit (MRL) is set very low, at the limit of detection. A residue above the MRL is illegal under the *Pesticides Act 1999* and renders the offender liable to prosecution and a fine. Excessive residues also put Australia's export trade at risk. If it is necessary to apply a fungicide late, select a product with a short WHP.

Table 70. Canola and pulse foliar fungicides – 2016 Foliar fungicides for canola, chickpea, field pea, faba bean and lupin

Example foliar fungicide trade name and manufacturer	Active ingredient	Harvest withholding period (WHP) – weeks/days		Rate to apply per hectare (L/ha or kg/ha)	Cost of product per Litre ($)	Size of pack (kg or L – range of pack sizes)	Canola	Chickpea	Field pea	Faba bean	Lupin
		Harvest	Grazing								
Bravo® Weather Stik – Syngenta	chlorothalonil (720 g/L)	7 days	Do not graze	1.4–2.3 L	13.20	10–100 L 5–200 L	–	–	–	Chocolate spot, rust	–
Barrack® Betterstick – Crop Care	chlorothalonil (720 g/L)	7 days	Do not graze	1.4–2.3 L (Faba beans) 1.0-2.0 L(Chickpeas)	13.20	10–100 L 5–200 L	–	Ascochyta blight	–	Chocolate spot, rust	–
Barrack® 720 – Crop Care Unite® 720 – Nufarm	chlorothalonil (720 g/L)	14 days	14 days	1.4–2.3 L (faba beans) 1.0–2.0 L (chickpeas)	13.20	5–200 L 5–1000 L	–	Ascochyta blight	–	Chocolate spot, rust	–
Echo® 900 Fungicide – Sipcam	chlorothalonil (900 g/kg)	14 days	14 days	1.2–1.9 kg (faba beans) 0.8-1.6 kg (chickpeas)	17.55	1–20 kg	–	Ascochyta blight	–	Chocolate spot, rust	–
Rovral® Liquid – FMC Iprodione Liquid 250 – Cheminova	iprodione (250 g/L)	42 days	42 days	2.0 L	18.30	5–1000 L	Sclerotinia stem rot	–	–	–	–
Dithane® Rainshield Neo Tec Fungicide – Dow AgroSciences	mancozeb (750 g/kg)	28 days	14 days	1.0–2.2 kg	9.50	20 kg	–	Ascochyta blight, Botrytis grey mould	Ascochyta blight (blackspot)	Ascochyta blight, chocolate spot, Cercospora, rust	Anthracnose
Manzate® DF – Sipcam	mancozeb (750 g/kg)	28 days	14 days	1.0–2.2 kg	9.50	10–20 kg	–	Ascochyta blight, Botrytis grey mould	Ascochyta blight, (blackspot)	Ascochyta blight, chocolate spot, rust	Anthracnose
Penncozeb® 750 DF – Nufarm	mancozeb (750 g/kg)	28 days	14 days	1.0–2.2 kg	10.45	10 & 20 kg	–	Ascochyta blight	Ascochyta blight, (blackspot)	Ascochyta blight, chocolate spot, Cercospora,rust	Anthracnose
Polyram® DF – Nufarm	metiram (700 g/kg)	6 weeks	21 days	1.0–2.2 kg	13.20	15 kg	–	Ascochyta blight, Botrytis grey mould	Ascochyta blight, (blackspot)	Ascochyta blight, chocolate spot, Cercospora, rust	–
Fortress® 500 – Crop Care Sumisclex® Broadacre – Sumitomo	procymidone (500 g/L)	Canola not required Faba beans 9 days	9 weeks Not stated	1.0 L (canola) 0.5 L (faba bean)	49.55	5–10 L 20 L	Sclerotinia stem rot	–	–	Chocolate spot	–
Prosaro® 420 SC – Bayer CropScience	prothioconazole (210 g/L) + tebuconazole (210 g/L)	Not required	14 days	375–450 mL/ha	77.00	5–20 L	Blackleg, Sclerotinia stem rot	–	–	–	–
Folicur® 430 SC – Bayer CropScience Hornet® – Nufarm	tebuconazole (430 g/L)	3 days PER13752 21 days	3 days PER13752 14 days	145 mL	13.20	Folicur 5–60 L Hornet 20 L	–	–	Powdery mildew	Cercospora (PER13752, expiry 30/06/16)	–
Triadimefon 125EC – Cheminova	triadimefon (125 g/L)	14 days	Not stated	500 mL	6.00	5–1000 L	–	–	Powdery mildew	–	–

Note: New labelling and rescheduling applies to all procymidone products. Health warnings are in place for pregnant women. Prices quoted are GST Inclusive at 15 January 2016 and approximate only. Prices will vary depending on pack size purchased.

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