NSW GOVERNMENT
Department of Primary Industries

Winter crop variety sowing guide 2018

NSW DPI MANAGEMENT GUIDE

Peter Matthews, Don McCaffery and Leigh Jenkins

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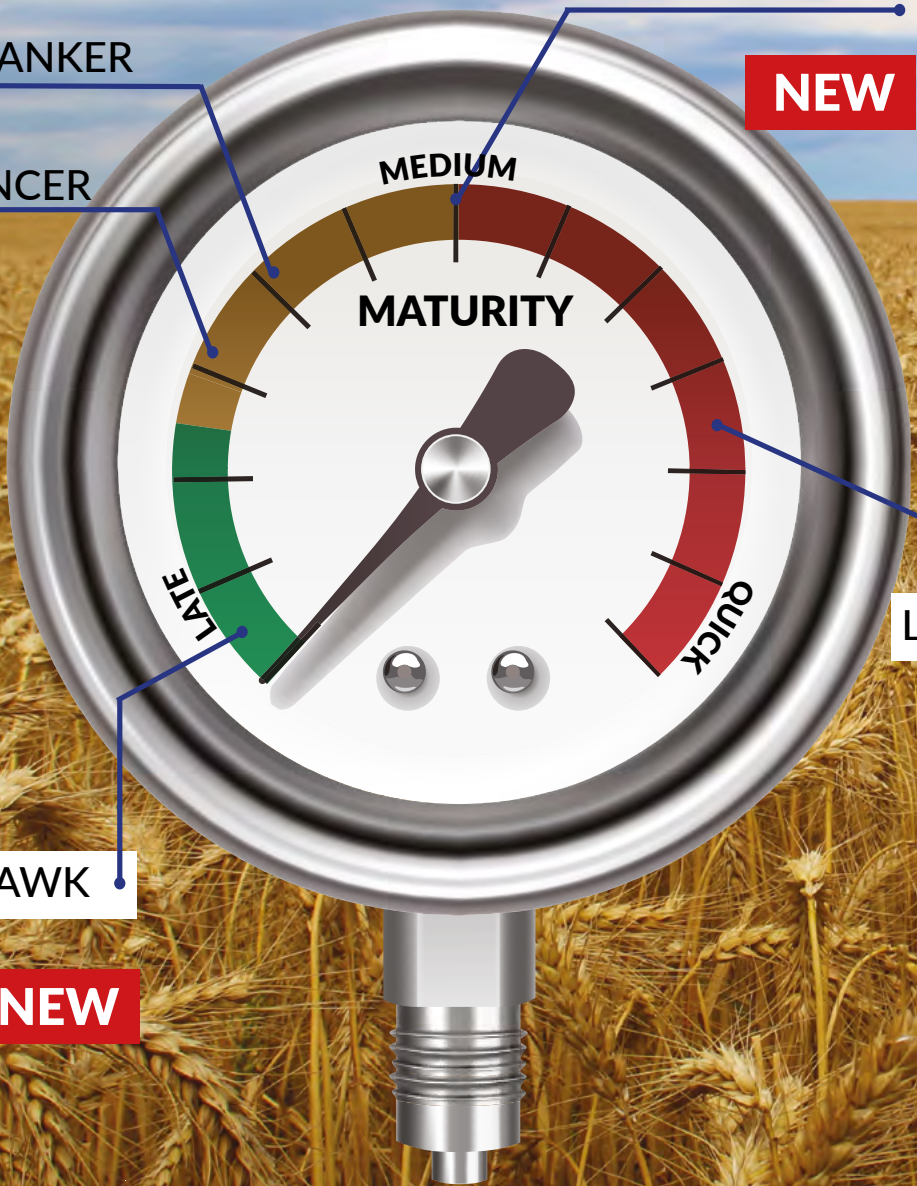

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Introduction

Welcome to the 2018 edition of the *Winter crop variety sowing guide*, published each year by the NSW Department of Primary Industries (NSW DPI). The aim of this guide is to help grain growers and their advisers make better cropping decisions and higher profits from winter crops.

Profit depends on choosing the most suitable variety for each paddock and sowing time, optimising tactical crop management to achieve the chosen variety's yield potential, and matching the end product of both variety choice and management to available markets. This guide is updated annually with new variety and technical information, based on the latest research and development results from both NSW DPI and industry programs.

Cropping decisions can also be influenced by the complexities of modern technology, fluctuating markets and the vagaries of seasonal conditions, notwithstanding the impact of climate change on weather patterns in more recent times. These factors all contribute to the winter crop producer's need for careful planning and management to optimise productivity and profitability.

Profitable winter crop growing demands a higher production per unit area at a lower cost per unit of production. This can be achieved by increasing grain yields through adopting new or improved technology, including variety choice and management options. The goal is not higher total production, but greater productivity from the resources invested in crop production, along with total sustainability of the farm business. Carefully consider the range of information contained in this guide, how it can be applied to your farm business, and 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 2018). 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 or the user's independent adviser.

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Acknowledgments

We gratefully acknowledge the Grains Research and Development Corporation (GRDC) for the financial support of the many research, extension and industry based projects from which information has been gathered for this publication. Yield and disease data for this publication is sourced from the National Variety Testing (NVT) program which is a GRDC initiative.

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: Wheat crop, Holbrook NSW. Inset: left – Sheep grazing on a cereal variety trial, Wagga Wagga; middle – dual-purpose grazing cereal trial, Holbrook; right – harvesting a wheat crop, Lockhart NSW. Photographer: Peter Matthews, NSW DPI.

This book is printed on Monza Satin stock, which is made from 99% recycled paper.

Plant Breeder's Rights

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

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.

Contents

Highlights and changes 2018

Cereal diseases

Wheat stripe rust: Growers will be faced with a potentially new strain of strip rust in 2018. A new strain was detected in Victoria during the 2017 season. It is currently being tested to determine what affect it will have on popularly grown wheat varieties. Until variety screening is completed and specific varietal reactions are known, growers and agronomists are urged to actively monitor crops through the season for any signs of stripe rust. If stripe rust is found in a variety previously considered resistant, samples should be collected and submitted to the National Cereal Rust Survey (see Managing grazing cereals on page 70), before applying fungicide to the crop.

Barley yellow dwarf virus **(BYDV)**: BYDV was present at low levels in most regions in 2017. With the currently dry autumn conditions in 2018 across NSW, growers are advised to treat any early-sown cereals with a registered insecticidal seed dressing to reduce aphid feeding and BYDV spread.

Crown rot: Crown rot was widespread throughout NSW in 2017 with the dry spring conditions worsening its affect on crops. The dry summer and autumn of 2018 have slowed crop stubble breakdown, so inoculum levels are expected to be high in infected paddocks. Growers are urged to test for crown rot inoculum levels in paddocks before sowing using the PreDicta® B test.

Smuts in cereals: With the increased areas sown to more flag-smut-susceptible barley types such as Hindmarsh$^{\phi}$, LaTrobe$^{\phi}$, Rosalind$^{\phi}$ and Spartacus CL$^{\phi}$, growers are encouraged to ensure all sowing seed is treated with an effective seed dressing and all seed checked as free from visibly smut-infected grain. 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.When considering a new variety, compare the yield, grain quality and disease resistances of the new variety with the currently grown varieties.

Varietal changes

Wheat. One new Australian Prime Hard wheat variety was released in the 2017 season, LRPB Mustang$^{\phi}$. LRPB Mustang$^{\phi}$ is a short season variety, suited to all growing region of NSW. A high-yielding mid season red wheat, RGT Zanzibar was also released and is suited to medium–high rainfall zones or irrigated production. There are a number of newly available wheat varieties yet to receive classification in NSW, including Longsword$^{\phi}$, a new winter wheat suitable for grazing and released for the medium–low rainfall zones of NSW, and Tungsten$^{\phi}$, a short season wheat variety. Until these varieties are classified, they are considered feed quality only.

A number of released wheat varieties had an upgrade in classification for the 2017 harvest and 2018 season, including Coolah$^{\phi}$, Cutlass$^{\phi}$, DS Darwin$^{\phi}$, Scepter$^{\phi}$ and Sunmax$^{\phi}$. The variety characteristics and reactions to diseases table for wheat on page 24 lists the maximum quality classification of varieties at the time of publishing. Some newer varieties might not have a final classification for all NSW regions pending further sample testing.

Barley. Compass$^{\phi}$ and Spartacus CL$^{\phi}$ now are both accredited malt barley varieties.

Oats. A new milling oat Kowari$^{\phi}$ was released by the National Oat Breeding Program in 2017. It is similar in maturity to Mitika$^{\phi}$ and suited to NSW. Kowari$^{\phi}$ has improved ß-glucan content, with high protein and groat percentage and has a low hull lignin content.

Canola. There are 10 new releases for 2018.

Nuseed® Quartz is a new conventional hybrid. Hyola® 50 and SF Sensation have been withdrawn.

Hyola® 350TT and HyTTec Trophy are two new TT hybrids. Hyola® 450TT, Monola® 314TT and Pioneer Atomic TT have been withdrawn.

Pioneer® 43Y92 (CL), Saintly CL and Victory® V7002CL are three new CLEARFIELD® hybrids. Archer, Carbine, Hyola® 474CL, Hyola® 577 CL, Pioneer 43Y85 (CL), Pioneer 44Y87 (CL) and Pioneer 44Y89 (CL) have been withdrawn.

DG 408RR, Hyola® 506RR, InVigor R 3520 and Pioneer® 44Y27 (RR) are new Roundup Ready® hybrids. Hyola® 525RT, Hyola® 725RT, Hyola® 600RR, IH30 RR, Monola® 513GT, Nuseed GT50, Pioneer 44Y24 (RR) and Pioneer 44Y26 (RR) have been withdrawn.

Small changes have been made to Table 41. Suggested sowing times on page 74; sowing up to one week earlier in central and southern NSW, but only with varieties with slower phenology i.e. not flowering before late July/early–mid August depending on location.

The most recent ***Blackleg management guide*** resistance ratings and resistance groups for new varieties are also included for 2018.

Chickpea. There are no new chickpea variety releases for NSW in 2018, although a new line CICA1303 has been released for growing areas in central Qld.

PBA Seamer$^{\phi}$ (released in 2016) has attracted strong interest in the northern region due to its higher level of ascochyta blight resistance than current northern desi varieties. It accounted for an estimated 40% of the chickpea area in 2017 following the extreme Ascochyta challenges experienced in crops in the wet 2016 season.

Seasonal conditions in 2017 were a complete contrast to 2016, with northern and southern areas experiencing many frosts. Southern NSW was particularly hard hit in both severity (lows of minus 7 °C) and number.

This, along with extremely dry conditions through to September, severely limited yield potential; however, good rainfall in mid October meant that any grain that had been set could fill, saving many crops from complete failure. Harvest was also challenging due to the late rains that caused a second flush of growth and pods, resulting in harvest timing difficulties with the increase in smaller, defective seeds.

After early outbreaks of Ascochyta in June–July 2017, overall levels were low of the four key chickpea diseases (Ascochyta, Phytophthora, Sclerotinia and Botrytis) throughout northern NSW; consequently, there will be lower amounts of inoculum from 2017 to infect 2018 crops. However, dry conditions in 2017 means some Ascochyta inoculum from 2016 (very high levels) and the June–July 2017 outbreaks will have survived into the coming 2018 season.

A change in virulence in the Ascochyta pathogen population has occurred in Victoria, South Australia, New South Wales and Queensland. This has resulted in separate resistance ratings for southern and northern Australia. In southern Australia, current varieties are rated as either susceptible (S) or moderately susceptible (MS) to Ascochyta. This follows observations of severe Ascochyta on previously resistant varieties in 2015, 2016 and 2017 across South Australia and Victoria. Severe Ascochyta was also observed in 2017 on PBA Seamer$^{\Phi}$ which, when released in 2016, was rated Resistant (R) to Ascochyta.

Faba bean. There are no new faba bean variety releases for 2018. The bean aphid (*Megoura crassicauda*) was identified at Tamworth and on the Liverpool Plains – potentially of great importance to the Australian faba bean industry. A native of north-eastern Asia (Korea, Japan, Siberia), this aphid species was only described in Australia in 2016 when it was found on broad beans in a Sydney home garden.

Observations during the 2017 season at the Liverpool Plains Field Station show this aphid to have an extremely fast reproduction rate and an ability to create large colonies on faba bean plants in just a few days. Host preference trials at Tamworth are ongoing, but indicate that the aphid has a very limited host range. Fortunately, faba bean is its preferred host, but it can survive on a number of vetch species and also feeds and multiplies on field peas. The aphid does not feed on chickpeas, lupins or lucerne. Its risk to the faba bean industry is primarily through feeding damage, but preliminary virus transmission studies have demonstrated its ability as a vector for a number of non-persistently transmitted viruses such as *Bean yellow mosaic virus* (BYMV) and *Pea seed-borne mosaic virus* (PSbMV).

So far, the aphid has not been found in commercial crops, but growers and advisers should report any suspicious aphid activity.

Field pea. PBA Bateman$^{\Phi}$ is a new release for 2018. It has performed well in the eastern cropping zones of NSW where virus infection from *Cucumber mosaic virus* and *Bean yellow mosaic virus* can cause significant yield loss in susceptible varieties when seasonal conditions are conducive to high aphid numbers. Field pea is now the preferred pulse for brown manuring in central and southern NSW, where a double-break is being adopted for weed, soil fertility and soil water management, and for following canola and wheat crops. It is also the most suitable pulse for crop-topping to control weed seed set.

Lupin. The narrow-leaf lupin PBA Bateman$^{\Phi}$ and the albus lupin Murringo$^{\Phi}$are new releases for 2018. PBA Bateman$^{\Phi}$ offers major yield improvements over current varieties, particularly in the eastern cropping zones of NSW where virus infection from *Cucumber mosaic virus* and *Bean yellow mosaic virus* can cause significant yield loss in susceptible varieties; however, seed will be in limited supply for 2018. Murringo$^{\Phi}$ has similar yield potential and disease resistance to Luxor$^{\Phi}$; however, like Luxor$^{\Phi}$ and Rosetta$^{\Phi}$ it is very susceptible to anthracnose.

Following anthracnose detection in a small number of commercial lupin crops in southern NSW in 2016, a biosecurity restriction zone was put in place that aimed to eradicate the disease. No disease was found in 2017, but surveying for the disease will continue in 2018 before disease-free status can be declared. PBA Jurien$^{\Phi}$ and PBA Barlock$^{\Phi}$ are R whilst PBA Gunyidi$^{\Phi}$ (R–MR) and Mandelup$^{\Phi}$ (MR) are slightly more susceptible. All other narrow-leaf and albus lupin varieties are susceptible to anthracnose. More information including management strategies is available in the **Lupin** chapter.

Interpreting variety trial results

The National Variety Trial (NVT) data presented in the *Winter crop variety sowing guide* are long-term multi environment trial (MET) results. These results are currently the most accurate and reliable means of interpreting variety performance across sites and years. Within the limitations of the printed guides format, results are presented for the main cereal types (wheat, barley, triticale and oats) on both a separate yearly regional mean basis (2013, 2014, 2015, 2016 and 2017) and on a combined regional mean basis that has been presented in previous editions of the guide. For crop types with a smaller number of testing sites (canola and pulse crops), MET's are presented only on a combined regional mean basis. The yearly regional mean values presented in the Guide have been extracted from the NVT 'Long term yield report App' and values are only shown for a variety when the variety was present at sites in that year. For consistency the data has been extracted at the default values of accuracy and VAF filters, which are ≥0.8 and ≥50% respectively within the App. Users can change these depending on their risk acceptance, under the 'Advanced' tab on the web tool. Definitions of the filters 'Accuracy' and 'VAF' can be found within the web tool. The regional mean yields shown in the guide are average varietal performance across trial locations within each year or region. This averaging can mask the variety by environment interaction, that is, the ability of a variety to yield differently at each location across seasons (years). For growers and agronomists wishing to further interrogate the NVT results on a varieties performance across the state, go to the **NVT site (**www.nvtonline.com.au). On the website locate the 'Long term yield report App'. This web tool gives users the ability to view data in yield based groupings and/or seasonal outcome across states, regions or selected trials down to a single site level.

The individual trial results for 2017 can also be located by using the interactive map on the NVT website home page and selecting the site of interest.

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 pre-harvest 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.

Growers can grow the varieties of their choice regardless of classification zone and deliver them to selected clients on a negotiated basis. 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. Some varieties sown too early will flower in late winter. Avoid this as it can result in crops flowering in late winter, when frosts can cause damage leading to a reduced yield and which can also affect grain quality. 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.
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 carefully chosen 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.

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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 (plants per m^2)
- germination percentage (90% = 90 in the formula)
- seed size (1000 seed weight in grams)
- 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 (plants/m^2)		establishment percentage × germination percentage
.....35.....	×	.....140.....	× 100 ÷	(80 × 90)

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

Your calculation

1000 seed weight # (grams)		target plant population (plants/m^2)		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. Growers should soil test before sowing, or if a deficiency is observed in crop, take plant tissue samples and have them tested. Consult your agronomist on interpreting soil or plant tissue test results.

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. Further information on weed control strategies is in the management guide ***Weed control in winter crops***.

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.

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Northern NSW – Varieties

Yield performance experiments from 2012–2017.

The yield results presented are NVT 'Production Value' multi environment trial (MET) data shown on a yearly regional group mean and regional mean basis from 2012–2017. Further results can be found on the **NVT website** (www.nvtonline.com.au).

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

	North east				
	Yearly group mean			Regional mean	Number of trials
Variety	2012	2015	2016		
% EGA_Wedgetail (t/ha)	3.24	3.15	5.26	3.43	
EGA_Wedgetail ■	**100**	**100**	**100**	**100**	**9**
Einstein ■	–	107	64	82	6
Longsword ■	–	–	121	134	2
LRPB Kittyhawk ■	–	112	105	109	6
Mackellar ■	93	97	92	93	9
Manning ■	–	83	73	73	7
Naparoo ■	98	65	101	88	9
RGT Accroc ■	–	106	105	102	6
SF Adagio ■	–	110	98	102	7
SF Scenario ■	–	92	89	88	7
SQP Revenue ■	87	87	95	86	9
Sunlamb	103	122	93	108	8
Wylah ■	97	91	100	96	9

■ Winter wheat

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

	North east						
	Yearly group mean					Regional mean	Number of trials
Variety	2013	2014	2015	2016	2017		
% EGA_Gregory (t/ha)	3.11	3.94	4.17	5.16	3.52	4.04	
Coolah	–	107	103	106	113	108	17
Cutlass	–	–	–	–	115	108	2
DS Faraday	–	–	101	100	98	100	12
EGA Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**22**
EGA_Wedgetail ■	81	77	81	100	58	84	22
Kiora	108	98	92	101	102	100	22
Longsword ■	–	–	–	–	71	92	2
LRPB Flanker	–	105	104	105	107	105	17
LRPB Gauntlet	111	103	103	95	108	103	22
LRPB Gazelle*	98	93	83	101	–	94	20
LRPB Kittyhawk ■	–	–	81	96	59	83	12
LRPB Lancer	115	104	101	98	112	104	22
Mitch	115	106	101	106	112	107	22
Strzelecki	88	90	91	95	–	91	20
Sunlamb	–	–	85	98	59	85	12
Sunmax	–	–	90	104	84	94	12
Suntime	102	96	93	98	98	97	22
Sunvale	103	97	96	92	102	97	22
Sunzell	88	88	90	93	82	90	22
Feed wheats							
RGT Zanzibar	–	–	–	111	73	98	7

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

	North west						
	Yearly group mean					Regional mean	Number of trials
Variety	2013	2014	2015	2016	2017		
% EGA_Gregory (t/ha)	**2.78**	**3.21**	**4.23**	**4.90**	**2.13**	**3.50**	
Coolah	–	104	105	108	114	107	25
Cutlass	–	–	–	–	117	107	6
DS Faraday	–	–	100	101	96	99	19
EGA Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**31**
EGA_Wedgetail ■	86	87	73	97	60	84	31
Longsword ■	–	–	–	–	58	87	6
LRPB Flanker	–	103	105	106	106	105	25
LRPB Gauntlet	99	99	103	99	102	100	31
LRPB Gazelle*	102	99	86	98	–	98	25
LRPB Kittyhawk ■	–	–	72	95	58	82	19
LRPB Lancer	100	100	102	102	110	102	31
Mitch	102	103	103	108	114	106	31
Strzelecki	96	95	89	94	–	92	25
Sunlamb	–	–	76	97	56	84	19
Sunmax	–	–	88	102	90	95	19
Suntime	99	98	93	98	102	97	31
Sunvale	98	97	96	94	101	97	31
Sunzell	94	93	87	93	82	90	31

■ Winter wheat

* Soft/biscuit wheat variety.

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

Variety	North east						
	Yearly group mean					Regional mean	Number of trials
	2013	2014	2015	2016	2017		
% EGA_Gregory (t/ha)	**3.00**	**4.26**	**3.77**	**5.12**	**3.49**	**3.96**	
Beckom	–	–	108	100	114	106	15
Buchanan	–	–	106	105	102	105	15
Condo	109	111	109	100	110	107	26
Coolah	–	–	–	104	106	104	9
DS Faraday	–	–	102	–	104	102	9
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**26**
EGA Wylie	94	99	97	87	–	94	23
Elmore CL Plus	99	97	99	99	99	99	26
Jade	98	–	100	97	–	99	18
Janz	96	–	96	–	–	97	12
Livingston	108	104	105	94	109	102	26
LRPB Crusader	100	107	101	91	100	99	26
LRPB Dart	108	101	100	90	102	99	26
LRPB Flanker	–	105	104	104	105	104	20
LRPB Gauntlet	99	104	101	93	104	99	26
LRPB Impala*	106	100	102	106	100	103	26
LRPB Mustang	–	–	–	99	111	106	9
LRPB Reliant	–	110	109	101	111	106	20
LRPB Spitfire	104	102	101	91	101	99	26
Mitch	108	–	104	109	102	105	21
Scepter	–	–	–	–	111	107	3
Sunguard	99	101	100	95	–	99	23
Sunmate	109	103	106	–	112	103	20
Suntop	108	106	107	100	110	105	26
Sunvale	98	93	95	93	95	94	26
Tungsten	–	–	93	90	96	91	15
Wallup	106	105	104	94	105	102	26
Feed wheats							
B53	–	110	106	99	–	105	17

Variety	North west						
	Yearly group mean					Regional mean	Number of trials
	2013	2014	2015	2016	2017		
% EGA_Gregory (t/ha)	**2.49**	**3.65**	**3.26**	**5.14**	**1.88**	**3.40**	
Beckom	–	–	112	102	119	107	20
Condo	110	104	109	99	111	104	32
Coolah	–	–	–	105	106	103	14
DS Faraday	–	–	103	–	103	103	12
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**32**
EGA Wylie	96	95	101	88	–	94	26
Elmore CL Plus	100	99	98	100	107	100	32
Jade	97	–	101	97	–	98	20
Janz	–	–	94	–	–	99	6
Livingston	108	99	104	94	109	100	32
LRPB Crusader	98	97	102	91	96	96	32
LRPB Dart	101	92	93	90	97	93	32
LRPB Flanker	–	105	107	104	107	105	26
LRPB Gauntlet	100	98	104	96	99	99	32
LRPB Impala*	103	102	98	105	109	103	32
LRPB Mustang	–	–	–	98	116	104	14
LRPB Reliant	–	107	114	100	115	107	26
LRPB Spitfire	101	96	98	90	98	95	32
Mitch	105	–	98	107	105	104	26
Scepter	–	–	–	–	124	108	6
Sunguard	100	98	101	97	–	98	26
Sunmate	111	101	106	–	117	103	24
Suntop	109	103	106	99	111	104	32
Sunvale	95	93	92	93	94	94	32
Tungsten	–	–	96	92	112	96	20
Wallup	105	98	102	93	105	99	32
Feed wheats							
B53	–	103	108	99	–	103	20

* Soft/biscuit wheat variety.

Suggested sowing times – Northern

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 Northern NSW

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																			
Mackellar■, SF Adagio■, RGT Accroc■, SF Scenario■	>	★	★	★	★	★	★	★	<	<									
EGA_Wedgetail■, Kittyhawk■, Manning■, Naparoo■, SQP Revenue■		>	>	★	★	★	★	★	★	★	<								
Sunlamb				>	★	★	★	★	<										
Longsword■				>	★	★	★	★	★	<									
Sunbrook, Sunmax					>	★	★	★	<	<									
Kiora, Lancer, Suntime, Sunzell						>	★	★	★	★	<								
Coolah, DS Faraday, EGA_Gregory, Flanker, Gazelle, Mitch, RGT Zanzibar							>	★	★	★	<								
Beckom, EGA_Burke, EGA_Wylie, Sunvale, Sunvex								>	★	★	★	<							
Elmore CL PLUS, Impala, Janz, Merinda, Reliant, Sunguard, Suntop, Wallup									>	★	★	★	★	<					
Baxter, Jade										>	★	★	★	★	<	<			
B53, Condo, Crusader, Livingston, Mustang, Spitfire, Sunmate, Tungsten											>	★	★	★	★	<	<		
Dart												>	★	★	★	★	<	<	
Plains																			
EGA_Wedgetail■, Kittyhawk■, Longsword■, Sunlamb, Naparoo■				>	★	★	★	★	★	<									
Sunbrook					>	★	★	★	<	<									
Sunmax						>	★	★	★	<									
Kiora, Sunbri, Suntime, Sunzell,						>	>	★	★	★	★	<	<						
Coolah, DS Faraday, EGA_Gregory, Flanker, Gazelle, Lancer, Mitch								>	★	★	★	<							
Beckom, EGA_Burke, EGA_Wylie, Gauntlet, Sunvale, Sunvex									>	★	★	★	<						
Elmore CL PLUS, Impala, Janz, Merinda, Reliant, Sunguard, Suntop, Wallup									>	★	★	★	★	<	<				
Baxter, Jade										>	★	★	★	★	<	<			
B53, Condo, Crusader, Emu Rock, Livingston, Mustang, Spitfire, Sunmate, Tungsten											>	★	★	★	★	<			
Dart												>	★	★	★	★	<		

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

■ Winter wheat.

Note: For durum suggested sowing times see Table 15. Suggested sowing times, Durum wheat varieties on page 37.

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 5. Predicted mean coleoptile length for durum wheat varieties at 21 NVT sites across Australia from 2010–2015

Variety	Predicted mean coleoptile length (cm)
Caparoi	7.6
DBA_Aurora	7.6
DBA_Bindaroi	7.6
DBA_Lillaroi	7.9
DBA_Vittaroi	7.5
EGA_Bellaroi	7.9
Hyperno	7.8
Jandaroi	7.1
Kalka	7.5
Saintly	7.4
Tamaroi	8.1
Tjilkuri	7.7
WID802	7.7
Yawa	7.6
Check varieties	
Federation (long)	9.5
Whistler (short)	6.0

Table 6. Predicted mean coleoptile length for early and long season wheat varieties at 20 NVT sites across Australia from 2008–2015

Variety	Predicted mean coleoptile length (cm)
Beaufort	8.3
Bolac	5.7
Coolah	6.6
Cutlass	7.1
DS Darwin	5.6
DS Faraday	6.1
DS Pascal	5.8
EGA_Bounty	6.3
EGA_Burke	6.1
EGA_Eaglehawk	6.4
EGA_Gregory	6.3
EGA_Wedgetail	5.9
Einstein	5.8
Estoc	7.0
Flanker	6.2
Forrest	6.1
Gauntlet	6.6
Gazelle	5.8
Kiora	6.5
Kittyhawk	6.3
Lancer	6.7
Mackellar	6.2
Manning	5.8
Mitch	7.0
Naparoo	6.4

Variety	Predicted mean coleoptile length (cm)
Phantom	6.6
RGT Accroc	6.6
RGT Calabro	6.5
Rosella	7.0
Sentinel	6.3
SF Adagio	6.2
SF Moskito	6.7
SF Ovalo	9.0
SF Scenario	6.7
SQP Revenue	6.4
Strzelecki	6.5
Sunbri	6.7
Sunlamb	6.3
Sunmax	6.0
Sunsoft 98	5.9
Suntime	6.2
Sunzell	6.4
Tennant	7.2
Trojan	6.9
Wylah	6.1
Yenda	7.0
Check varieties	
Federation (long)	9.5
Whistler (short)	5.7

Table 7. Predicted mean coleoptile length for main season wheat varieties at 55 NVT sites from 2008–2015

Variety	Predicted mean coleoptile length (cm)
Arrow	6.5
Axe	6.0
B53	6.4
Barham	6.8
Baxter	7.1
Beckom	6.4
Buchanan	6.6
Chara	6.3
Clearfield Janz	6.4
Cobra	6.6
Condo	6.5
Corack	6.8
Correll	7.7
Crusader	6.7
Dart	7.2

Variety	Predicted mean coleoptile length (cm)
Diamondbird	6.6
DS Darwin	5.6
EGA_Gregory	6.4
EGA_Hume	6.5
EGA_Kidman	6.4
EGA_Wills	6.8
EGA_Wylie	6.9
Ellison	7.0
Elmore CL Plus	7.1
Emu Rock	6.5
Grenade CL Plus	6.6
Impala	5.7
Jade	6.2
Janz	7.0
Justica CL Plus	6.7

Variety	Predicted mean coleoptile length (cm)
Kord CL Plus	6.7
Lincoln	6.1
Livingston	6.6
Mace	6.9
Merinda	6.5
Merlin	7.2
QAL2000	7.2
QALBIS	6.7
Reliant	6.6
Scepter	6.6
Scout	7.3
Shield	6.6
Spitfire	7.1
Sunco	7.0
Sunguard	7.0

Variety	Predicted mean coleoptile length (cm)
Sunlin	6.7
Sunmate	7.1
Sunstate	6.4
Suntop	7.1
Sunvale	7.0
Sunvex	7.4
Tenfour	6.6
Tungsten	6.3
Wallup	6.3
Yitpi	7.8
Check varieties	
Federation (long)	9.8
Whistler (short)	5.9

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Southern NSW – Varieties

Yield performance experiments from 2012–2017.

The yield results presented are NVT 'Production Value' multi environment trial (MET) data shown on a yearly regional group mean and regional mean basis from 2012–2017. Further results can be found on the NVT website (www.nvtonline.com.au).

Table 8. Long season varieties (southern): Compared with EGA_Wedgetail = 100%

Variety	South east							
	Yearly group mean						Regional mean	Number of trials
	2012	2013	2014	2015	2016	2017		
% EGA_Wedgetail (t/ha)	4.95	3.39	3.72	4.77	5.84	4.16	4.55	
EGA_Wedgetail ■	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**21**
Einstein ■	–	–	114	92	97	102	102	17
Longsword ■	–	–	–	–	87	92	92	7
LRPB Kittyhawk ■	–	–	96	102	94	97	97	17
Mackellar ■	107	101	116	101	105	–	106	18
Manning ■	–	94	125	95	105	108	108	19
Naparoo ■	100	93	86	93	109	96	96	21
RGT Accroc ■	–	–	113	108	120	116	116	17
SF Adagio ■	–	111	115	105	108	111	110	19
SF Scenario ■	–	102	104	97	107	–	104	16
SQP Revenue ■	112	105	95	96	104	112	102	21
Sunlamb	104	–	92	100	99	101	99	19
Wylah ■	87	88	97	97	89	–	93	18

■ Winter wheat

Table 9. Early season variety trial results (sown before 15 May): Compared with EGA_Gregory = 100%

Variety	South east						
	Yearly group mean					Regional mean	Number of trials
	2013	2014	2015	2016	2017		
% EGA_Gregory (t/ha)	3.92	3.41	4.87	5.73	4.70	4.57	
Bolac	95	103	95	106	98	100	24
Coolah	–	111	105	110	108	108	19
Cutlass	–	–	105	111	107	108	14
DS Darwin	–	103	102	99	97	100	19
DS Faraday	–	–	102	100	101	101	14
DS Pascal	–	106	92	110	98	101	19
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**24**
EGA_Wedgetail ■	91	96	91	108	99	98	24
Estoc	102	107	–	–	–	103	10
Forrest	89	97	85	108	96	96	24
Kiora	97	107	96	109	100	102	24
Longsword ■	–	–	–	107	99	102	8
LRPB Flanker	–	106	105	105	107	105	19
LRPB Gauntlet	99	102	101	97	95	99	24
LRPB Gazelle*	92	103	87	109	–	98	22
LRPB Kittyhawk ■	–	–	90	105	94	96	14
LRPB Lancer	100	106	101	103	98	102	24
LRPB Trojan	109	116	111	112	112	112	24
Mitch	104	112	–	–	–	108	10
Strzelecki	93	93	92	96	–	94	22
Sunlamb	–	–	93	104	97	97	14
Sunmax	–	–	96	109	104	102	14
Suntime	96	101	95	103	96	99	24
Sunvale	94	97	95	95	90	95	24
Sunzell	92	92	92	95	–	93	22
Feed wheats							
RGT Zanzibar	–	–	–	124	115	113	8

Table 9. Early season variety trial results (sown before 15 May): Compared with EGA_Gregory = 100% (continued)

Variety	South west#						
	Yearly group mean					Regional mean	Number of trials
	2013	2014	2015	2016	2017		
% EGA_Gregory (t/ha)	**3.21**	**4.20**	**3.61**	**5.20**	**4.91**	**4.14**	
Bolac	100	102	98	109	100	102	31
Coolah	–	107	109	112	107	109	24
Cutlass	–	–	110	115	107	111	17
DS Darwin	–	101	103	101	99	101	24
DS Faraday	–	–	101	100	100	100	17
DS Pascal	–	105	99	114	101	105	19
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**31**
EGA_Wedgetail ■	95	93	89	110	95	98	31
Estoc	105	106	106	106	–	106	28
Kiora	103	105	102	112	102	106	31
Longsword ■	–	–	–	114	97	102	10
LRPB Flanker	107	103	106	106	105	105	24
LRPB Gauntlet	99	101	103	100	99	100	31
LRPB Gazelle*	99	105	96	111	–	103	28
LRPB Kittyhawk ■	–	–	89	108	93	96	17
LRPB Lancer	103	105	105	106	101	104	31
LRPB Trojan	114	109	115	116	110	113	31
Mitch	110	108	–	–	–	110	14
Strzelecki	92	96	92	96	–	94	27
Sunlamb	–	–	90	106	94	96	17
Sunmax	–	–	97	110	101	103	17
Suntime	98	102	99	104	99	101	31
Sunvale	94	99	97	96	95	97	31
Sunzell	91	94	91	95	–	93	28
Feed wheats							
RGT Zanzibar	–	–	–	130	107	113	10

\# Includes irrigated trials
■ Winter wheat
* Soft/biscuit wheat variety.

Table 10. Main season variety trial results – Southern (sown after 14 May): Compared with EGA_Gregory = 100%

Variety	South east						
	Yearly group mean					Regional mean	Number of trials
	2013	2014	2015	2016	2017		
% EGA_Gregory (t/ha)	**3.59**	**3.68**	**4.66**	**5.84**	**4.35**	**4.46**	
Beckom	114	113	107	108	110	110	24
Buchanan	–	–	100	110	107	105	13
Chara	–	97	97	99	99	99	19
Condo	109	112	105	101	97	105	24
Coolah	–	–	–	103	105	104	8
Corack	–	108	104	100	102	104	19
DS Darwin	–	97	97	95	95	97	19
DS Faraday	–	–	100	99	98	100	13
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**24**
Elmore CL Plus	100	97	97	98	96	98	24
Emu Rock	107	103	100	96	95	100	24
Grenade CL Plus	99	93	94	91	90	93	24
Jade	99	–	96	98	–	97	16
Janz	101	–	95	–	–	95	10
Livingston	101	95	97	89	90	94	24
LRPB Cobra	110	109	103	106	102	106	24
LRPB Crusader	99	93	94	87	85	92	24
LRPB Dart	100	92	93	84	–	90	22
LRPB Flanker	–	104	102	106	104	104	19
LRPB Gauntlet	101	98	98	93	93	97	24
LRPB Impala*	102	98	98	100	100	99	24
LRPB Mustang	–	–	–	100	99	102	8
LRPB Reliant	–	103	103	97	98	100	19
LRPB Spitfire	101	94	94	90	88	93	24
LRPB Trojan	110	109	104	107	107	107	24
Mace	110	107	103	97	98	103	24
QAL2000*	96	92	93	101	–	96	10
QALBIS*	90	82	87	91	–	88	10
Scepter	–	–	106	105	111	108	13
Sunguard	99	98	97	96	–	97	22
Sunmate	102	97	97	–	–	95	16
Suntop	106	101	101	95	99	100	24
Sunvale	93	91	93	93	88	92	24
Tungsten	–	–	92	97	95	94	13
Wallup	105	102	99	97	95	100	24
Yenda*	87	80	84	100	95	90	15
Yitpi	98	95	95	98	98	97	24
Feed wheats							
B53	–	102	100	100	–	100	17
Tenfour	116	118	110	106	105	111	24

* Soft/biscuit wheat variety.

Table 10. Main season variety trial results – Southern (sown after 14 May): Compared with EGA_Gregory = 100% (continued)

Variety	South west#						
	Yearly group mean					Regional mean	Number of trials
	2013	2014	2015	2016	2017		
% EGA_Gregory (t/ha)	3.08	3.83	3.02	4.95	4.12	3.78	
Beckom	116	114	117	112	108	114	35
Chara	–	100	105	103	101	102	24
Condo	111	104	112	105	98	106	31
Coolah	–	–	–	104	105	107	10
Corack	116	111	115	102	104	109	35
DS Darwin	–	105	107	100	100	103	21
DS Faraday	–	–	102	–	99	102	10
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**30**
Elmore CL Plus	102	103	103	102	99	102	34
Emu Rock	111	103	111	100	99	104	35
Grenade CL Plus	104	101	102	95	96	99	35
Jade	–	–	102	102	–	100	14
Janz	102	–	105	98	98	101	23
Livingston	103	102	106	91	97	99	30
LRPB Cobra	112	111	116	114	103	112	35
LRPB Crusader	100	94	103	91	93	96	30
LRPB Dart	104	98	105	89	–	97	28
LRPB Flanker	–	104	103	107	102	104	24
LRPB Gauntlet	103	101	104	95	98	100	30
LRPB Impala*	106	105	104	103	102	104	30
LRPB Mustang	–	–	–	102	100	105	10
LRPB Reliant	–	102	100	95	98	99	24
LRPB Spitfire	104	100	105	94	96	99	30
LRPB Trojan	113	112	113	112	105	111	35
Mace	114	112	115	101	102	108	35
QAL2000*	100	108	100	106	–	104	7
QALBIS*	94	95	91	94	–	94	7
Scepter	–	–	119	107	110	115	20
Sunguard	101	98	101	99	95	99	30
Sunmate	105	111	108	–	–	103	20
Suntop	107	111	111	97	104	105	30
Sunvale	93	94	94	95	92	94	30
Tungsten	–	–	97	101	98	99	17
Wallup	106	100	109	102	99	103	30
Yenda*	91	102	90	107	97	99	8
Yitpi	103	97	97	99	98	99	35
Feed wheats							
B53	–	102	104	102	–	101	21
Tenfour	120	119	123	111	105	116	30

\# Includes irrigated trials
* Soft/biscuit wheat variety.

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Suggested sowing times – Southern

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 11. Suggested sowing times southern NSW

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																				
Mackellar ■, SF Adagio ■, RGT Accroc ■, SF Scenario ■		>	★	★	★	★	★	★	★	<	<									
EGA_Wedgetail ■, Kittyhawk ■, Manning ■, Naparoo ■, Rosella ■, SQP Revenue ■			>	>	★	★	★	★	★	★	★	<								
Sunlamb					>	★	★	★	★	<										
Longsword ■					>	★	★	★	★	★	<									
Sunmax						>	★	★	★	<										
Bolac, DS_Pascal, Forrest, Kiora, Sunzell , Suntime, Yenda							>	★	★	★	★	<								
Coolah, DS Faraday, EGA_Gregory, Flanker, Gazelle, Lancer, RGT Zanzibar								>	★	★	★	★	<							
Beckom, DS_Darwin, Estoc, , Sunguard, Suntop, Sunvale, Sunvex, Trojan									>	★	★	★	<							
Corack, Elmore CL PLUS, Grenade CL PLUS, Impala, Janz, Merinda, QALBis, QAL2000, Reliant, Scepter, Wallup										>	★	★	★	★	<					
B53, Condo, Crusader, Emu Rock, Livingston, Mustang, Spitfire, Sunmate, Tungsten											>	★	★	★	★	<				
Dart, Tenfour												>	★	★	★	★	<			
Plains																				
EGA_Wedgetail ■, Kittyhawk ■, Sunlamb, Rosella ■					>	★	★	★	★	<	<									
Longsword ■					>	★	★	★	★	★	<									
Sunmax						>	★	★	★	<										
Bolac, DS_Pascal, Kiora, Suntime, Yenda							>	★	★	★	★	<								
Coolah, DS Faraday, EGA_Gregory, Flanker, Gazelle, Lancer, Sunzell								>	★	★	★	★	<							
Beckom, DS_Darwin, Estoc, Gauntlet, Reliant, Scepter, Sunguard, Suntop, Sunvale, Sunvex, Trojan									>	★	★	★	<							
Cobra, Corack, Elmore CL PLUS, Grenade CL PLUS, Impala, Janz, Livingston, Mace, Merinda, QALBis, QAL2000, Wallup										>	★	★	★	<	<					
B53, Condo, Crusader, Emu Rock, Mustang, Spitfire, Sunmate, Tungsten										>	>	★	★	★	★	<				
Dart, Tenfour											>	>	★	★	★	★	<			

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

■ Winter wheat.

Note: For durum suggested sowing times see Table 15. Suggested sowing times, Durum wheat varieties on page 37. Varietal characteristics and reaction to diseases

Table 12. Varietal characteristics and reaction to diseases (page 1 of 3)

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 [4]	RLN *P. thornei* tolerance [5]	RLN *P. neglectus* resistance [4]	RLN *P. neglectus* tolerance [5]	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance		
Bread wheat																					
Beckom	AH	AH	S	MS–S	MR–MS	MS–S	MR–MS	MR–MS	S	MS–S	MS–S	T–MT	S [3]	MT–MI	R	MS	MS–S	MR–MS	T–MT	AGT	2015
Bolac	AH	APH	S	MS [2]	R–MR	S	MR–MS	R–MR	MS	MS–S	MR–MS	MI	MS–S	MI [3]	S	MS–S	S	MR	MI	Viterra	2006
Buchanan	NYC	NYC	S	MS	MS	MR	S	R–MR	MS–S	MR–MS	MR–MS [3]	T–MT [3]	MS [3]	MT [3]	MS	–	–	–	–	Austgrains	2015
Chara	AH	APH	S [3]	S [2]	MS	S	MR–MS	MS–S	MS–S	MS–S	MS	MT–MI	S–VS	–	R	MS	S	MR	I	DELWP Victoria	1998
Cobra	APW	AH	S	MS	S [3]	MR	R–MR	MS–S	MS–S	MR–MS	MS–S	MI	MS–S [3]	MT–MI [3]	MS	MS	S	R–MR	MT	LongReach	2011
Condo	AH	AH	S	MS–S	MS–S	S	MR	MS–S	S	MS	MS	T–MT	S	MT [3]	MR	MR–MS	S	MR–MS	MT	AGT	2014
Coolah	APH	APH	MS–S [3]	S	R	MR	MR	R–MR	MS–S	MS–S	MR–MS [3]	T–MT	MS–S [3]	T–MT [3]	S	S	S	MR–MS	MT	AGT	2016
Corack	APW	APW	S	MS	S	S–VS	MR	MS	S–VS	MR [3]	MS–S	MI	MS–S	MT [3]	R–MR	S	MS–S	MR	T–MT	AGT	2011
Crusader	APH	APH	S	MR–MS	MR	MS–S	R–MR	MS	S	MS	S	MI	S–VS	MI	MS	R–MR [1]	S	MR	MT	LongReach	2007
Cutlass	APH	AH	S [3]	MS	MS	R	R	MS	MS–S	MS–S	MS–S [3]	MI [3]	MS–S [3]	T–MT [3]	MR	MS	S	MR–MS	MT	AGT	2015
Dart	APH	APH	MS–S	MS	MS	S	MR	MR	S–VS	MS	MS	MI	MS–S	MI [3]	S	MR–MS	S	R–MR	MT	LongReach	2012
DS Darwin	ASW	AH	S	MS–S	MR	S	MR–MS	MR	S–VS	S	S	MI	MS–S	MI–I	MS–S	MR	–	–	–	Dow Seeds	2015
DS Faraday	APH	FEED	S [3]	S	R–MR	MR	MR	R–MR	MS–S	MS–S	MS–S [3]	MT	S [3]	MT–MI [3]	MS	MS–S	–	–	–	Dow Seeds	2016
DS Pascal	FEED	APW	S	MS	S	MS	MS–S	R–MR	MS–S	MR–MS	S	I–VI [3]	S [3]	MT–MI	S	–	–	–	–	Dow Seeds	2015
EGA_Burke	APH	AH	S	MS–S [1]	MR	MS	MR	MS–S	S	MS–S	MS	MT	MS–S	MT–MI	–	R–MR [1]	MS–S	S–VS	–	EGA	2006
EGA_Gregory	APH	APH	S	MS–S	MS–S	MR	MR	MR [6]	MS–S	S	MS–S	T–MT	S	MT	S	MS–S	S	MS	T	EGA	2004
EGA_Wedgetail	AH	APH	S	–	MR	MS–S	MR–MS	MS	MS–S	MS–S	VS	MI–I	S	MI–I [3]	S	–	S	MR	T–MT	EGA	2002
EGA_Wylie	AH	AH	MR–MS	MS [1]	MS–S	MS	R	MS	MS–S	MS–S	MS–S	T–MT	MS–S	MI	–	MR [1]	S	MS	–	EGA	2004
Ellison	APH	APH	S–VS	S [1]	R–MR	–	MR	MS	MS–S	MR–MS	MS–S	I–VI	MS–S	MI	–	MS [1]	MR	MR	I	Uni Sydney	2003
Elmore CL PLUS	AH	AH	S	S	MS–S	R–MR	MR	MR–MS	MS–S	S	MS–S	MI–I	S	T–MT [3]	S	MS [1]	MS–S	MR–MS	I	AGT	2011
Emu Rock	APW	AH	MS–S	MS	MS	S–VS	MS	MR–MS	S–VS	MR–MS	S	I–VI	MS–S	MI [3]	S	MS	–	MR	–	InterGrain	2011
Estoc	ASW	ASW	MS–S	MR–MS	MR–MS	S	MR	MR–MS	S–VS	S	S	I–VI	S	MT	MR	MS	MS	MR	MT	AGT	2010
Flanker	APH	APH	MS–S	MS–S	R	MR	R–MR	R–MR	S	MS–S	MS–S [3]	T–MT	S [3]	MT [3]	S	MS	S	MS	–	LongReach	2015
Forrest	ASW	APW	S–VS	MS	MR	S	R–MR	R–MR	MS–S	MR–MS	S–VS	I–VI	VS	MI	S	MR	S	MR–MS	–	Dow Seeds	2011
Gauntlet	APH	AH	MS–S	MS–S	MS	MS–S	R–MR	MR–MS	MS–S	MS	MR	MT	S	MT–MI	MR–MS	MR–MS [1]	MS–S	MR–MS	MT	LongReach	2011
Grenade CL PLUS	APW	APW	S	MR–MS	MR	S	MR	MR–MS	S	S	S	I–VI	MS–S	–	R	MS	MS	MR–MS	MT	AGT	2012
Jade	AH	FEED	MS–S	MS	R–MR	S	MS–S	R–MR	MS–S	MS–S	MS	MT–MI	MS–S	MI	S	–	–	MR–MS	–	Elders	2015
Janz	APH	APH	S	MR–MS	MR	MR	MR	MS	MS–S	MS–S	S	I	S–VS	MT–MI	S	S	S	MS	I	DAF Qld	1989
Kiora	APH	APH	S	MS	MR–MS	MR–MS	MR	R–MR	MS–S	MS–S	MR–MS	MT	S	MT–MI [3]	MS	MS	S	MR	I	AGT	2014
Kittyhawk	APH	APH	S–VS	S	R–MR	MS	MR–MS [3]	R–MR	MS	MR–MS	S [3]	I	MS–S [3]	MT–MI [3]	S	MR–MS	S	MR	MT–MI	LongReach	2016
Lancer	APH	APH	MS–S	S	MS–S	R–MR	R	MR	MS–S	MS	MS	T–MT	S	MT–MI [3]	S	MR–MS	S	MR	MI–I	LongReach	2013
Livingston	AH	AH	S	S	R	MS–S	MR–MS	MR–MS	S	MS–S	MS	MT	VS	MI [3]	S	MR–MS [1]	–	MR–MS	I	AGT	2007
Longsword	NYC	NYC	S [3]	MR–MS	MR–MS [3]	MS–S	MR	R–MR	MS–S	MR–MS	MR [3]	MT [3]	MR–MS [3]	VI [3]	MR–MS	–	–	MR–MS [3]	MT–T	AGT	2018
Mace	AH	AH	S	MR–MS	S	MS–S	MR–MS	S–VS	S	MR–MS	MS	MT	MS	MI–I [3]	MR–MS	MR–MS	MS–S	MR–MS	MT	AGT	2007
Mitch	AH	APW	MS	MS	S [3]	S–VS	MS	MR	S	MS	S	MT	S	T [3]	S	MR	–	MR–MS [3]	MT–MI	AGT	2014
Mustang	APH	APH	MS–S [3]	MS	R	MS–S	MR–MS	R–MR	S	MS–S	MS–S [3]	MI [3]	MS–S [3]	MI [3]	MR	MR–MS	–	MR [3]	–	LongReach	2017
Reliant	APH	AH	MS–S	MS–S	R	MR	R	MR–MS	S	S	MS–S [3]	T–MT	S–VS [3]	MT–MI [3]	MS–S	MS	S	MS	–	LongReach	2016
Scepter	AH	AH	S	MS	MS–S	MS–S	MR–MS	MS–S	MS–S	MR–MS	MS–S [3]	MT	S [3]	MT–MI [3]	MR–MS	MS	MS–S	MR	MT	AGT	2015

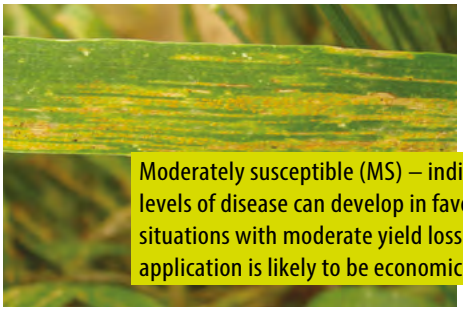
Table 12. Varietal characteristics and reaction to diseases (continued; page 2 of 3)

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 ❹	RLN *P. thornei* tolerance ❺	RLN *P. neglectus* resistance ❹	RLN *P. neglectus* tolerance ❺	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance		
Scout	ASW	APW	S	S	MR	MS	MR–MS	MS	S	S–VS	MS	MT–MI	S	MI	R	S–VS	MS	MS	MT–MI	LongReach	2009
Spitfire	APH	APH	MS	MS–S	MS–S	MS–S	MR	MR	MS–S	S	MS	MT–MI	MS–S	MT–MI	MS	S	MS	MR–MS	MT–MI	LongReach	2010
Strzelecki	APH	AH	S	MR ❶	–	R	MR–MS	MR	MS	MS	S–VS	I	S	MT–MI	–	MS ❶	MS–S	MS	–	DAF 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
Sunguard	AH	AH	MS	MS–S	VS	MR	R	MR	S	MS–S	S	MT	S–VS	MT–MI	–	MR ❶	MS–S	MS	I	AGT	2011
Sunlamb	ASW	ASW	S	MS	S	MS	R	MR–MS	MR–MS	MR–MS	MS	MI	MS–S	–	MR	–	–	MR–MS	MI	AGT	2015
Sunmate	APH	AH	MS–S	MS	R–MR	MS	MR–MS	MR–MS	S	MS–S	MR–MS	T–MT	S	MT–MI ❸	MR–MS	MR	S	MR ❸	MT–MI	AGT	2014
Sunmax	APH	APH	MS–S	MS–S	R–MR	MS–S	R–MR	R–MR	S	MS	MS ❸	MT–MI	S ❸	T–MT ❸	MR–MS	MR	–	MR–MS	T–MT	AGT	2016
Suntime	APH	APH	MS–S	S	MS	MS	MR–MS	R–MR	MS–S	S	MR–MS	MT	S	MT–MI	MR–MS	MR–MS	MS–S	MR–MS	MT–T	AGT	2015
Suntop	APH	APH	MS–S	MS	R	MR–MS	MR–MS	MR–MS	S	MS–S	MR–MS	T–MT	S	MT	S	MR	S	MR–MS	MT	AGT	2012
Sunvale	APH	APH	MS–S	MS	–	S	R–MR	MR ❻	MS–S	MS–S	MS–S	MT–MI	S	MI	–	R–MR ❶	S	S–VS	I	Uni Sydney	1995
Sunvex	APH	AH	S	VS ❶	MS–S	MR	R	MR	MR–MS	MR–MS	MS–S	I	MS–S	MT–MI	–	MS ❶	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 ❶	–	MR–MS	T–MT	AGT	2006
Trojan	ASW	APW	MS	MS	S–VS	MR	MR–MS	MR	MS–S	MS–S	MS–S	MI	MS–S	MT ❸	MS	MR–MS	S	MR–MS ❸	MT–MI	LongReach	2013
Tungsten	NYC	NYC	S	S	MR–MS ❸	MS	MS	R–MR	MS–S	MS–S	S ❸	MI–I	MS–S ❸	MT–MI ❸	MS	–	–	–	–	Elders	2017
Wallup	APH	APH	S	MS	S–VS	S–VS	MR–MS	MR–MS	S	MS–S	MR–MS	MT	MR–MS	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																					
B53	FEED	FEED	MS	S	MR–MS	S	MS	MR	S	MS	MS	T–MT	MS–S	MT–MI	S	–	–	–	–	Elders	2015
Mackellar	FEED	FEED	–	–	–	S–VS ❸	MR	R–MR	R–MR	MR–MS	MS	–	MS–S	–	–	S	–	–	–	CSIRO	2001
Manning	FEED	FEED	VS	S–VS	R	MS	R–MR	R–MR	MR–MS	MR–MS	S	–	MS–S	–	S	–	–	–	–	CSIRO	2013
Naparoo	FEED	FEED	S	S	VS	R	R–MR	R	MS	MS	S	–	S–VS	–	–	–	–	–	–	AGT	2007
RGT Accroc	FEED	FEED	S–VS	S	S–VS	S	MS	R	MR & S	MR–MS	MS–S ❸	–	S ❸	–	S	–	–	R–MR	–	Seedforce	2016
RGT Zanzibar	FEED	FEED	S ❸	S	S	S–VS	VS	R	S	MS	MS ❸	–	MS–S ❸	–	MS–S	–	–	–	–	Seedforce	2017
SF Adagio	FEED	FEED	S–VS	MS	MS ❸	S	S–VS	R–MR	MR–MS	MR–MS	MS–S ❸	–	MS ❸	–	S	–	–	R–MR	–	Seedforce	2014
SF Scenario	FEED	FEED	S–VS	MS	R–MR	S	MS–S	R	MR–MS	MS	S	–	S ❸	–	S	–	–	R–MR	–	Seedforce/RAGT	2014
SQP Revenue	FEED	FEED	S	S–VS	S	VS	R–MR	R	S	MS	S	–	S	I–VI ❸	S	MS	–	–	–	Ausgrainz	2009
Tenfour	FEED	FEED	MS–S	MS	MR	S	S–VS	S–VS	MS–S	MR–MS	S	I	S	MT	MS	–	–	MR	–	Elders	2015
Durum																					
Caparoi	ADR	ADR	VS	MR–MS	R	R–MR	R–MR	MR	MR	MR	MR	T–MT	MS	MI	MR–MS ❸	MS	MR	MR–MS	VI	NSW DPI Tamworth	2008
DBA Aurora	ADR	ADR	VS	MS–S	R	R	R–MR	R–MR	MR–MS	MR	R–MR	MT	MR–MS	I–VI ❸	MS–S	MS	–	–	–	Durum Breeding Australia	2015
DBA Bindaroi	ADR	ADR	S–VS ❸	MS	R	MR	MR–MS	R–MR	S	MR–MS	MR ❸	MT	MR–MS ❸	MI ❸	MS	–	–	–	–	Durum Breeding Australia	2017
DBA Lillaroi	ADR	ADR	S–VS	S	R–MR	R	R–MR	R–MR	MS–S	MR–MS	R–MR	MT	MR–MS	MI–I	S	–	–	–	–	Durum Breeding Australia	2014
DBA Vittaroi	ADR	ADR	S–VS	MS–S	R	MR	MR	MR	MR–MS	MR–MS	MR–MS	MI	MS	MI–I	MS–S	–	–	MR	–	Durum Breeding Australia	2017

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.



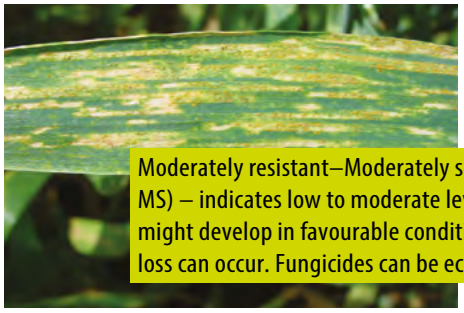
Moderately susceptible (MS) – indicates moderate levels of disease can develop in favourable situations with moderate yield losses. Fungicide application is likely to be economic.

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 ofdisease 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 can 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.

Table 12. Varietal characteristics and reaction to diseases (continued; page 3 of 3)

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 ❹	RLN *P. thornei* tolerance ❺	RLN *P. neglectus* resistance ❹	RLN *P. neglectus* tolerance ❺	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance		
EGA_Bellaroi	ADR	ADR	VS	MR ❶	R	R–MR	MR	MR	MR–MS	MR	MR	MT–MI	MS	MI–I	–	R–MR ❶	MS–S	MR	VI	NSW DPI Tamworth	2002
Hyperno	ADR	FEED	S–VS	MR–MS	R	R	R–MR	MR	MR–MS	MR–MS	R–MR	T–MT	MR	MT	MS	MS	R	S–VS	VI	AGT	2008
Jandaroi	ADR	FEED	VS	MR	R–MR	MR	MR	MR	MR–MS	MR–MS	MR–MS	MT–MI	MR–MS	MI	MS	R–MR ❶	MR	MS–S	VI	NSW DPI Tamworth	2007
ASW Soft/Noodle																					
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
Soft domestic																					
Gazelle	ASFT	ASFT	S	MS–S	S	MR	MR	MR	MS–S	MS–S	S	MI–I	S	MT	MS–S	MS–S	S	MR	–	LongReach	2012
Impala	ASFT	ASFT	MS–S	MS–S	S	S–VS	MR	MR	S	MS–S	S	MI–I	S–VS	MT–MI	MS–S	MR–MS	MS–S	MR–MS	MT–MI	LongReach	2011
QAL2000	ASFT	ASFT	S–VS	MR ❶	–	R	R–MR	VS	MR–MS	MS–S	MR–MS	MT–MI	S	MI	–	–	–	–	–	VAWCRC	2000
QALBis	ASFT	ASFT	S	R–MR	MR–MS	–	R–MR	S–VS	–	MS–S	MS–S	I–VI	S	MI	–	S ❶	–	–	–	VAWCRC	2002
Yenda	AGP	ASFT	S	MS–S	MR	–	R	S	MS	MR–MS	MS–S	MI–I	MR	MT–MI	MS	MR	–	R–MR	I	AGT	2006

– Insufficient data

NYC No grain quality classification in NSW currently.

Crown rot and **common root rot** ratings come from screening in SARDI, SA (❷) and DAF Qld (❶). SARDI = South Australian Research and Development Institute; NSW DPI = NSW Department of Primary Industries; DAF Qld = Department of Agriculture and Fisheries, DELWP Victoria = Department of Environment, Land, Water and Planning Victoria.

❶ North

❷ South

Provisional rating – Root lesion nematode (RLN)

❸ Data relating to these varieties is based on less than four years of testing and is to be considered provisional information.

Resistance ratings to RLN

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

❹ 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.

❺ 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.

Stripe rust

❻ Varieties expected to respond to control measures if stripe rust begins early.

Resistances

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

R–MR (Resistant to 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 to 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 to 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 to 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 to 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 to 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 to 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: Variety characteristics and reaction to diseases

Cereal cyst nematode (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).

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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 the suggested sowing time tables.

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

Beckom.[Φ] Australian Hard quality in NSW. High-yielding mid maturity variety suited to sowing in early May. Broadly adapted variety throughout NSW. Short in height, Beckom[Φ] produces plants with moderate early vigour and straw strength, with good threshability. Moderate grain size; aluminium and boron tolerant. AGT.

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

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

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

Coolah.[Φ] Australian Prime Hard quality in NSW. Coolah[Φ] is a high yielding and more disease resistant alternative to its parent EGA_Gregory[Φ], adapted to range of environments across NSW. Suited to an end of April through to mid May sowing. It has good tolerance to acid soils, with improved lodging over EGA_Gregory[Φ]. Coolah[Φ] produces large and consistent grain size, resulting in low screenings loss and high test weight. 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.

Cutlass.[Φ] Australian Prime Hard quality in northern NSW and Australian Hard in southern 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. DS Darwin [Φ] is an early–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. DS Darwin[Φ] has a good grain package and exhibits low screenings, a large seed size and good test weight. Moderately resistant to black point. Dow Seeds.

DS Faraday.[Φ] Australian Prime Hard quality in northern NSW. DS Faraday[Φ] is a main season variety with a maturity similar to EGA_Gregory[Φ] and has resistance to all three rusts. DS Faraday[Φ] has shown a yield improvement over EGA_Gregory[Φ] in northern NSW environments. DS Faraday[Φ] has improved tolerance over EGA_Gregory[Φ] to pre-harvest sprouting to manage the risk in a wet harvest periods. Dow Seeds.

DS Pascal.[Φ] Australian Premium White quality in southern NSW. DS Pascal[Φ] is an early season line, being 1–2 days quicker than Bolac[Φ], 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. Dow Seeds.

EGA_Burke.[Φ] Australian Prime Hard quality in northern NSW and Australian Hard in southern NSW. Suitable for early–mid season sowings, with a maturity similar to Giles. Pacific Seeds.

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

EGA_Wedgetail.[Φ] Winter wheat– see note on 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[Φ] with improved disease and lodging resistance. Medium maturity, slightly longer maturity than Baxter[Φ]. 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[Φ] is a long-season spring wheat best suited to mid–high rainfall areas of southern NSW. Forrest[Φ] 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–mid maturing line, carrying Clearfield Plus® technology, which provides tolerance to label rates of Intervix® herbicide. Grenade CL PLUSΦ combines the flexibility of improved weed management options through using Intervix® with high yield and cereal cyst nematode resistance. AGT.

Jade. Australian Hard milling quality in northern NSW. Early to mid maturity variety, similar in maturity and plant height as MaceΦ. Strong straw. Jade will be commercialised via the Elders network.

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

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

Livingston.Φ Australian Hard quality in NSW. Early maturing variety, later than H45 but earlier than VenturaΦ 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 VenturaΦ 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 VenturaΦ, LongReach CrusaderΦ 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 Flanker.Φ Australian Prime Hard milling quality in NSW. High yielding EGA_GregoryΦ type adapted to NSW where EGA_GregoryΦ is grown and has shown a 3–6% yield increase. Can be prone to crop lodging in high rainfall environments or under irrigation. Mid–late in maturity and has demonstrated a similar plasticity in maturity to EGA_GregoryΦ. Reliable grain package with good test weights and sound for screenings. 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–late season maturity, similar to QAL2000Φ and slightly quicker than YendaΦ. 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 LincolnΦ and VenturaΦ. 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 Kittyhawk.[Φ] Winter wheat – see note on page 32. Australian Prime Hard milling quality in NSW. Similar maturity and planting window to EGA_Wedgetail[Φ]. Dual-purpose variety, suitable for grazing and grain recovery. Has improved stripe rust resistance and grain quality over EGA_Wedgetail[Φ]. Pacific Seeds.

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

LongReach Reliant.[Φ] Australian Prime Hard quality in northern NSW and Australian Hard quality in southern NSW. High yield potential, mid season variety suited to the low–medium-yielding environments in NSW. Developed from a cross between EGA_Gregory[Φ] and Crusader[Φ]. Tillering ability similar to EGA_Gregory[Φ] and tightly packed heads like Crusader[Φ]. Reliable grain package with good grain size and test weight like EGA_Gregory[Φ]. Pacific Seeds.

LongReach Spitfire.[Φ] Australian Prime Hard quality in NSW. Early–mid season maturity, similar to Ventura[Φ] and Livingston[Φ]. 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–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.

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.

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

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

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

Rosella. Note – Winter wheats on page 32. 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.

Scepter.[Φ] Australian Hard quality classification in NSW. Potential higher yielding Mace[Φ] replacement, with improved stripe rust resistance over Mace[Φ]. Scepter[Φ] is rated moderately susceptible to susceptible to stripe rust so will still require a fungicide management program to maximise yields. Early mid-season variety, which is slightly later than Mace[Φ]. Boron tolerant and moderately tolerant to acid soils. AGT.

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

Sunlamb.[Φ] Australian Standard White quality in NSW. 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[Φ], and a few days earlier than Naparoo[Φ]. Moderately intolerant of acid soils. AGT.

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

Sunmax.[Φ] Australian Prime Hard quality in NSW. Sunmax[Φ] is a long-season spring wheat, slower in maturity than Sunzell[Φ], but quicker than the older variety Sunbrook, best suited to a mid–late April sowing. With its late maturity, avoid sowing outside its preferred sowing window as there is an increased risk of screenings. It has acid soils tolerance and improved lodging tolerance over EGA_Gregory[Φ]. AGT.

Suntime.[Φ] Australian Prime Hard quality in northern and southern NSW. Mid–late maturity variety, about 4–6 days quicker in flowering than Sunzell[Φ] and 5–10 days slower than EGA_Gregory[Φ]. Suited to northern NSW and an alternative to Sunzell[Φ], Lancer[Φ] and EGA_Gregory[Φ]. Moderately tolerant to acid soils. 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[Φ] is quicker maturing than EGA_Gregory[Φ], similar in maturity to Janz. AGT.

Sunvale. 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[Φ] derivative. Mid–late maturing line with similar maturity to Sunvale[Φ]. 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[Φ]. 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

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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.

LongReach Mustang.[Φ] Australian Prime Hard quality in NSW. Tested as LRPB12-0494. A high- yielding variety suited to NSW and QLD, with a reliable grain package similar to other prime hard main season varieties. Compact canopy with good straw strength maximises harvest efficiency and ease of stubble management. Good foliar disease resistance and useful root disease package. Maturity similar to Spitfire [Φ] with a significant yield improvement over other quicker prime hard varieties. Pacific Seeds.

Longsword.[Φ] Winter wheat– see note on page 32. Grain quality classification for NSW pending, currently Longsword[Φ] is deliverable as FEED only in NSW. Longsword[Φ] is a winter type and requires vernalisation as with other winter wheats. It has Mace[Φ] as a parent and is relatively quick to mature once vernalisation requirements have been met. The quicker maturity make it suitable for low-medium rainfall environments that traditional longer season winter wheats would not normally be grown in. Most suited to April sowings and can be grazed, given its winter growth habit. AGT.

Tungsten.[Φ] Not yet classified in NSW. An early–medium maturity variety, two days later than Mace [Φ]. Strong straw, with a plant height similar to Mace[Φ]. High protein grain with good test weight and low screenings, currently AH in Victoria and South Australia. Developed by Edstar Genetics, commercialised by Elders.

Feed wheats

B53. White grained early maturing feed wheat variety with a high yield performance and very wide adaptation. Plant height is slightly less than EGA_Gregory[Φ] with strong straw. It is being marketed as 'Feed' class but with 'Specialty End Use' potential under contract. Intolerant to boron. Elders.

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

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[Φ]. Resistance to *Barley yellow dwarf virus*. Bred by CSIRO and commercialised by GrainSearch.

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

RGT Accroc. Red winter wheat, feed grain quality, suited to the high rainfall zone. Suitable for sowing late February to early April for early grazing. Good standability. Maturity is 3–5 days earlier SF Adagio[Φ]. Bred by RAGT, available via Seed Force Broadacre Agents.

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

SF Scenario. 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.

Tenfour. White grained early maturity feed wheat variety with high yield potential and wide adaptation. Good standability. Limited seed available for the 2018 season in southern NSW. Tenfour was developed by Edstar Genetics and commercialised by Elders.

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

RGT Zanzibar. Red winter wheat, feed grain quality, suited to the high rainfall zone. Tested as SFR 86-055. Suitable for sowing late April to early May. Good standability. Bred by RAGT, available via Seed Force Broadacre Agents.

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 into April for grazing, depending on vernalisation (cold) requirement. See Managing grazing cereals on page 70.

Contributing authors

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Table 13. Diseases and crop injury guide – wheat (Page 1 of 2)

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Foliar diseases				
Yellow spot *Pyrenophora triticirepentis*	Tan coloured leaf lesions with a yellow border. Lesions eventually join, resulting in leaf death. Lesions usually randomly distributed along individual leaves and early in season are more concentrated on lower leaves in the canopy.	More severe in northern and central NSW, associated with retained wheat stubble. Can develop in all crops late in season after above average rainfall. Quite common early in the growing season.	Primary infection from ascospores from wheat stubble, which are airborne for a short distance. Secondary infection from conidia produced on infected leaves during season, which are airborne for longer distances.	Wheat stubble removal, crop rotation (avoid wheat-on-wheat). Resistant varieties. Foliar fungicides applied as a preventative before rain events 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; re-emerged as an issue in southern crops in 2016. Can occur in high rainfall regions.	Initially airborne spores, then rainsplashed spores within crop from infected leaves. Has a long latent period.	Resistant varieties. Seed and foliar fungicides. Fungicide resistance has developed in Victoria and Tasmania with some fungicides less effective. Resistant isolates were detected in southern NSW in 2016.
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 airborne 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 barley grass in previous season. Minor disease. Control not warranted.
Physiological black chaff (melanism or false black chaff) genetic disorder	Glumes, and sometimes stems just below the head, discoloured to brown–purple–black. Browning can also appear on stems in some varieties, which always extends downwards from a node.	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 when night time temperatures are between 5–20 °C.	Airborne 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.	Airborne spores from living plants.	Resistant varieties, foliar fungicides; control volunteer wheat over summer–autumn period.
Stem rust *Puccinia graminis* f.sp. *tritici*	Redbrown, 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.	Airborne 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 (oat, corn and rose grain) from infected grasses and cereals. Not seed-borne.	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 four 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.

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***.

Table 13. Diseases and crop injury guide – wheat (continued: page 2 of 2)

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Root and crown rots				
Takeall *Gaeumannomyces graminis* var. *tritici*	Blackened roots, stem bases and crown; stunting; 'white heads' and pinched grain.	More common in central and southern NSW, 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*	Brown stem bases, crown and sometimes roots go brown;, 'white heads'; pinched grain.	More common in northern and western areas, favoured by a moist early season and dry finish. Becoming more common in the south.	Stubble-borne on grass and cereal residues.	Crop rotation, preferably for 18 months to two years; grow more resistant 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 based on PreDicta B testing. Registered seed treatment has limited activity as a standalone management strategy.
Common root rot *Bipolaris sorokiniana*	The root between the crown and seed (sub-crown internode) is always dark (brown to black); roots and sometimes the stem base are brown; plants have reduced tillering and biomass ('ill thrift').	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. Sorghum and maize are also hosts.	Resistant varieties; crop rotation; optimise nutrition (especially phosphorus), 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 GS31).
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.	Airborne 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 with high humidity during flowering; 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. Note: basal infections from crown rot (*F. pseudograminearum*) can also cause low levels of head blight in wet seasons.	Crop rotation; avoid highly susceptible varieties especially durum; fungicides at flowering applied correctly to provide good coverage of heads.
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.***

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/m^3	t/m^3	
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.

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 12. Varietal characteristics and reaction to diseases on page 24** for additional information.

Caparoi$^{\Phi}$. ADR quality. A mid season maturity durum, with a maturity between EGA_Bellaroi$^{\Phi}$ and Jandaroi$^{\Phi}$. It is a semi-dwarf durum variety with good yield potential in all regions. The grain quality is better than EGA_Bellaroi$^{\Phi}$. Caparoi$^{\Phi}$ has improved dough strength compared with EGA_Bellaroi$^{\Phi}$, but is inferior to Jandaroi$^{\Phi}$ for this trait. Caparoi$^{\Phi}$ is superior to Jandaroi$^{\Phi}$ 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, released for the southern grains region. High yield potential, with yield levels similar to Hyperno$^{\Phi}$ 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$^{\Phi}$ and Caparoi$^{\Phi}$. Avoid sowing DBA_Aurora$^{\Phi}$ 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 very susceptible to crown rot. Bred by the Southern Program of Durum Breeding Australia (University of Adelaide). Marketed by SA Durum Growers Association.

DBA_Bindaroi$^{\Phi}$. ADR quality. Early–mid maturing durum wheat variety that is adapted to dryland production areas in NSW, with a higher yield potential than Caparoi$^{\Phi}$. DBA Bindaroi$^{\Phi}$ has erect plant growth and is shorter in stature than Caparoi$^{\Phi}$ with better straw strength. Grain, semolina and pasta making quality superior to Caparoi$^{\Phi}$ with improved colour and brightness. Low screening variety, similar to Jandaroi$^{\Phi}$. Improved crown rot resistance compared with current durum varieties. Bred by the Northern Program of Durum Breeding Australia (NSW Department of Primary Industries). Marketed by Seednet.

DBA_Lillaroi$^{\Phi}$. ADR quality. An early–medium maturity variety, three days later to head emergence than Jandaroi$^{\Phi}$, with a higher grain yield. Excellent durum quality with the largest grain size of the commercial varieties, low screenings, high test milling yield, and the improved 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$^{\Phi}$ 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.

DBA_Vittaroi$^{\Phi}$. ADR quality. An early–mid maturing durum variety that is suitable for high-input irrigated durum production systems. DBA_Vittaroi$^{\Phi}$ is shorter in stature then either EGA Bellaroi$^{\Phi}$ or Caparoi$^{\Phi}$, with superior straw strength. It is approximately seven days earlier to heading than EGA Bellaroi$^{\Phi}$. Grain, semolina and pasta making quality are superior to EGA Bellaroi$^{\Phi}$. Low screenings, similar to Jandaroi$^{\Phi}$ and superior to EGA Bellaroi$^{\Phi}$. Bred by the Northern Program of Durum Breeding Australia (NSW Department of Primary Industries). Marketed by Seednet.

EGA_Bellaroi$^{\Phi}$. ADR quality. A mid season maturity durum variety. The grain yield is inferior to the newer-released varieties Caparoi$^{\Phi}$, DBA_Bindaroi$^{\Phi}$ DBA_Lillaroi$^{\Phi}$, DBA_Vittaroi$^{\Phi}$ and Jandaroi$^{\Phi}$. The grain protein is consistently higher than other current commercial varieties. EGA_Bellaroi$^{\Phi}$ makes good quality pasta, but has poor dough strength. Moderately resistant to common root rot and very susceptible to crown rot. EGA_Bellaroi$^{\Phi}$ has reduced crop lodging under high yield situations compared with most durum varieties, it has now been outclassed by DBA_Vittaroi$^{\Phi}$ for reduced crop lodging and grain yield in high yielding irrigated durum production systems. Marketed by Seednet.

Hyperno.$^{\Phi}$ ADR quality for northern NSW. A mid season maturity durum with excellent yield potential. Maturity is earlier than EGA_Bellaroi$^{\Phi}$. 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[Φ], EGA_Bellaroi[Φ] 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.

Table 15. Suggested sowing times, Durum wheat varieties

Variety	April				May				June				July		
Weeks	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Northern Slopes															
Caparoi, EGA_Bellaroi, Hyperno						>	★	★	★	★	★	<			
DBA_Aurora#					>	★	★	<							
DBA_Bindaroi#, DBA_Vittaroi#						>	★	★	★	★	★	<			
DBA_Lillaroi#							>	★	★	★	★	★	<	<	<
Jandaroi							>	★	★	★	★	★	<	<	<
Northern Plains (Moree, Narrabri)															
Caparoi, EGA_Bellaroi, Hyperno							>	★	★	★	★	<			
DBA_Aurora#					>	★	★	<							
DBA_Bindaroi#, DBA_Vittaroi#						>	★	★	★	★	★	<			
DBA_Lillaroi#								>	★	★	★	★	<	<	<
Jandaroi								>	★	★	★	★	<	<	<
Liverpool Plains															
Caparoi, EGA_Bellaroi, Hyperno								>	★	★	★	<			
DBA_Aurora#					>	★	★	★	<						
DBA_Bindaroi#, DBA_Vittaroi#						>	★	★	★	★	★	★	<		
DBA_Lillaroi#								>	★	★	★	★	★	<	<
Jandaroi									>	★	★	★	★	<	<
South Western Plains (Griffith, Hillston)															
Caparoi, EGA_Bellaroi,						>	★	★	<						
DBA_Aurora#					>	★	★	★	<						
DBA_Bindaroi#, DBA_Vittaroi#						>	★	★	★	★	<				
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 might be reduced. DBA_Lillaroi and Jandaroi given their quicker maturities are suitable for double cropping following cotton.

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

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 10). 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 that protein levels above 13% are achieved.

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.

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

	North east						
	Yearly group mean					Regional mean	Number of trials
Variety	2013	2014	2015	2016	2017		
% Caparoi (t/ha)	2.46	3.48	3.47	4.86	2.87	3.47	
Caparoi	**100**	**100**	**100**	**100**	**100**	**100**	**14**
DBA_Aurora	108	105	106	113	110	**109**	**14**
DBA_Bindaroi	–	101	103	106	107	**104**	**11**
DBA_Lillaroi	102	95	106	102	104	**101**	**14**
DBA_Vittaroi	–	–	105	101	109	**105**	**8**
EGA_Bellaroi	79	88	95	103	76	**91**	**14**
Hyperno	115	110	97	104	118	**107**	**14**
Jandaroi	97	90	103	100	98	**98**	**14**

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

	North west						
	Yearly group mean					Regional mean	Number of trials
Variety	2013	2014	2015	2016	2017		
% Caparoi (t/ha)	2.09	1.44	2.68	4.07	1.77	2.39	
Caparoi	**100**	**100**	**100**	**100**	**100**	**100**	**14**
DBA_Aurora	115	115	104	118	112	114	14
DBA_Bindaroi	–	109	104	108	108	107	11
DBA_Lillaroi	95	103	105	99	107	101	14
DBA_Vittaroi	–	–	100	102	110	105	8
EGA_Bellaroi	75	88	94	103	76	90	14
Hyperno	125	118	105	110	115	114	14
Jandaroi	86	99	104	95	101	97	14

Table 18. Durum – South west region – compared with Caparoi = 100%

	South west #						
	Yearly group mean					Regional mean	Number of trials
Variety	2013	2014	2015	2016	2017		
% Caparoi (t/ha)	3.88	4.53	3.34	4.41	–	3.80	
Caparoi	**100**	**100**	**100**	**100**	–	**100**	**13**
DBA_Aurora	106	105	114	122	–	112	13
DBA_Bindaroi	–	100	105	110	–	104	10
DBA_Lillaroi	97	97	104	99	–	100	13
DBA_Vittaroi	–	–	106	100	–	105	7
EGA_Bellaroi	95	94	100	109	–	99	13
Hyperno	103	101	98	109	–	103	12
Jandaroi	94	92	100	97	–	96	13

Includes irrigated and dryland variety trials.

Yield results are a combined across sites analysis of NVT yield trials from 2013–2017.

The tables present NVT 'Production Value' MET (multi environment trials) data on a yearly region mean grouping and a regional mean basis.

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.

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 the middle of 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 rates on page 10 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

No new acid tolerant barleys have ben released in recent years for NSW. The older varieties Yambla and Tulla can tolerate high soil aluminium up to 10–15%. Most varieties tolerate high manganese levels very well.

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 22. Variety characteristics and reaction to diseases on page 46
- Herbicide tolerance.

See variety details in Table 22. Variety characteristics and reaction to diseases on page 46.

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.

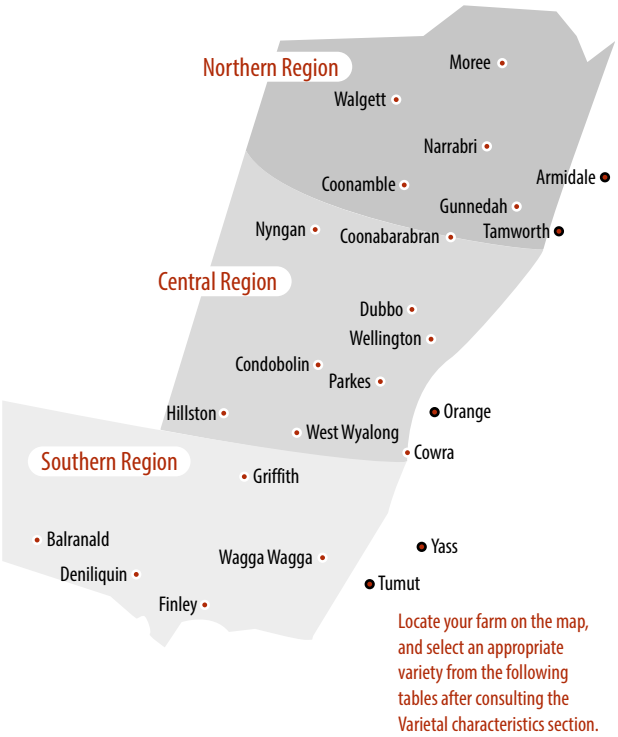

Figure 1. Map of NSW showing barley-growing zones.

Variety selection

Varietal characteristics

The following is a list of barley varieties, including new releases for 2018. The variety descriptions should be read in conjunction with Table 22. Variety characteristics and reaction to diseases on page 46.

There has been a number of new specialist malt barley varieties released in the past two years, these are grown under contract to specific companies, examples include Charger(Φ), SakuraStar(Φ) and SouthernStar(Φ). Limited information is available on the performance of some of these new varieties, with limited testing in NVT (National Variety Trial) barley trials. Growers should seek as much information from the respective company on the variety's yield performance and disease resistance ratings and ensure grain contracts reflects any differences in yield or disease management for other, more locally adapted, barley varieties.

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

Admiral.(Φ) Malt. Limited information on the performance of Admiral(Φ) in NSW. A 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(Φ), hence is suited to high-yield potential environments and also early-sowing opportunities. Marketed by Seednet.

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

Bass.(Φ) Malt. Baudin(Φ) replacement with excellent grain plumpness and high test weight, suited to medium–higher rainfall districts. Similar maturity to Baudin(Φ). Moderately short variety with good straw strength and head retention. Bred by InterGrain and marketed by Syngenta.

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

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(Φ) has shown consistently high grain yield, particularly in favourable environments. Contract production is exclusively managed by Australian Grain Growers Cooperative.

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

Compass.[Φ] Malt. Developed by the University of Adelaide as an early to mid season maturing variety option. It has a similar growth habit to Commander[Φ], but higher yield potential. In high-yielding situations it has shown to be prone to crop lodging. Compass[Φ] is earlier flowering and has improved resistance to net form of net blotch compared to Commander[Φ]. Later flowering than Hindmarsh[Φ]. More susceptible to leaf scald than Commander[Φ]. Leaf rust resistance is variable, rated very susceptible in northern NSW. Seednet.

Fathom.[Φ] Feed. Fathom[Φ] 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[Φ], best suited to lower and medium rainfall environments. Fathom[Φ] is a moderately tall variety, but shows good straw strength and has excellent grain plumpness with screenings levels lower than Hindmarsh[Φ]. Developed by the University of Adelaide. Seednet.

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

Gairdner.[Φ] Malt. Adapted to medium to higher rainfall areas (>400 mm). Mid to late season maturity and strong straw. Best sown early. Gairdner[Φ] has a thin grain, producing significantly greater screenings losses relative to Schooner and is also around 1% lower in grain protein. Resistance to *Barley yellow dwarf virus* (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[Φ] replacement. Performs better than Oxford under late planting conditions. GrangeR is, on average, 10 cm taller than Baudin[Φ] and 3–4 cm taller than Gairdner[Φ], 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.

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[Φ]. Leaf rust needs to be managed, rated as 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 can be segregated for

Northern NSW barley yield performance experiments from 2013–2017

The yield results presented are NVT 'Production Value' multi environment trial (MET) data shown on a yearly regional group mean and regional mean basis from 2013–2017. Further results are on the NVT website (www.nvtonline.com.au).

Table 19. Northern NSW main season sown: Compared with Hindmarsh = 100%

Variety	North east						
	Yearly group mean					Regional mean	Number of trials
	2013	2014	2015	2016	2017		
% Hindmarsh (t/ha)	**3.66**	**2.90**	**3.94**	**4.91**	**3.67**	**3.83**	
Alestar	92	89	86	96	78	91	12
Bass ◆	88	89	88	85	73	86	12
Baudin ◆	90	81	81	81	–	83	11
Biere	–	–	97	93	85	93	6
Bottler	–	–	–	97	90	97	4
Buloke ◆	88	92	91	85	–	88	11
Charger	91	93	90	89	88	90	12
Commander ◆	95	97	96	86	93	92	12
Compass ◆	104	108	108	94	109	103	12
Fathom	102	108	110	93	97	101	12
Flinders ◆	89	89	88	90	73	88	12
Gairdner ◆	75	74	69	–	71	73	9
GrangeR ◆	92	92	89	100	–	93	11
Grout	92	93	93	85	89	90	12
Hindmarsh	**100**	**100**	**100**	**100**	**100**	**100**	**12**
LaTrobe ◆	100	100	100	101	99	100	12
Maltstar	92	83	79	94	82	88	12
Navigator ◆	85	81	79	92	63	84	12
Oxford	89	82	78	98	68	87	12
RGT Planet	–	–	–	115	90	107	4
Rosalind	–	110	109	107	101	107	9
Schooner ◆	84	89	87	–	–	86	4
Scope CL ◆	87	93	92	83	81	87	12
Shepherd	89	93	89	90	87	90	12
Spartacus CL ◆	–	102	100	103	96	100	9
Urambie	89	78	76	–	–	84	8
Westminster ◆	80	81	76	–	–	81	8

Variety	North west						
	Yearly group mean					Regional mean	Number of trials
	2013	2014	2015	2016	2017		
% Hindmarsh (t/ha)	**3.02**	**3.43**	**3.79**	**4.28**	**2.15**	**3.44**	
Alestar	–	101	90	94	90	94	16
Bass ◆	97	103	89	90	86	93	19
Baudin ◆	100	100	84	91	–	93	16
Biere	–	–	98	88	84	92	12
Bottler	–	–	–	91	95	98	7
Buloke ◆	92	98	92	87	–	92	16
Commander ◆	100	102	97	86	96	95	19
Compass ◆	106	104	106	95	106	103	19
Fathom	109	108	104	99	100	104	19
Flinders ◆	95	102	89	–	–	93	12
Gairdner ◆	74	87	78	72	78	78	19
GrangeR ◆	93	100	93	93	89	94	19
Grout	95	99	94	89	92	94	19
Hindmarsh	**100**	**100**	**100**	**100**	**100**	**100**	**19**
LaTrobe ◆	99	100	100	99	99	100	19
Oxford	96	102	84	–	–	92	12
RGT Planet	–	–	–	100	96	103	7
Rosalind	–	107	107	102	102	105	16
Schooner ◆ ◆	82	91	90	84	–	87	16
Scope CL	91	98	92	86	85	91	19
Shepherd	88	96	93	83	88	90	19
Spartacus CL ◆	–	98	101	97	94	98	16
Urambie	93	95	83	–	–	90	12

Note: ◆Accredited malt varieties.
For grazing and grain recovery consider Urambie.
For malting production, consider Buloke, Commander, Compass, La Trobe, Scope CL and Spartacus CL.
In more reliable rainfall regions also consider GrangeR and Navigator.
For food grade production, consider Hindmarsh.
For feed grain production only consider Fathom, Grout, Oxford, RGT Planet, Rosalind, and Shepherd.


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Southern NSW barley yield performance experiments from 2013–2017

The yield results presented are NVT 'Production Value' multi environment trial (MET) data shown on a yearly regional group mean and regional mean basis from 2013–2017. Further results are on the NVT website (www.nvtonline.com.au).

Table 20. Southern NSW main season sown: Compared with Hindmarsh = 100%

	South east						
	Yearly group mean					Regional mean	Number of trials
Variety	2013	2014	2015	2016	2017		
% Hindmarsh (t/ha)	**4.02**	**3.93**	**3.65**	**5.22**	–	**4.20**	
Alestar	87	102	95	114	–	101	8
Bass ◆	93	88	89	108	–	95	8
Baudin ◆	87	93	88	106	–	94	8
Biere	–	–	78	89	–	86	4
Bottler	–	–	–	119	–	105	2
Buloke ◆	90	93	91	99	–	94	8
Charger	89	112	95	109	–	102	8
Commander ◆	88	95	96	97	–	94	8
Compass ◆	98	104	100	91	–	98	8
Fathom	97	96	95	101	–	97	8
Flinders ◆	88	94	88	107	–	95	8
Gairdner ◆	77	91	75	92	–	84	8
GrangeR ◆	90	97	95	111	–	99	8
Hindmarsh	**100**	**100**	**100**	**100**	**–**	**100**	**8**
LaTrobe ◆	101	100	102	102	–	101	8
Navigator ◆	81	93	90	104	–	93	8
Oxford	86	95	95	120	–	101	8
RGT Planet	–	–	–	137	–	119	2
Rosalind	–	107	112	117	–	111	6
Schooner ◆	82	82	75	78	–	79	8
Scope CL ◆	88	93	89	98	–	92	8
Spartacus CL ◆	–	99	103	100	–	101	6
Urambie	86	92	91	–	–	93	6
Westminster ◆	81	92	87	–	–	94	6

	South west						
	Yearly group mean					Regional mean	Number of trials
Variety	2013	2014	2015	2016	2017		
% Hindmarsh (t/ha)	**3.99**	**3.91**	**3.38**	**5.61**	**3.40**	**4.13**	
Alestar	88	92	87	107	87	94	18
Bass ◆	92	87	88	105	92	94	18
Baudin ◆	87	88	83	104	–	91	16
Biere	–	–	88	92	–	91	8
Bottler	–	–	–	111	89	98	6
Buloke ◆	90	90	87	100	–	93	16
Commander ◆	88	91	85	100	95	92	18
Compass ◆	98	105	98	97	104	100	18
Fathom	95	97	92	104	100	98	18
Flinders ◆	89	89	86	102	87	92	18
Gairdner ◆	80	86	74	94	84	85	18
GrangeR ◆	90	90	89	106	89	94	18
Hindmarsh	**100**	**100**	**100**	**100**	**100**	**100**	**18**
LaTrobe ◆	100	99	100	102	100	101	18
Oxford	85	84	83	–	–	92	12
RGT Planet	–	–	–	122	93	108	6
Rosalind	–	105	107	111	102	107	14
Schooner ◆	85	84	77	86	–	84	16
Scope CL ◆	89	90	85	98	91	92	18
Spartacus CL ◆	–	100	102	101	102	101	14
Urambie	86	87	82	–	–	90	12

Note: ◆Accredited malt varieties.

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

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

For food grade production consider Hindmarsh.

For feed grain production only consider, Oxford, RGT Planet, Rosalind 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 21. 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●		>	★	★	★	★	★	★	★	★	<								
Gairdner, GrangeR, Maltstar▲, Navigator, Oxford, Westminster							>	★	★	★	★	<							
Bass▲, Baudin								>	★	★	★	★	★	<					
Alestar▲, Buloke, Commander, Mackay, RGT Planet▲, Scope CL									>	★	★	★	★	★	<				
Compass, Hindmarsh, La Trobe, Rosalind, Spartacus CL▲									>	>	★	★	★	★	<				
Fathom , Grout, Shepherd										>	★	★	★	★	★	<			
Central region																			
Urambie●		>	★	★	★	★	★	★	★	★	★	<							
Bass▲, Gairdner, Oxford, Westminster▲							>	★	★	★	★	<							
Baudin, GrangeR, SY Rattler▲								>	★	★	★	★	<	<					
Alestar▲, Buloke, Commander, Mackay, RGT Planet▲, Scope CL									>	★	★	★	★	<	<				
Compass, Rosalind										>	★	★	★	<	<				
Fathom, Grout, La Trobe, Hindmarsh, Shepherd, Spartacus CL▲										>	★	★	★	★	<	<			
Southern region																			
Urambie●		>	★	★	★	★	★	★	★	★	<								
Admiral▲, Bass▲, Baudin, Charger▲, Fairview▲, Flinders▲, Gairdner, GrangeR , Oxford, Westminster▲							>	>	★	★	★	★	★	★	<	<			
Alestar▲, Buloke, Commander, RGT Planet▲, Scope CL										>	★	★	★	★	★	★	<		
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. Urambie can be sown from mid–late March, if grazed.

▲ Limited information available on performance in NSW.

Table 22. 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 [5]	RLN *P. thornei* Tolerance [6]	RLN *P. neglectus* Resistance [5]	RLN *P. neglectus* Tolerance [6]	Issued by	Year registered
Alestar	–	S–VS	MR–MS & S	S	R–MR	MS	–	S	MS–S	R [2]	MR [2]	MT–MI [2]	MR [2]	MI–I [2]	Limagrain/Edstar/Elders	2017
Bass [3]	good	S–VS	MS–S	S	S	S–VS	MR	S–VS	MS	S	MR–MS [2]	MT [2]	MR–MS	I	InterGrain/Syngenta	2012
Baudin [3]	good	S–VS	MR–MS & S	MS–S	VS	VS	R–MR	–	S	S	MS–S	–	MS–S [2]	MT–MI [2]	DAFWA	2002
Beire	–	S	S	S	R	MS–S	–	S–VS [2]	MS	S	MR–MS [2]	–	MR [2]	MI–I [2]	GrainSearch	2017
Bottler	–	S–VS	MS	S	R	MS–S	–	S [2]	MS [2]	–	R [2]	–	MR–MS [2]	MT [2]	GrainSearch	2017
Buloke [3]	medium	S	MR	S	R–MR	S	R–MR	S–VS [2]	MS	S	MS [2]	–	MR–MS [2]	–	DELWP Victoria	2004
Charger	good	VS	VS	S–VS	R	S	R	S	MS	R	MR–MS [2]	MT–MI [2]	MR	MT [2]	Carlsberg & University of Adelaide	2013
Commander [3]	medium	VS	MR–MS & S	MS–S	MR–MS & S	S	R	S	MS–S	R	MR–MS	MT	MR–MS	MT	University of Adelaide	2008
Compass [3]	medium	S–VS	MR–MS	MS–S	MR–MS & S	VS	R	S	MS	R	MR	T–MT	MR–MS	T	University of Adelaide	2013
Fathom	good	MR–MS	MS–S	MR	MR–MS & S	MS–S	R	S–VS	MS–S	R	MR [2]	–	MR–MS [2]	–	University of Adelaide	2012
Flinders [3]	good	S–VS	MR–MS	S	R	MR–MS	MR	S–VS	MS	S	MR [2]	–	MR–MS [2]	–	InterGrain/Syngenta	2014
Gairdner [3]	medium–good	VS	MR–MS	S	S–VS	S	MR	S–VS	MS–S	S	MS–S	I-VI	MR–MS	MI	DAFWA	1998
GrangeR [3]	good	VS	MR–MS & S	S–VS	R	MS–S	R	S–VS	S	R	MR–MS	MT–MI	MR–MS	MI–I [2]	Heritage Seeds	2013
Grout	good	VS	MR–MS & S	S	R & S	VS	MR	S	S	–	MR–MS	MT	MS	MT	DAF Qld	2005
Hindmarsh [4]	good	MR–MS & VS	MS	S–VS	MR–MS & S–VS	S	MR	S	S	R	MR–MS	T–MT	MR–MS	MT	DELWP Victoria	2006
La Trobe [3]	good	MR–MS & VS	MS	S	MR–MS & S–VS	S	R–MR	S–VS	S	R	MR–MS	MT	MR–MS	MT	InterGrain/Syngenta	2013
Maltstar	–	S–VS	S	S–VS	R–MR	MR–MS	–	S	MS–S	S	MR	MT–MI	MR–MS	MI–I	Limagrain/Edstar/Elders	2017
Navigator [3]	medium	S	MR–MS & S–VS	MR–MS	S–VS	VS	MR	S	MS–S	R	MR–MS	MI–I	MR–MS	I [2]	University of Adelaide	2012
Oxford	good	S–VS	MS–S	S	R	MS	R & S	S–VS	MS–S	S	MR	MI–I	MR	I	Nickerson/Heritage Seeds	2009
RGT Planet	Very good	MS–S	S	S–VS	R	MR–MS [2]	–	MS–S [2]	MS–S	R [2]	R–MR [2]	–	MR–MS [2]	MT [2]	RAGT/SeedForce	2017
Rosalind	good	S	MR	S–VS	MR–MS & S–VS	MR–MS	–	MS–S	S	R	MR [2]	T [2]	MR–MS [2]	MT	InterGrain/Syngenta	2015
Schooner [3]	medium	S	MR–MS	MS–S	S–VS	S–VS	R–MR	MS–S	S	VS	MR–MS [2]	MT [2]	MS	–	University of Adelaide	1983
Scope CL [3]	medium	S–VS	MR–MS	MS–S	R–MR	S	R–MR	S–VS	MS	S	MR–MS	MI	MR–MS	MI [2]	DELWP Victoria	2010
Shepherd	good	S–VS	MR & S	S–VS	S	MS	MR	MS–S	MS–S	–	MS–S	MI	MR–MS	MI [2]	DAF Qld/DAFWA	2008
Spartacus CL [3]	medium–good	VS	MR & S	S–VS	MR–MS & S–VS	S	MR	S	MS	R	MR–MS [2]	MI [2]	MR–MS [2]	MI [2]	InterGrain/Syngenta	2016
Urambie [1]	very good	MS	MR	S	MR–MS	S	R	–	MS–S	–	MR [2]	–	MS [2]	–	NSW DPI	2005
Westminster [3]	good	MS	MS–S	S	R	MR–MS	R	S	MS–S	–	MS	I	MR–MS	I–VI	Nickerson/GrainSearch	2010

– insufficient data.

❶ suitable for grazing and grain recovery.

❷ provisional rating,

❸ may be accepted as malting. Accredited by Barley Australia.

❹ food grade.

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.

❺ RLN Resistance ratings

The root-lesion nematode (*P. thornei* and *P. neglectus*) resistance ratings that appear in this sowing guide are national consensus ratings based on glasshouse and field data collected from all Australian grain regions.

❻ RLN Tolerance ratings

The root-lesion nematode (*P. thornei* and *P. neglectus*) tolerance ratings that appear in this sowing 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 = Department of Primary Industries; DAF Qld = Department of Agriculture and Fisheries, 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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.

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

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

Navigator.[Φ] Malt. Navigator[Φ] is mid–late maturing, similar to Gairdner[Φ] but offering higher yield potential, significantly improved physical grain quality. Navigator[Φ] 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[Φ]. 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.

RGT Planet.[Φ] Introduced European malt barley, which has shown a high yield potential in NSW . Currently under malt evaluation in Australia. Mid season flowering, but maturity is flexible with a multi-environmental fit. Similar maturity to Commander[Φ]. Excellent standability. Bred by RAGT, and will be available via Seed Force Broadacre Agents.

Rosalind.[Φ] Feed. A broadly-adapted, high-yielding mid-season barley that has performed well across NSW. Maturity is later than La Trobe[Φ] and earlier than Buloke[Φ]. 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[Φ]. Bred by InterGrain and marketed by Syngenta.

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[Φ]. Developed by Agriculture Victoria Services and Seednet.

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

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[Φ] is based on the variety Flagship[Φ] and incorporates a patented novel gene for improved beer quality. It has almost identical agronomic characteristics to Flagship with good early vigour. SouthernStar[Φ] also has sensitivity to sprouting so timely harvest must be a priority. SouthernStar[Φ] can be grown under production contracts with Barrett Burston Maltings and Cargill.

Spartacus CL.[Φ] Malt. A new Clearfield barley suited for sowing in NSW. Spartacus CL[Φ] is an early-maturing semi-dwarf barley with a maturity similar to La Trobe[Φ]. Spartacus CL[Φ] 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 plantback issues might be a concern. Similar height and plant type to La Trobe[Φ]. Short coleoptile length. Moderately good straw strength and head retention, with a good physical grain quality. High level of pre-harvest sprouting tolerance. Bred by InterGrain and marketed by Syngenta.

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[Φ], Westminster[Φ] 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[Φ]. Introduced malt barley from Nickerson International Research, licensed to GrainSearch in Australia.

The following are more recently named or released varieties. Some lines might only have limited seed available in 2018.

Alestar[Φ]**.** A medium–long season potential malting barley, three days earlier than Commander[Φ]; five days earlier than Gairdner[Φ] and Oxford[Φ]. Under malt evaluation with Barley Australia. Good yield potential in medium- to high-yielding environments. Test weight, screenings and plumpness (retention) similar to Hindmarsh[Φ]; high grain colour (brightness); good straw quality with high resistance to lodging and straw breakage; excellent head retention. Bred by Limagrain UK, developed by Edstar Genetics in Australia. Released in 2017, commercial quantities of seed available for the 2018 season, commercialised by Elders.

Biere[Φ]**.** Biere has a very fast maturity, being seven days early maturing then Hindmarsh[Φ] or La Trobe[Φ]. High seedling vigour. Low input line suited to late sowing situations (post May) and even early spring sowings. Limited commercial grain production will be supported in 2018 in selected regions as it goes through malt accreditation. GrainSearch.

Bottler[Φ]**.** A mid-season maturity variety, five days later then Gairdner[Φ], with high yield potential. Suits

medium and high rainfall zones, with potential for irrigation use. Strong standability and good grain quality package. Limited grain production will be supported in selected regions in 2018 as it enters and progresses through malt accreditation. GrainSearch.

Maltstar[Φ]**.** A long season potential malting barley, similar to Commander[Φ]. Maltstar[Φ] is under malt evaluation with Barley Australia. Good yield potential in medium to high yielding environments. Has high test weight, low screenings and high grain colour (brightness). It has good straw quality with high resistance to lodging and straw breakage; excellent head retention. Bred by Limagrain UK, developed by Edstar Genetics in Australia. Released in 2017, commercialised by Elders with seed available for the 2018 season.

SakuraStar[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. Targeted to replace SouthernStar[Φ] as has improved pre-harvest sprouting tolerance. Superior grain size compared with SouthernStar[Φ] and is similar to Buloke[Φ]. Contract production only, can be grown under production contracts with Barrett Burston Maltings and Cargill.

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; 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 up to the start of stem elongation (Z32). Under higher pressure and in conducive seasons, Systiva® needs to be backed up by applying a foliar fungicide around awn peep (Z49) in susceptible varieties.

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[Φ], Compass[Φ], Grout[Φ] and Navigator[Φ] are very susceptible to **leaf rust**. 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.

Table 23. 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.	Rain-splashed 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 °C.	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 °C) 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 °C) moist conditions. Only likely to be a problem in very late crops or where crops are in close proximity to other infected wheat and barley 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 because this is not a 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.

Table 23. Disease and crop injury guide – barley (continued)

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
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.	Soil borne 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 Group B herbicide build-up, 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 northern and western areas, becoming common in the south, favoured by moisture/heat stress during season.	Stubble-borne on grass and cereal residues.	Crop rotation. More resistant varieties. Grass weed control. Balance inputs to available soil water. Inter-row sowing and avoid delayed sowing to minimise losses.
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.	Stubble-borne 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.	Rain-splashed 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.	Seed-applied 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.	Seed applied fungicides, resistant varieties.

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 Industry information on page 65 .

Net blotch

There are two forms: the spot form and the net form. Both forms survive on 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, it can, however, 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 an effective control for 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 68 on page 128 for details. Note that this only disinfects the seed and will not provide protection against infection from spores coming from infected barley stubble.

The new fungicide seed treatment Systiva® has been recently registered for use in barley, with trial results indicating that it appears to provide useful levels of early 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 Z31 and Z39 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$^{\phi}$ 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.

Powdery mildew

Powdery mildew can occasionally be severe on seedlings and tillering barley in northern and central NSW; favoured in 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 states. Some seed treatments provide effective and economic control of powdery mildew at the seedling stage in areas where the disease frequently develops. See **Table 68 on page 128** for details.

Managing diseases with foliar fungicides

Foliar fungicides are often used as one component of disease management 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 early growth stages 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 foliar fungicide application.

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 emerged at this time of application.

Fungicide resistance has been documented in a number of cereal foliar pathogens in Australia, such as barley powdery mildew, net blotch – net form (*Pyrenophora teres* f. *teres*) 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 take-all, crown rot 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 disease 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 from 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

Growers should be aware that varieties with a Hindmarsh background (Hindmarsh$^{\phi}$, La Trobe$^{\phi}$, Spartacus CL$^{\phi}$ and Rosalind$^{\phi}$) are more susceptible to loose smut in barley. Over the past two seasons loose smut has built up in the more susceptible varieties where a seed fungicide has not be used or poorly applied. 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 68 on page 128 for details.

Black point

The 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 124 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.

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 ◊, 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 seed 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 sowing rates on page 10 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 on page 70.

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.

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 **Cereal insecticide seed dressings for aphid and Barley yellow dwarf virus (BYDV) control 2018 on page 132** 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 on page 70**) 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 29. Oat varieties on page 59**. Producers aiming at milling markets should consider Bannister ϕ, Durack ϕ, Kowari ϕ, Mitika ϕ, Possum ϕ, Williams ϕ, Wombat ϕ or Yallara ϕ.

For high-quality feed grain oats for livestock, consider low husk lignin varieties Kowari ϕ, Mannus, Mitikaϕ, Yarran or Yiddahϕ. 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.

Bannisterϕ, Durackϕ, Kowari ϕ, Mitikaϕ, Possumϕ, Williamsϕ, Wombatϕ or Yallaraϕ are accepted milling varieties. The newer varieties Bannisterϕ, Durackϕ, Kowari ϕ, Williamsϕ and Wombatϕ, 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?

Figure 2. Map of NSW showing oat-growing zones

Table 24. 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 25. 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 ▲	106	106	87	87
Eurabbie	114	107	119	118
Mannus	99	97	98	101
Yarran ▲	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 27. 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 26. Grain only varieties compared with Mitika (2013–2017)

Variety	North east						
	Yearly group mean						
	2013	2014	2015	2016	2017	Regional mean	Number of trials
% Mitika (t/ha)	**2.81**	**3.43**	**3.25**	**–**	**0.64**	**2.97**	
Bannister	115	108	91	–	75	102	5
Durack	90	103	106	–	93	102	5
Kowari	102	103	104	–	98	103	5
Mitika	**100**	**100**	**100**	**–**	**100**	**100**	**5**
Possum	103	105	104	–	81	101	5
Williams	106	108	91	–	61	101	5
Wombat	108	105	91	–	70	97	5
Yallara	97	108	100	–	88	102	5

Variety	South east						
	Yearly group mean						
	2013	2014	2015	2016	2017	Regional mean	Number of trials
% Mitika (t/ha)	**3.36**	**3.34**	**3.41**	**5.48**	**2.20**	**3.73**	
Bannister	108	105	99	114	117	108	17
Durack	96	92	100	87	84	92	17
Kowari	104	103	103	104	96	103	17
Mitika	**100**	**100**	**100**	**100**	**100**	**100**	**17**
Possum	108	99	98	93	96	98	17
Williams	101	97	96	109	104	102	17
Wombat	105	98	92	97	114	98	17
Yallara	96	91	97	83	99	91	17

Variety	South west						
	Yearly group mean						
	2013	2014	2015	2016	2017	Regional mean	Number of trials
% Mitika (t/ha)	**3.73**	**3.21**	**3.88**	**5.64**	**2.60**	**3.72**	
Bannister	104	100	103	117	111	107	13
Durack	96	91	86	92	98	93	13
Kowari	103	102	103	105	102	103	13
Mitika	**100**	**100**	**100**	**100**	**100**	**100**	**13**
Possum	103	97	93	101	101	99	13
Williams	101	90	95	116	113	103	13
Wombat	100	94	91	105	104	99	13
Yallara	93	91	77	90	99	89	13

The table presents NVT 'Production Value' multi environment trial(MET) data on a yearly regional group mean and regional mean basis from 2013–2017.

Preferred milling varieties are Kowari, Mitika and Yallara. Preferred variety for feeding grain to livestock is Mitika.

Table 28. Sowing times for oats in NSW

Variety / Weeks	January		February				March				April				May				June		
	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															>	★	★	★	<	<	
Kowari, Mitika, Yarran▲															>	>	★	★	★	<	
Slopes/plains grain only																					
Bannister, Possum, Williams, Wombat, Yallara															>	★	★	★	★	<	
Kowari, Mitika, Yarran▲															>	★	★	★	★	★	<
Durack																>	★	★	★	★	★

> 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.

- **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 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*.

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.

Warning: There are now no commercial varieties with resistance to all the current field pathotypes of stem rust. 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.Φ 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 Φ and heads about 3–4 days later than Mitika Φ. It is susceptible to and intolerant of cereal cyst nematodes. Bannister Φ is resistant to leaf rust and moderately resistant to bacterial blight. Bannister Φ has a slightly lower hectolitre weight and slightly higher screenings compared with Mitika Φ. Seednet.

Durack.Φ Released in 2016 from the National Oat Breeding Program. Durack Φ is a moderately tall variety, similar in height to Yallara Φ. Durack Φ is the earliest maturing oat variety of any of the current milling varieties available. It is approximately 7–10 days earlier than Mitika Φ. Durack Φ is susceptible to the stem rust pathotypes found in southern Australia. Leaf rust resistance is variable depending on the pathotype present, rated from susceptible to resistant. A fungicide program should be considered in areas prone to oat rust diseases. Durack Φ has performed well in the shorter season environments of southern and central NSW yielding similar to Yallara Φ. Grain quality for Durack Φ is good, with improved hectolitre weight compared to all current grain varieties. Screenings are low and similar to Yallara Φ. Protein is similar to Mitika Φ and higher than Bannister Φ, Williams Φ and Yallara Φ. Groat percent is similar to Mitika Φ and an improvement compared with Williams Φ and Bannister Φ. Heritage Seeds.

Kowari.Φ A new release in 2017 from the National Oat Breeding Program, it is a new potential milling oat variety with dwarf stature, slightly taller than MitikaΦ. It has a maturity similar to MitikaΦ. The grain quality is excellent. KowariΦ has slightly lower hectolitre weight than MitikaΦ, similar 1000 grain weight compared with MitikaΦ. It combines high β-glucan with low screenings. KowariΦ has high grain protein and a slightly higher groat percent compared with MitikaΦ. KowariΦ has a response, similar to MitikaΦ for stem rust and improved leaf rust resistance. Like MitikaΦ, it has low hull lignin. Heritage Seeds.

Mitika.Φ A dwarf milling oat released in 2005. It is earlier maturing than Possum Φ and Echidna, favouring Mitika Φ in a dry finish. Mitika Φ was resistant to stem rust until 2010, when a new pathotype of stem rust was identified, rendering it susceptible. It is moderately susceptible to leaf rust. Mitika Φ has improved resistance to bacterial blight and is superior to Echidna for septoria resistance. Mitika Φ is susceptible to BYDV, septoria and red leather leaf disease. It is very susceptible 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 Φ has high hectolitre weight, low screenings and high groat percentage compared with Echidna. Mitika Φ also has improved feed quality with low hull lignin and high grain digestibility. Heritage Seeds.

Possum.Φ Possum Φ is a dwarf milling grain variety. It is a replacement for Echidna in medium and high rainfall areas. Possum Φ has a similar yield to Echidna in high rainfall zones and slightly lower yield in medium rainfall zones. PossumΦ 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 Φ is susceptible to bacterial blight and BYDV and very susceptible to, and intolerant of, cereal cyst nematode. Possum Φ is not recommended for areas where cereal cyst or stem nematode is a problem. PossumΦ is susceptible to red leather leaf and intolerant of stem nematode. Developed by SARDI, released in 2003. Seednet.

Williams.Φ Released in 2013 by the National Oat Breeding Program, Williams Φ has a high grain yield potential and has performed well in trials throughout NSW medium-high rainfall zone. Williams Φ is an early to mid-season variety similar to Yallara Φ, but 3–7 days later than Mitika Φ. It is taller than Mitika Φ by 15 cm, 5 cm taller than Bannister Φ, and 15 cm shorter

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

Table 29. Oat 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	–
Durack	quick	poor	–	very early	high	high	S	R & S	MS–S	MS	–
Kowari	quick	poor	–	early	med–high	low	MR & S	R	S	MS	–
Mitika	quick	poor	very good	early	high	low	MR & S	MS & S	MS & S	S	–
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 and Coolabah (grain yield).
* Refer to Table 32.
• Lignin content of Blackbutt can be variable.

than Yallara ϕ. Williams ϕ is resistant to leaf rust and, depending on the stem rust pathotype present, can range from moderately resistant to susceptible. It is susceptible to and intolerant of cereal cyst nematodes. Williams ϕ is resistant to bacterial blight and moderately resistant–moderately susceptible to BYDV. Williams ϕ has a lower hectolitre weight and higher screenings than Mitika ϕ. Williams ϕ is not recommended for low rainfall areas due to the potential for high screenings. Heritage Seeds.

Wombat. ϕ A dwarf milling variety, which is similar in height to Possum ϕ and slightly taller than Mitika ϕ. It is a mid-season variety flowering about six days later than Mitika ϕ. Wombat ϕ was the first dwarf milling variety with cereal cyst nematode resistance and tolerance. It is also moderately tolerant to stem nematode. Wombat ϕ 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 ϕ. Developed by SARDI. Seednet.

Yallara.ϕ A medium–tall, early- to mid-season variety similar to Euro for flowering and maturity. Yallara ϕ was released in 2009. Yallara ϕ 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 ϕ is susceptible and intolerant to stem nematode and moderately susceptible to red leather leaf disease. Yallara ϕ has excellent grain quality. It has a high hectolitre weight, low screenings and a high groat percent. Yallara ϕ 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 ϕ was evaluated for hay production and although the hay yield may be lower than popular hay varieties it has excellent hay quality. Seednet.

Table 30. 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.

Table 31. Hay oat 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	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	MR & MS	MR	–
Tungoo	medium	–	–	mid–late	MS & S	MS	MR & MS	MR	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).

Feed grain, hay and grazing varieties

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

Austin.Φ An erect, medium maturity forage oat with very strong initial growth. Good tillering ability , with good recovery after cutting or grazing. High total season dry matter production. Resistance to current races of leaf(crown) rust. Released in 2018, commercialised by AusWest Seeds.

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.

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 resistance 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 Φ. Maturity is 7–10 days earlier than TaipanΦ. Good germination and establishment with early sowings into warm soil. High level of resistance to all current pathotypes of leaf 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 medium–late maturity grazing variety released by Pacific Seeds. It has, semi-erect early growth, with early growth similar to Aladdin Φ. High level of resistance 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 A medium maturity forage oat with 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. Eurabbie 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.

Flinders.Φ An erect forage variety with quick early forage growth. Late maturing, flowering a few days earlier then Taipan. High total season dry matter production. Resistance to current field strains of leaf(crown) rust. Released in 2018, commercialised by PGG Wrightson.

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 Φ has excellent early vigour and lodging, and shattering resistance. Good foliar disease resistance spectrum. It is moderately resistant 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 Φ has excellent hay quality. Released by SARDI in 2012. Forester Φ 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 53.Φ Medium maturity forage oat line, with resistance to leaf rust in northern NSW. Semi-erect growth habit. Marketed by 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 Φ. 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 resistant than Eurabbie and Yarran. The variety might exhibit physiological yellowing in winter. Bred by NSW DPI at Temora. Released in 2006. Waratah Seeds.

Massive.™ A very late maturing forage oat variety, marketed by Upper Murray 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 Φ 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 BrusherΦ but slightly lower than WintarooΦ. Hay quality is similar to WintarooΦ. Mulgara Φ 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 Φ 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 resistance 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.

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.

Savannah.Φ A new medium-late maturing forage oat line with semi-erect growth habit. Marketed by PGG Wrightson Seeds.

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

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

Victory.™ Late maturing forage oat line, slightly earlier then Massive in maturity. Semi-erect growth habit. Marketed by Upper Murray Seeds.

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.

Wizard.[Φ] A new medium-maturity grazing variety with good semi-erect early growth and quick recovery from grazing. Early growth similar to Genie [Φ] and better than Aladdin [Φ]. Resistant to leaf rust strains currently found in northern NSW. Selected for Queensland and northern NSW. Released by DAF Qld and Heritage Seeds in 2017, and available through Heritage Seeds.

Table 32. 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, Kowari, Mannus, Mitika, Mulgara, Nile, Tungoo, Wintaroo, Yarran, Yiddah	Blackbutt (variable), Graza 80, Quoll	Euro, Potoroo, Wandering	Bannister, Carrolup, Coolabah, Dawson, Drover, Dunnart, Durack, 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 **Industry information on page 65** for details).

Further reading

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

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 32** on this page 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.

Contributing authors

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Table 33. Forage, silage or hay oat varieties

Variety	Growth habit	Speed to grazing	Maturity	Diseases	
				BYDV	Leaf (crown) rust
Aladdin	semi-erect	medium–quick	late	–	S *
Austin	erect	quick	medium	–	R*
Bass	semi-prostrate	medium	medium	T	S
Blackbutt	prostrate	slow	medium	MT	S
Bond	semi-erect	quick	medium–late	–	R
Boss	semi-erect	medium–quick	medium	–	S
Comet	semi-erect	medium–quick	medium–late	–	R
Cooee	erect	very quick	medium	–	S
Dawson	erect	very quick	medium–late	–	S
Drover	semi-prostrate	medium	medium–late	–	S *
Empire	erect	medium–quick	late	–	–
Eurabbie	semi-prostrate	medium	medium	S	S
Flinders	erect	quick	late	–	R*
Genie	erect	very quick	late	–	S
Graza 50	erect	quick	late	–	S
Graza 51	erect	quick	medium–late	–	S
Graza 53	semi-erect	medium–quick	late	–	R
Graza 80	erect	quick	late	–	S
Graza 85	semi-erect	quick	late	–	–
Lordship	semi-erect	very quick	late	T	S
Mammoth	–	quick	–	T	–
Mannus	prostrate	medium	medium	MS	MS & S
Massive	–	–	–	–	S
Nile	semi-prostrate	medium	medium–late	T	S
Outback	erect	quick	medium–late	–	S
Quamby	erect	medium	medium–late	–	S
Saia	erect	medium	early	T	S
SF Colossus	–	–	medium–late	–	–
SF Tucana	–	–	late	–	–
Savannah	semi-erect	medium–quick	medium–late	–	S
Taipan	erect	quick	late	–	S
Wizard	semi-erect	medium–quick	medium	–	R*

– 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 maturity, the relative maturity may change depending on which region in NSW they are grown, particularly in southern NSW

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.

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
PO Box 527, ASCOT VALE, Victoria, 3032
t: 03 9670 0523
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)
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: Deb Baume m: 0481 322 821
e: sadgasecretary@gmail.com

Pulse Australia Ltd
www.pulseaus.com.au
PO Box H236, AUSTRALIA SQUARE, Sydney, NSW, 1215
t: 02 8007 7553
e: nick@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 can 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.

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 8 for calculating sowing rates.

Table 34. 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 the crop continuous and quick regrowth (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. Over-grazing greatly reduces the plant's ability to recover. (See Managing grazing cereals on page 70).

Disease

Triticale is susceptible to loose smut and should be treated with a fungcicidal seed dressing. It is slightly less susceptible to take-all than wheat. 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 stripe rust, or consider using foliar fungicides to control the disease in-crop if required.

Consider seed or fertiliser–fungicide treatment for controlling seedling stripe rust in susceptible varieties, especially those sown early for grazing.

Variety selection

Grazing and grain recovery: Endeavour$^{\phi}$, Cartwheel$^{\phi}$, Crackerjack 2, Kowari and Tuckerbox.

Outclassed: Tobruk$^{\phi}$ (stripe rust).

Grain only: Astute$^{\phi}$, Bison$^{\phi}$, Fusion$^{\phi}$ – for main season sowings (mid-May–June).

Outclassed: Chopper$^{\phi}$, Hawkeye$^{\phi}$, Tahara and Tobruk$^{\phi}$ (for earlier sowings in higher rainfall areas) (all stripe rust and grain yield).

Varietal characteristics

These varietal notes must be read in conjunction with Table 27. Slopes/Plains dual-purpose compared with Bimbil = 100% on page 56.

Dual-purpose grazing varieties

Cartwheel.[Φ] Released in 2016. A long-season dual-purpose triticale that is suitable for an early March to early April sowing. A stripe rust resistant replacement for Tobruk[Φ]. Good early forage production when sown in March and recovers from grazing to give excellent forage in winter. Straw strength is good and has shorter stature than Tobruk[Φ]. Grain yield after grazing is equivalent to Tobruk[Φ]. Seed is available from Waratah Seeds.

Crackerjack 2. A medium-late season replacement for the original Crackerjack. Earlier sowing option then the original Crackerjack, with sowing from early April. Excellent establishment and early vigour. Suited to rotational grazing and silage or hay production. Improved stripe rust resistance over the original Crackerjack. Released by Heritage Seeds.

Endeavour.[Φ] 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.

Kowari. New triticale variety registered in 2016, currently undergoing seed production. Longer season variety, tip-awned, dense grained triticale. Suits early sowing and grazing. Good rust resistance, not resistant to cereal cyst nematode. Bred at Sherlock, South Australia, by Kath Cooper.

Tobruk.[Φ] 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 moderately susceptible - susceptible 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.

Grain only varieties

Astute.[Φ] Released in 2015. Mid maturity variety suited to the medium–high rainfall areas of NSW, with high yield potential. Astute is a suitable replacement for Hawkeye, with a similar flowering time. It is a fully-awned variety, with good lodging resistance. Seed is available through AGT Affiliates. AGT.

Bison.[Φ] Released in 2014. An early to mid-maturity variety, suited to low–medium yield potential environments, performing well across NSW. Reduced-awned variety; possible replacement for Rufus with improved stripe rust resistance. Seed is available through AGT Affiliates. AGT.

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] Released in 2012. Mid-maturity triticale resistant to cereal cyst nematode. 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. Non PBR.

Hawkeye.[Φ] A broadly adapted mid-season variety. Good early vigour and highly stable across environments. Moderately resistant 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.

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. Non-PBR.

Yowie. A later-maturing main season variety (slightly later heading than Tahara), spring-type, grain triticale. Moderately resistant–moderately susceptible 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.

Table 35. 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▲		>	★	★	★	★	★	★	★	★	★	★	★	★	<					
Crackerjack 2						>	★	★	★	★	★	<	<							
Kowari#							>	★	★	★	★	★	<							
Tuckerbox									>	★	★	★	★	★	★	<				
Yowie										>	★	★	★	★	★	<				
Astute, Bison, Fusion, Goanna, Hawkeye▲, Tahara▲											>	★	★	★	★	★	<			
Chopper▲, KM10												>	>	★	★	★	★	★	<	<

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

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

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

Table 36. Triticale variety performance – NSW (compared with Fusion = 100%)

Variety	North east					
					Regional mean	Number of trials
	2012	2013	2014	2015	(2008–2015)	
% Fusion (t/ha)	3.38	3.00	2.87	3.15	**4.14**	
Astute	–	98	96	99	104	6
Bison	–	100	100	107	101	6
Chopper▲	88	92	95	100	89	15
Fusion	**100**	**100**	**100**	**100**	100	11
Goanna	84	86	87	86	87	10
Hawkeye▲	92	94	91	95	95	15
KM10	–	–	92	94	87	4
Tahara▲	82	84	86	82	84	15
Yowie	82	85	82	84	86	11

Variety	South east					
					Regional mean	Number of trials
	2012	2013	2014	2015	(2008–2015)	
% Fusion (t/ha)	5.90	4.34	4.44	4.40	**4.57**	
Astute	–	101	103	105	105	10
Bison	–	100	102	106	101	10
Chopper▲	90	91	86	95	87	29
Fusion	**100**	**100**	**100**	**100**	**100**	**22**
Goanna	90	88	81	89	86	18
Hawkeye▲	94	91	93	99	95	29
KM10	–	–	88	91	89	7
Tahara▲	88	87	77	85	83	29
Yowie	88	83	80	90	86	22

Variety	South west irrigated					
					Regional mean	Number of trials
	2012	2013	2014	2015	(2008–2015)	
% Fusion (t/ha)	6.46	–	8.07	6.49	**6.08**	
Astute	–	–	104	111	112	2
Bison	–	–	100	110	103	2
Chopper▲	87	–	91	99	87	6
Fusion	**100**	**–**	**100**	**100**	**100**	**5**
Goanna	92	–	92	96	91	4
Hawkeye▲	105	–	96	108	102	6
KM10	–	–	90	100	91	2
Tahara▲	86	–	91	90	86	6
Yowie	100	–	91	104	96	5

▲Outclassed – Chopper, Hawkeye and Tahara (all stripe rust and yield).

The tables presents NVT 'Production Value' MET (multi environment trials) data on a regional mean basis from 2008–2015. Yearly group means shown for 2012, 2013, 2104 and 2105. No recent data is available for the NSW north-western region as only a limited number of trials were conducted in the period of 2008–2015.

Table 37. Variety characteristics and reaction to diseases

Variety	Grazing production	Straw strength	Maturity	Resistances						Acid soils–sensitivity to aluminium
				Stem rust	Leaf rust	Stripe rust: Tobruk pathotype	Stripe rust: Yr 17–27 pathotype	Cereal cyst nematode	RLN *P. neglectus*	
Dual-purpose										
Cartwheel	quick–early	very good	mid–late	R	R	–	R	R	R–MR	–
Crackerjack 2	quick–early	moderate	mid–late	–	–	–	–	–	–	–
Endeavour	quick–early	very good	late	R	R–MR[P]	R–MR	R–MR	R	–	V. tol
Kowari	quick–early	good	mid–late	R	R–MR	–	R–MR	MS	MR	–
Tobruk▲	quick–early	very good	mid–late	R	R–MR[P]	MS–S[a]	MR	–	–	–
Tuckerbox	quick–early	–	mid	MR	R–MR[P]	MR–MS	MR	R	–	V. tol
Grain only										
Astute	NR	very good	early–mid	R–MR	R–MR	–	R–MR	R	R	V. tol
Bison	NR	good	early–mid	R–MR	R–MR	–	R	R	R	V. tol
Chopper▲	NR	very good–good	very early	MR–MS	R–MR[P]	MS–S	MR–MS	R	MR	–
Fusion	NR	medium-good	mid	R	R–MR[P]	MR[b]	R–MR	R	R–MR	V. tol
Goanna	NR	good	early–mid	R	R–MR[P]	MR–MS	R–MR	R	MR–MS	–
Hawkeye▲	NR	good	mid	R–MR	R–MR[P]	MR, MS–S[b]	MR, MS[b]	R	R	V. tol
KM10	NR	good	very early	R	MR–MS	–	R–MR	S	R–MR	–
Tahara▲	NR	moderate	early–mid	R	R–MR[P]	MS	MR–MS	R	R	V. tol
Yowie	NR	good	mid	R	R–MR[P]	MR–MS, MS[b]	MR	R	–	–

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
P Provisional rating
▲ Outclassed
a Susceptible to head infection
b mixed population, some plants are more susceptible to stripe rust.
– Unknown or no data

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.

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 feed grains such as barley. Grain is traded domestically through merchants or directly 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. Apply adequate nitrogen fertiliser to alleviate this problem.

Storage

Triticale grain is very prone to weevil attack; more so than barley. Be careful of high grain moisture contents (see Grain insects – options for control on page 124).

Contributing authors

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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. Choose dual-purpose varieties 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 38. 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.

Dual-purpose grazing cereal varieties have been evaluated across NSW for their dry matter production and grain yield recovery. The latest variety performance data can be found under the **Dual-purpose grazing cereal** tab.

https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops

Testing early forage quality of oat, wheat, barley, cereal rye and triticale, grown under similar conditions, has shown similar protein, energy or digestibility levels. The decision to sow an alternative cereal to oats is, therefore, mostly made depending on 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.

Consider the diseases that affect the various grazing cereals. Diseases such as *Barley yellow dwarf virus* (BYDV) or *Wheat streak mosaic virus* can limit crop is grown in a particular area. Applying seed insecticide dressings can reduce the impact of diseases such as BYDV have on the crop by reducing the levels of early aphid feeding activity that spreads the virus. See **Table 69. Cereal insecticide seed dressings for aphid and Barley yellow dwarf virus (BYDV) control 2018 on page 132** for a list of currently available seed dressings for aphid control. Cereal rust diseases can also be an issue so avoid susceptible varieties. Forage quality and palatability decreases with high foliar rust loads.

Growth habit

Understanding a variety's winter habit and maturity will influence the variety choice, 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 is 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 semi-winter types require a shorter cold temperature exposure to initiate heading than the varieties with a strong winter habit.

Maturity

Cereals described as late maturing do not necessarily have a strong winter habit, but respond to a photoperiod response, where the day length controls the rate of development. Without this strong requirement for vernalisation, these types, when sown early in warm/long day conditions, can 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; see the

specific crop section in this book for suggested plant populations. 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, then 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.

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 69 on page 132. Always check the pesticide label before cereal crops sown with treated seed are grazed.

Delaying early grazing of winter types allows more feed to accumulate 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. 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 3 below.

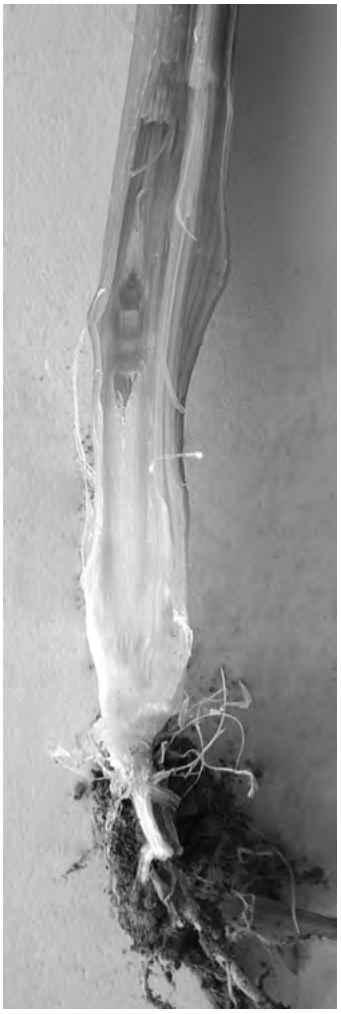

Figure 3. Cross-section showing wheat head in young plant.

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 trade-off. 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 opening up 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 are regarded as normal

on highly digestible, high moisture, green feed. Adding hay or roughage to the diet will generally reduce scouring, but also reduce animal performance as the animal substitutes the hay/roughage for the higher quality forage. 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.

Livestock health

A number of health conditions or disorders such as mineral and vitamin imbalances, enterotoxaemia (pulpy kidney), hypomagnesaemia (grass tetany), hypocalcaemia (milk fever), bone growth disorders in lambs (rickets), photosensitisation in sheep and nitrate poisoning can affect stock that are grazing cereals. Growers should seek advice from their local livestock adviser or veterinary officer and develop a plan to minimise the possibility of animal health disorders.

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 (Table 40).

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 whole farm feed production, 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 39 shows an estimated relationship between crop height and available dry matter (DM) (kg/ha) for crops 25 cm or shorter. Use this as a guide only. For a more precise estimate, take dry matter cuts.

Table 39. 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 40. 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.

Contributing authors

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Canola

Crop management

Canola is an excellent break crop and is profitable in its own right. 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 the crop's 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 commonly grown crops. Growing a pulse crop the year before sowing canola can be useful for fixing and conserving more organic N, controlling weeds and storing more soil water. A pulse crop will also have a low stubble load at sowing, which will aid with crop establishment, 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 high in aluminium and manganese. Highly acidic layers have been identified at 5–10 cm and 10–15 cm across a range of soil types in central and southern NSW. Soil sampling at 5 cm intervals should identify acidic layers. Incorporating lime to a depth of at least 10 cm is recommended to amend acidity at 5–15 cm.

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. Avoid paddocks with major weed problems or choose an appropriate herbicide-tolerant variety.

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 being used on canola.

Sowing

Canola can be sown using no-till systems 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.

Burning stubble residue from the previous crop can be a useful strategy to improve canola emergence, but this should be done as close as possible to sowing to minimise soil moisture loss from the surface.

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.

Canola can be successfully dry-sown in reliable rainfall zones, allowing emergence on opening rains. Seed should be placed at around 1.5–2 cm deep and pressure on closing devices (e.g. press wheels) should be minimised.

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 seed storage, ensuring it is in a cool, dry place and evenly treated with the appropriate seed dressings.

Aim to establish 30–50 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.

Sowing too deep, sowing late into cold, wet soils, and no-till sowing into dense stubble can reduce establishment. In these situations, use the higher sowing rate, consider sowing the seed at a shallower depth, or select a variety with high vigour. 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 41. 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 for most commercial varieties.

Earlier than desirable for early and most mid varieties, choose a slow developing variety. Do not sow early developing varieties this early.

Later than desirable, choose a fast-developing variety.

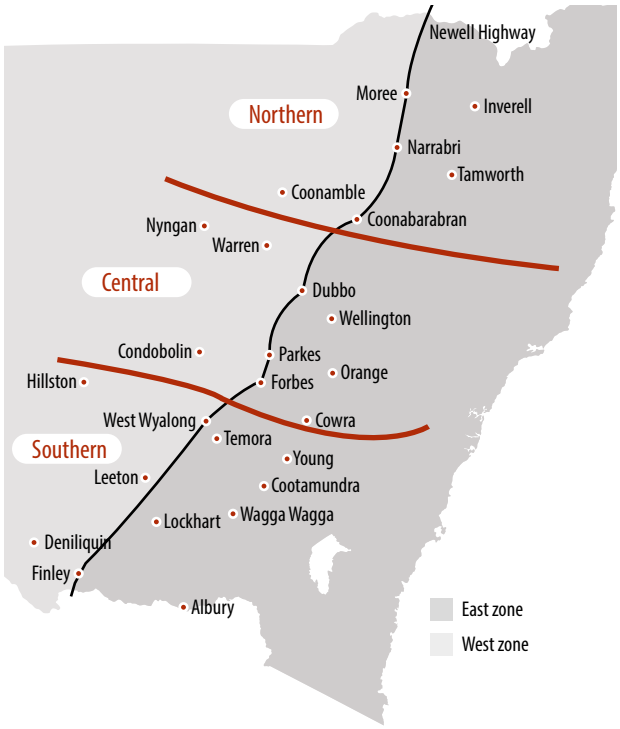

Figure 4. Map of NSW showing canola-growing zones

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 be successful, but ensure a later flowering variety is sown. An early flowering variety sown before mid April can flower early in winter and limit grain yield potential – crops can be at greater risk of frost damage when flowering early. Where there is a low risk of frost damage at early pod-fill, early maturing varieties can be sown from the second week of April in the region's western zone.

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 if sown after this period.

Southern irrigation areas. Sowing time is often governed by the water supply authorities' irrigation season closure timing. 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 phenology and maturity. For most situations, mid–early to mid maturing varieties are preferred.

For all regions, use Table 41 for suggested sowing times.

Nutrition

Nitrogen (N)

High yielding crops have a high N requirement, which can be provided by 2–4 years of legume-dominant pasture, including pulse crops that supply some of the N requirement, 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 seasons where the crop has high yield potential. 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. As a rule of thumb, canola requires 80 kg/ha N per tonne of grain, so a 2.5 t/ha crop requires 200 kg/ha N, which can be supplied through a combination of soil mineral N at sowing, fertiliser and soil mineralisation during the growing season.

High application rates of N can reduce oil content; however, excess N does not cause canola to 'hay off' as it does in cereals.

Canola is sensitive to high rates of N in close proximity to the seed, especially in the lighter textured, warmer and drier soils typical of low rainfall zones.

Eastern zones of central and southern NSW: No more than 10 kg/ha of N should be sown in direct contact with the seed on the common row spacing of 20–25 cm.

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 a row spacing of 30 cm and wider.

Avoid placing high rates of N (above 25 kg/ha) under canola seed as this can also affect emergence.

Sulfur (S)

Canola has a high 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 P is applied at sowing. Unless the crop is sown into a soil with high P, apply at least 8 kg/ha of P for every tonne of canola expected to be harvested, e.g. apply 20 kg/ha of P if the target yield is 2.5 t/ha. Low or deficient P levels can limit the crop's potential response to N. 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 N, canola seed is sensitive to phosphate fertilisers.

Avoid drilling high rates of P in direct contact with canola seed. Rates as low as 10 kg/ha of P applied in direct contact with seed can reduce establishment with the low soil disturbance of narrow sowing points and disc seeders.

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

Protect germinating and establishing crops 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 of residual protection. Bifenthrin is registered for RLEM, BOM and bryobia mites, but the application rate varies according to the targeted mite species. Alpha-cypermethrin will control RLEM, while methidathion is registered for both RLEM and BOM.

Seed treatments

Imidacloprid (see **Table 70. Canola and pulse seed dressings – 2018 on page 133**) and Poncho® Plus (clothianidin + imidacloprid) are registered for use on canola seed to protect against RLEM, BOM and aphids. Poncho® Plus is also registered to control lucerne flea, wireworm and cutworm. 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 supply seed pre-treated with imidacloprid, Poncho® Plus and Cruiser® Opti.

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

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

Lucerne flea

Lucerne flea is an occasional pest found in establishing canola crops. The pest is identified by its jumping and hopping action between plants rather than flying. It is present across a range of soil types in southern NSW. Early-sown crops are more at risk. 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.

Wet springs and summers favour slug reproduction. 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 treating with insecticide to prevent virus transmission, and 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. Seed 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. The GRDC GrowNotes publication ***Reducing aphid and virus risk*** has more information. 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 present in high numbers. They are more frequent in central and northern NSW. 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 **Portuguese millipedes**, **cutworms**, **wireworms**, **bronzed field beetle**, **cockchafers** and **false wireworms** have damaged emerging canola seedlings in recent years. Occurrence of these pests is difficult to predict and is therefore best managed by thorough paddock sampling. In severe cases, plant stands can be thinned to such an extent that the paddock requires re-sowing. The most severe damage tends to occur in crops following pasture, or where stubble has been retained.

Diseases

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 each 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.

Upper canopy infection

Symptoms of upper canopy infection (infection on stems, branches and pods) have increased in NSW in recent years and were widespread in 2017. 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. 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

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.

Table 43 and **Table 44** list the blackleg resistance rating for each variety. Please note they are the ratings released in autumn 2018. Blackleg resistance ratings can change from year to year.

Sclerotinia stem rot

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 canopy wetness (at least 48 hours) during flowering favours disease development. Yield losses can be up to 20% in some years, but have been as high as 35%. Districts with reliable spring rainfall and long flowering periods for canola appear to develop the disease more frequently. Intensive wheat/canola rotations are also very effective at building up levels of soil-borne sclerotia and increasing disease pressure.

Burning canola stubble will not effectively control Sclerotinia as sclerotia survive mainly on or in the soil. The most effective means of reducing the disease level are: Increasing the length of time between broadleaf crops in the same paddock; separation from last year's canola stubble; avoiding early crop flowering; and using foliar fungicides, which are best applied at 20–30% bloom (14–20 open flowers on the main stem).

Compared with 2016, the dry spring conditions across most of inland NSW in 2017 kept potential sclerotinia stem rot levels low. However, the disease still developed at low levels in districts that are affected every year. 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 stem rot 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, such as those in 2017. Consult your farm adviser and refer to the fact sheet ***Sclerotinia stem rot in canola*** on the GRDC website. The fungicides Prosaro® and Aviator®, 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, synonym *Turnip yellows virus*), *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 in the past. 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.***

The GRDC GrowNotes: ***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 averaged across the whole plant (main stem and branches) have started to change to a bronze colour, and most seeds are firm when rolled between the forefinger and thumb. This stage is later than previous recommendations where only the main stem was used to assess seed colour change. Recent research has shown that the main stem is only contributing 25–35% of the yield with the branches contributing 65–75%. Windrowing too early increases the risk of harvesting immature green seed, which is also smaller, 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 48 canola varieties on the market in NSW for 2018.

New releases – there are 10 for NSW:

- DG 408RR from Landmark
- Hyola® 350TT and Hyola® 506RR from Advanta Seeds
- InVigor R 3520 from Bayer
- Nuseed® Quartz and HyTTec Trophy from Nuseed Pty Ltd
- Pioneer® 43Y92 (CL) and Pioneer® 44Y27 (RR) from Pioneer Brand Seeds
- Saintly CL from Heritage Seeds
- Victory® V7002CL from AWB

Outclassed, but still available:

AV-Garnet.

Withdrawn

Archer, Carbine, Hyola® 50, Hyola® 450TT Hyola® 474CL Hyola® 577 CL, Hyola® 525RT, Hyola® 725RT, Hyola® 600RR, IH30 RR, Monola® 314TT, Monola® 513GT,Nuseed GT50, Pioneer 43Y85 (CL), Pioneer 44Y87 (CL), Pioneer 44Y89 (CL), Pioneer 44Y24 (RR), Pioneer 44Y26 (RR), Pioneer Atomic TT, SF Sensation.

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 autumn 2018 and based on blackleg nursery data from 2015–2017. Resistance ratings and resistance groups are updated each year – available on the GRDC website.

Note: Varieties are grouped according to their physiological maturity in Table 43 and Table 44. 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 is presented in Table 43 and Table 44. Comparative performance in NVT trials is the average oil content across a group of sites for that maturity grouping (early or mid) in 2017 – 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. View this data 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 herbicide tolerant – Triazine tolerant plus Roundup Ready.

Conventional varieties

AV-Garnet$^{\phi}$. Mid to mid–early maturing OP variety. Widely adapted. Medium plant height. Blackleg rating MS; resistance group A. Tested in NVT trials 2006–2017. Marketed by Nuseed Pty Ltd.

Nuseed® Diamond. Early maturing hybrid. Very fast to flowering. Suited to low–medium rainfall zones. Medium plant height. Blackleg rating MR; resistance group ABF. Tested in NVT trials 2012–2017. Marketed by Nuseed Pty Ltd.

Nuseed® Quartz. New release (coded NCH14C047). Mid–mid-early maturing hybrid. Suited to medium–high rainfall zones. Medium plant height. Blackleg rating R; resistance group ABD. Tested in NVT trials 2016 and 2017. 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 resistance group BC. Not tested in NVT trials. Marketed by Seed Force.

Victory® V3002. Early–mid maturing conventional specialty (high stability oil) hybrid. Blackleg rating MR; resistance group ABF. Tested in NVT trials 2011–2017. 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, simazine or terbuthylazine herbicides.

ATR-Bonito$^{\phi}$ Early to early–mid maturing OP variety. Suited to medium–low rainfall zones. Plant height slightly shorter than ATR-Gem$^{\phi}$. Blackleg rating MS; resistance group A. Tested in NVT trials 2012–2017. Marketed by Nuseed Pty Ltd. EPR is $5.50/tonne inc. GST.

ATR-Gem$^{\phi}$ Mid–early maturing OP variety. Widely adapted. Blackleg rating MS; resistance group A. Tested in NVT trials 2011–2016. Marketed by Nuseed Pty Ltd.

ATR-Mako$^{\phi}$ Mid–early maturing OP variety. Suited to medium–high rainfall zones. Slightly taller plant height than ATR-Gem$^{\phi}$ Blackleg rating MR; resistance group A. Tested in NVT trials 2014–2017. Marketed by Nuseed Pty Ltd. EPR is $5.50/tonne inc. GST.

ATR-Stingray$^{\phi}$ Early maturing OP variety. Fast to flowering. Short plant height. Blackleg rating MR; resistance group C. Tested in NVT trials 2010–2017. Marketed by Nuseed Pty Ltd.

ATR-Wahoo$^{\phi}$ Mid–late maturing OP variety. Suited to medium–high rainfall areas. Plant height similar to ATR-Gem$^{\phi}$ Blackleg rating MS; resistance group A. Tested in NVT trials 2012–2017. Marketed by Nuseed Pty Ltd. EPR is $5.50/tonne inc. GST.

DG 560TT. Mid maturing hybrid. Suited to medium rainfall areas. Medium plant height. Blackleg rating MR; resistance group BF. Tested in NVT trials in 2015 and 2016 only. Marketed by Landmark.

DG 670TT. Mid–late maturing hybrid. Suited to medium–high rainfall areas. Medium–tall plant height. Blackleg rating MR; resistance group BF. Tested in NVT trials in 2016 only. Marketed by Landmark.

Hyola® 350TT. New release (coded T48481). Early maturing hybrid. Suited to low–medium rainfall areas. Medium plant height suited to direct harvesting. Blackleg rating R; resistance group ABDF. Tested in NVT trials 2016–2017. Marketed by Advanta Seeds.

Hyola® 559TT. Mid maturing hybrid. Suited to low–high rainfall areas. Medium plant height, taller than Hyola® 450TT. Blackleg rating MR; resistance group ABD. Tested in NVT trials 2012–2017. Marketed by Advanta Seeds.

Hyola® 650TT. Mid–late maturing hybrid. Suited to medium–high rainfall areas. Medium plant height. Blackleg rating R; resistance group ABD. Tested in NVT trials in 2013–2017. Marketed by Advanta Seeds.

HyTTec® Trophy. New release (coded NCH15T085). Early to early–mid maturing hybrid. Suited to medium–low rainfall zones. Medium plant height, similar to ATR-Bonito. Blackleg rating R–MR; resistance group ABD. Tested in NVT trials for the first time in 2017. Bred and marketed by Nuseed Pty Ltd. EPR is $11.00/tonne inc. GST.

InVigor T 4510. Early-mid maturing hybrid. Suited to medium rainfall areas. Medium plant height. Blackleg rating MR–MS; resistance group BF. Tested in NVT in 2016 and 2017. Marketed by Bayer.

Monola® 416 TT. Early–mid maturing OP specialty oil variety. Suited to medium–low rainfall zones. Short–medium plant height. Blackleg rating MR; resistance group B. Tested in NVT trials 2014–2017. Marketed by Nuseed Pty Ltd.

Monola® 515 TT. Mid maturing OP specialty oil variety. Suited to medium rainfall zones. Blackleg rating MR; resistance group not known. Tested in NVT trials in 2014–2016. Marketed by Nuseed Pty Ltd.

Pioneer® 44T02 (TT). Early–mid maturing hybrid. Suited to medium–low rainfall zones. Medium plant height. Blackleg rating R–MR; resistance group ABD. Tested in NVT trials 2015–2017. Marketed by Pioneer Brand Seeds.

Pioneer® 45T01 (TT). Mid maturing hybrid. Suited to medium–high rainfall zones. Medium plant height. Blackleg resistance group AB. Tested in NVT trials 2013–2016. Marketed by Pioneer Brand Seeds.

SF Ignite TT. Mid to mid–late maturing hybrid. Suited to medium to high rainfall zones. Medium plant height. Blackleg rating MR; resistance group BF. Tested in NVT trials in 2016 and 2017. Marketed by Seed Force.

SF Turbine TT. Early–mid maturing hybrid. Suited to medium rainfall zones. Medium plant height. Blackleg rating MR–MS; resistance group BF. Tested in NVT trials 2015–2017. 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.

Banker CL. Mid maturing hybrid. Medium plant height. Blackleg rating MR–MS; resistance group A. Tested in NVT trials in 2014–2017. Marketed by Heritage Seeds.

Hyola® 575CL. Mid to mid–early maturing hybrid. Fast to flowering from early sowing. Suited to medium–high rainfall areas. Medium–tall plant height. Blackleg rating R; resistance group BF. Tested in NVT trials 2010–2016. 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 R; resistance group H. Not tested in NVT trials. Marketed by Advanta Seeds.

Pioneer® 43Y92 (CL). New release (coded PHI-1601). Early maturing hybrid, Suited to low–medium rainfall areas. Medium plant height. Blackleg rating R–MR; resistance group B. Tested in NVT trials in 2016 and 2017. Marketed by Pioneer Brand Seeds.

Pioneer® 44Y90 (CL). Early–mid maturing hybrid, but longer maturity compared with 44Y89 (CL). Suited to medium–low rainfall areas. Medium plant height. Blackleg rating R–MR; resistance group B. Tested in NVT trials 2015–2017. Marketed by Pioneer Brand Seeds.

Pioneer® 45Y91 (CL). Mid maturing hybrid. Suited to high rainfall areas. Medium–tall plant height. Blackleg rating MR; resistance group B. Tested in NVT trials in 2014, 2016 and 2017. Marketed by Pioneer Brand Seeds.

Saintly CL. New release (coded HSHC1503CL). Mid to mid–early maturing hybrid. Medium plant height, suited to medium rainfall areas. Blackleg rating MR; resistance group B. Limited release for 2018. Tested in NVT 2015–2017. Marketed by Heritage Seeds.

SF Edimax CL. Long season winter dual-purpose graze and grain hybrid. Suited to early sowing and spring sowing in high rainfall areas. Blackleg rating R–MR; resistance group C. Not tested in NVT trials. Marketed by Seed Force.

Victory® V7002CL. New release. Early-mid maturing specialty hybrid. Blackleg rating MR; resistance group BF. Tested in NVT for the first time in 2017. Limited release for 2018. Bred by Cargill. Marketed by AWB under contract.

Roundup Ready® varieties

DG 408RR. New release (coded 11H4054). Early–mid maturing hybrid. Medium plant height. Blackleg rating MS; resistance group AC. Tested in Early Maturing NVT for the first time in 2016 and more widely in 2017. Marketed by Landmark.

DG 460RR. Early–mid maturing hybrid. Short plant height. Blackleg rating MR; resistance group A. Tested in NVT trials in 2015–2017. Marketed by Landmark.

Hyola® 404RR. Early to mid–early maturing hybrid. Suited to low–medium rainfall areas. Medium plant height. Blackleg rating R–MR; resistance group ABD. Tested in NVT trials 2010–2017. Marketed by Advanta Seeds.

Hyola® 506RR. New release. Mid–early maturing hybrid. Suited to medium to high rainfall areas. Medium–tall plant height. Blackleg rating R and resistance group ABD. Tested in NVT trials 2016–2017. Marketed by Advanta Seeds.

IH51 RR. Mid maturing hybrid with Bayer's pod shatter tolerance trait PodGuard. Suited to later windrow timings or direct harvesting in medium–high rainfall areas. Blackleg rating MR–MS; resistance group A. Tested in NVT trials 2014–2016. Marketed by Bayer.

InVigor® R 3520. New release (coded AN14R5537). Early to early-mid maturing hybrid. Suited to low–medium rainfall areas. Blackleg rating MR; resistance group unknown. Tested in NVT trials in 2016 and 2017. Marketed by Bayer.

InVigor R 5520P. Mid maturing hybrid with pod shatter tolerance trait PodGuard. Suited to later windrow timings or direct harvesting in medium–high rainfall areas. Blackleg rating MR; resistance group AC. Tested in NVT trials in 2015–2017. Marketed by Bayer

Monola® G11. Early–mid maturing specialty oil hybrid. Suited to medium–low rainfall zones. Medium plant height. Blackleg rating MR; resistance group ABS. Tested in NVT trials in 2013–2016. Marketed by Nuseed Pty Ltd.

Nuseed GT-41. Early maturing hybrid. Suited to low–medium rainfall zones. Medium plant height. Blackleg rating MR; resistance group ABF. Tested in NVT trials 2012–2015. Marketed by Nuseed Pty Ltd.

Nuseed GT-42. Early to early-mid maturing hybrid. Suited to medium–low rainfall zones. Medium plant height. Blackleg rating R; resistance group ABDF. Tested in NVT trials 2015 and 2016. Marketed by Nuseed Pty Ltd.

Nuseed GT-53. Mid maturing hybrid. Suited to medium–high rainfall areas. Medium–tall plant height. Blackleg rating R; resistance group ABDF. Tested in NVT trials 2014–2017. Marketed by Nuseed Pty Ltd.

Pioneer® 43Y23 (RR). Early maturing hybrid. Suited to medium–low rainfall areas. Blackleg rating MR; resistance group B. Tested in NVT trials 2011–2017. Marketed by Pioneer Brand Seeds.

Pioneer® 44Y27 (RR). New release (coded PHR-1605). Early–mid maturing hybrid. Suited to high–low rainfall areas. Medium plant height. Blackleg rating R–MR; resistance group B. Tested in NVT trials in 2016 and 2017. Marketed by Pioneer Brand Seeds.

Pioneer® 45Y25 (RR). Mid maturing hybrid. Suited to medium–high rainfall areas. Can be sown relatively early. Medium plant height. Blackleg rating MR; resistance group BC. Tested in NVT trials 2012–2017. Marketed by Pioneer Brand Seeds.

Victory® V5003RR. Mid maturing RR specialty (high oleic, low linolenic oil) hybrid. Blackleg rating MR; resistance group A. Tested in NVT trials 2013–2017. 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®. Early–mid maturing dual herbicide-tolerant hybrid. Suited to low–medium rainfall areas. Short–medium plant height. Blackleg rating MS–S; resistance group B. Tested in NVT trials 2015–2017. Marketed by Bayer.

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Table 42. 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 Nuseed Quartz	
Triazine tolerant (TT)	ATR-Stingray Hyola 350 TT	ATR-Bonito ATR-Gem ATR-Mako HyTTec Trophy InVigor T 4510 Monola 416TT Pioneer 44T02 TT SF Turbine TT	DG 560TT Hyola 559TT Hyola 650TT Monola 515TT Pioneer 45T01 (TT)	ATR-Wahoo DG 670TT SF Ignite TT
CLEARFIELD®	Pioneer 43Y92 (CL)	Pioneer 44Y90 (CL) Saintly CL Victory 7002 CL	Banker CL Hyola 575CL Pioneer 45Y91 (CL)	
Roundup Ready®	InVigor R 3520 Nuseed GT-41 Pioneer 43Y23 (RR)	DG408RR DG 460RR Hyola 404RR IH51 RR Monola G11 Nuseed GT-42 Pioneer 44Y27 (RR)	Hyola 506RR InVigor R 5520P Nuseed GT-53 Pioneer 45Y25 (RR) Victory V5003RR	
Roundup Ready® plus Triazine tolerant (dual tolerance)		Bayer 3000TR		

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 dual-purpose graze and grain canola types are not included in this table. Maturity of these types is generally considered to be late–very late.

Further information

NSW DPI Agriculture website for:

Weed control in winter crops

Insect and mite control in field crops

Agnote DPI 495, *Virus diseases in canola and mustard*

Primefact 115, *Clubroot of canola and mustard*

Primefact 783, *Juncea canola in the low rainfall zone of south-western NSW*

Primefact 786, *Brassica juncea in north-western NSW*

GRDC website for:

Canola best practice management guide for southeastern Australia (GRDC, 2009)

Reducing aphid and virus risk (GRDC GrowNotes)

Fact sheets:

Blackleg management guide

Sclerotinia stem rot in canola

Australian Oilseeds Federation website for:

AOF standards manual

Contributing authors

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Table 43. Comparative performance in NVT trials[1] – early maturing

Variety	North west	Trial no.	North east	Trial no.	South west	Trial no.	Oil % #	Trial no.	Blackleg rating March 2018 ##	Blackleg group March 2018 ##
Year	2013–2017		2013–2017		2013–2017		2017		2018	2018
Early maturing conventional trials – mean seed yield expressed as a % of AV-Garnet										
AV-Garnet	**100**	**6**	**100**	**5**	**100**	**2**	**37.4**	**4**	**MS**	**A**
Nuseed Diamond	133	6	141	4	109	2	40.7	4	MR	ABF
Nuseed Quartz	126	3	128	2	n.d.	1	41.0	4	R	ABD
Victory V3002	108	5	109	4	n.d.	1	40.1	4	MR	ABF
AV-Garnet t/ha	**1.45**		**1.12**		**1.53**					
Early maturing Triazine tolerant (TT) trials – mean seed yield expressed as a % of ATR-Stingray										
ATR-Bonito	96	6	96	5	97	2	41.6	4	MS	A
ATR-Stingray	**100**	**5**	**100**	**3**	**100**	**1**	**38.7**	**2**	**MR**	**C**
Bayer 3000TR	103	3	n.d.	0	n.d.	1	38.4	2	MS–S	B
Hyola 350TT	109	2	n.d.	1	n.d.	1	40.0	4	R	ABDF
Hyola 559TT	106	6	104	3	109	2	42.5	3	MR	ABD
HyTTec Trophy	105	2	n.d.	1	n.d.	0	40.6	4	R–MR	ABD
InVigor T 4510	108	3	108	2	n.d.	1	38.8	4	MR–MS	BF
Monola 416TT	95	4	n.d.	0	n.d.	1	38.3	2	MR	B
Pioneer 44T02 TT	109	5	108	3	n.d.	1	41.4	4	R–MR	ABD
ATR-Stingray t/ha	**1.69**		**1.28**		**1.53**					
Early maturing Clearfield trials – mean seed yield expressed as a % of Hyola 575CL										
Hyola 575CL	**100**	**6**	**100**	**5**	**100**	**2**	**39.2**	**4**	**R**	**BF**
Pioneer 43Y92 (CL)	117	3	119	2	n.d.	1	40.0	4	R–MR	B
Pioneer 44Y90 (CL)	117	5	119	3	n.d.	1	40.6	4	R–MR	B
Saintly CL	113	4	116	2	n.d.	0	40.1	4	MR	B
Victory V7002CL	113	2	n.d.	1	n.d.	0	40.7	4	MR	BF
Hyola 474CL t/ha	**1.66**		**1.30**		**1.62**					
Early maturing Roundup Ready trials – mean seed yield expressed as a % of Hyola 404RR										
DG 408RR	105	2	n.d.	0	n.d.	0	42.1	2		
Hyola 404RR	**100**	**4**	**n.d.**	**0**	**100**	**2**	**41.5**	**2**	**R–MR**	**ABD**
InVigor R3520	105	2	n.d.	0	n.d.	1	40.1	2	MR	Unknown
Nuseed GT-42	94	3	n.d.	0	n.d.	1	38.8	2	R	ABDF
Pioneer 43Y23 (RR)	103	4	n.d.	0	101	2	37.9	2	MR	B
Pioneer 44Y27 (RR)	109	2	n.d.	0	n.d.	1	38.4	2	R–MR	B
Hyola 404RR t/ha	**1.80**				**1.62**					

The more trials, the greater the reliability.

n.d. no data.

[1] Based on predicted yields from an analysis across all sites (2013–2017 NVT trials). New varieties have less trial data supporting the five-year dataset and hence should be viewed with some caution, especially where there are only two 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 2017 only.

Blackleg ratings are the published ratings for autumn 2018.

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.

Table 44. Comparative performance in NVT trials[1] – mid maturing

Variety	North west	Trial no.	North east	Trial no.	South west	Trial no.	South east	Trial no.	Oil % #	Trial no.	Blackleg rating autumn 2018 ##	Blackleg group autumn 2018 ##
Year	2013–2017		2013–2017		2013–2017		2013–2017		2017		2018	2018
Mid maturing conventional trials– mean seed yield expressed as a % of AV-Garnet												
AV-Garnet	**100**	**4**	**100**	**5**	**100**	**5**	**100**	**5**	**38.7**	**3**	**MS**	**A**
Nuseed Diamond	118	4	113	4	109	5	108	5	39.1	3	MR	ABF
Nuseed Quartz	n.d.	1	123	2	126	2	125	2	40.8	3	R	ABD
Victory V3002	104	4	99	5	101	5	100	5	39.2	3	MR	ABF
AV-Garnet t/ha	**1.69**		**1.55**		**1.74**		**2.14**					
Mid maturing Triazine Tolerant (TT) trials – mean seed yield expressed as a % of ATR-Bonito												
ATR-Bonito	**100**	**9**	**100**	**9**	**100**	**10**	**100**	**27**	**43.8**	**7**	**MS**	**A**
ATR-Mako	102	7	100	6	103	6	101	22	41.0	9	MR	A
ATR-Stingray	99	7	99	7	95	8	97	18	40.6	3	MR	C
ATR-Wahoo	95	8	97	6	103	4	102	28	42.5	7	MS	A
Bayer 3000 TR	106	4	103	4	104	4	104	12	37.7	2	MS–S	B
Hyola 559TT	109	9	106	10	109	10	109	29	43.9	10	MR	ABD
Hyola 650TT	106	4	105	9	114	4	111	26	44.7	6	R	ABD
HyTTec Trophy	n.d.	1	121	2	126	2	124	6	41.9	9	R–MR	ABD
InVigor T 4510	112	3	115	4	117	4	117	12	42.2	10	MR–MS	BF
Monola 416TT	98	6	97	2	97	7	98	15	43.4	3	MR	B
Monola 515TT	87	7	83	4	88	6	88	17	43.8	4	MR	Unknown
Pioneer 44T02 (TT)	112	5	106	6	108	6	108	15	42.7	9	R–MR	ABD
SF Ignite TT	108	2	112	4	117	2	116	10	42.5	6	MR	BF
SF Turbine TT	109	5	109	6	110	6	110	18	41.8	10	MR–MS	BF
ATR-Bonito t/ha	**1.84**		**1.77**		**1.76**		**1.99**					
Mid maturing CLEARFIELD® trials– mean seed yield expressed as a % of Hyola 575CL												
Banker CL	111	7	120	6	113	6	115	21	41.1	10	MR–MS	A
Hyola 575CL	**100**	**9**	**100**	**10**	**100**	**10**	**100**	**29**	**41.7**	**10**	**R**	**BF**
Pioneer 43Y92 (CL)	117	3	122	4	112	4	114	8	41.5	6	R–MR	B
Pioneer 44Y90 (CL)	116	5	124	6	116	6	117	14	43.0	9	R–MR	B
Pioneer 45Y91 (CL)	111	4	118	3	110	1	112	14	43.1	8	MR	B
Saintly CL	117	5	123	5	111	6	110	17	43.8	9	MR	B
Victory V7002CL	n.d.	1	110	2	100	2	100	3	41.7	7	MR	BF
Hyola 575CL t/ha	**1.90**		**1.71**		**1.86**		**2.06**					
Mid maturing Roundup Ready trials – mean seed yield expressed as a % of Nuseed GT-53												
DG 408RR	97	2	n.d.	0	94	3	96	2	43.3	3	MS	AC
DG 460RR	89	3	n.d.	0	91	6	96	12	44.3	6	MR	A
Hyola 506RR	94	2	n.d.	0	94	3	98	9	45.1	6	R	ABD
IH51 RR	88	4	n.d.	0	90	7	94	14	42.9	6	MR–MS	A
InVigor R 5520P	87	3	n.d.	0	87	4	95	11	43.2	6	MR	AC
Monola G11	92	4	n.d.	0	80	9	84	12	43.1	3	R–MR	ABS
Nuseed GT-42	91	3	n.d.	0	89	6	92	7	41.6	4	R	ABDF
Nuseed GT-53	**100**	**3**	**n.d.**	**0**	**100**	**5**	**100**	**14**	**44.5**	**5**	**R**	**ABDF**
Pioneer 43Y23 (RR)	96	4	n.d.	0	92	10	96	7	38.7	2	MR	B
Pioneer 44Y27 (RR)	98	2	n.d.	0	95	4	101	7	43.6	5	R–MR	B
Pioneer 45Y25 (RR)	96	5	n.d.	0	102	5	103	17	45.7	3	MR	BC
Victory V5003RR	87	5	n.d.	0	88	9	91	18	43.6	6	MR	A
Nuseed GT-53 t/ha	**2.36**				**2.23**		**2.57**					

n.d. no data.

[1] Based on predicted yields from an analysis across all sites (2013–2017 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 two 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 2017 only.

\## Blackleg ratings are the published ratings for autumn 2017.

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Chickpea

Chickpea is a winter pulse crop that is profitable in its own right. The crop contributes to crop rotations by fixing nitrogen and providing a disease and weed break for cereal crops. However, chickpea crops require systematic monitoring for foliar and root diseases and insect pests.

There are two distinct types of chickpea grown in Australia: desi and kabuli. Desi chickpea has relatively small, light brown angular seeds that are used for split pea (dhal) or for flour after the hulls are removed. Desi varieties are most widely grown under dryland production in Queensland and northern New South Wales. Kabuli chickpea is more rounded and creamy-white in colour, and generally much larger in size than desi chickpea. Kabuli chickpea is usually sold whole, so seed size and appearance is critically important. Kabuli varieties flower at a similar time to the desi type, but have a longer grain filling period, requiring more soil water to ensure adequate seed size. Kabuli variety yields are generally lower (15–30%), and more variable than desi varieties, which can be offset by premiums for larger seed ranging from 8 mm to 10 mm.

Chickpea is well adapted to warm spring environments because it can better tolerate higher temperatures during and after flowering than other winter pulse crops such as faba bean, lupin and field pea.

Chickpea is best suited to loams and self-mulching clay soils that have neutral–alkaline pH. Soils with high chloride levels (>600 mg/kg) in the subsoil (30–90 cm depth) are best avoided. Acidic soils (pH_{Ca}<5.2) with high aluminium levels, sodic, saline and/or shallow soils are generally not suitable. Most pulses in southern NSW are grown in acidic soils where pH stratification can affect root growth, nodulation, crop growth and yield potential. Highly acidic layers have been identified at 5–10 cm and 10–15 cm across a range of soil types in central and southern NSW. Incorporating lime to a depth of at least 10 cm is recommended to amend acidity at 5–15 cm.

Chickpea does not tolerate waterlogging, and should not be grown in 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 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. Chickpea seed deteriorates in quality after 12 months, and should not be kept any longer than 18 months as planting seed. Information on seed treatment and establishing a profitable crop can be found on the Pulse Australia website. Refer to Further information on page 98.

Paddock selection

Maintain a distance of at least 500 m (further is better) from the previous year's chickpea paddocks and a break of at least three years between chickpeas in the same paddock. These practices aim to reduce 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, Sclerotinia, or waterlogging. Flooding can also carry disease inoculum long distances. Do not grow chickpea on chickpea.

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. During the early vegetative stage, standing cereal stubble will also help to deter aphids (which can transmit viruses).

Sowing depth

Sow chickpea seed 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 with a disc chain 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. A level seedbed can also 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 triazine 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 gaps in plant stands, as a uniform plant establishment has been found to be highly effective in reducing aphid infestation.

Table 46. 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
Genesis 090	30	75	113	131	169
Genesis Kalkee	45	113	169	197	253
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 Seamer	23	58	86	101	129
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 – 80% 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.

In some situations, 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
- the 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. Yield penalties can occur in above-average seasons. Wider row spacing (>50 cm) in southern NSW can result in lower grain yields.

Sowing time

Aim to sow in the early–mid period of the recommended 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 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 shorter in 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, frosted grains and tiger stripe/blotch seed markings.

Table 45. Suggested sowing times

Region	Weeks	April				May				June				July			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Moree–Narrabri																	
Walgett–Coonamble																	
Liverpool Plains																	
Central NSW (grey soil)																	
Central NSW (red soil)																	
Southern NSW																	

Preferred sowing time

Earlier or later than recommended, yield reduction likely.

Inoculation

Inoculation is essential, regardless of soil type or previous chickpea history. Use the commercially available Group N chickpea inoculant. Effective nodulation requires forward planning and care to ensure it is done correctly. Treat seed with fungicide first, then apply inoculant separately just before sowing. Avoid inoculating directly into air-seeder bins as the seed needs to dry before being sown. Newly inoculated seed is often sticky and does not flow properly causing uneven seed flow in the bin and leading to blocked hoses, patchy establishment and future weed burdens.

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 more 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.

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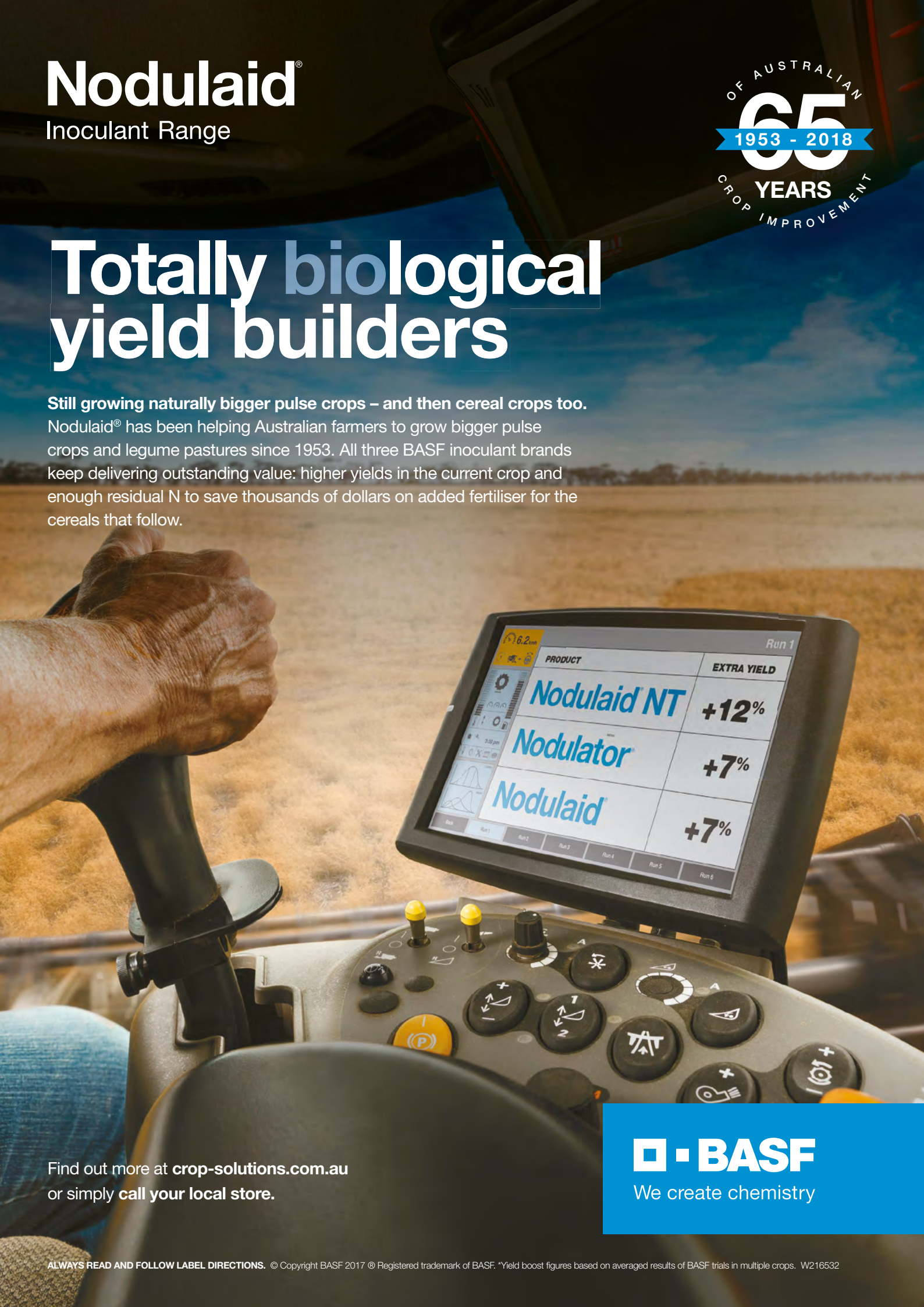

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A good method for determining the response from starter fertilisers is to put down test strips, leaving a control (nil) strip and a double rate strip for comparison.

Variety selection

When choosing a variety, many factors should be considered including:

- maturity to suit the environment
- disease susceptibility
- paddock suitability
- seed availability and cost
- seed size and sowing rate (with reference to sowing machinery)
- harvesting ease and marketing options.

A Pulse Breeding Australia (PBA) variety brochure or Variety Management Package (VMP) is available from the GRDC website, Pulse Australia or the relevant seed supply company for each variety. Refer to Table 47 and Table 48 for yield, varietal characteristics and disease reactions.

There is one new desi chickpea variety release for 2018, CICA1303, which is best suited to chickpea-growing areas in central Queensland.

A change in virulence in the ascochyta blight (AB) pathogen population has occurred in Victoria, South Australia, New South Wales and Queensland. This has resulted in separate ascochyta blight resistance ratings for southern and northern Australia. In southern Australia, current varieties are rated as either susceptible (S) or moderately susceptible (MS) to AB infection. This follows observations of severe AB on previously resistant chickpea varieties in 2015, 2016 and 2017 across South Australia and Victoria. Severe AB was also observed in 2017 on PBA Seamer$^{\phi}$ which, when released in 2016, was rated Resistant (R) to AB. Every case of virulent AB on PBA Seamer$^{\phi}$ in 2017 was in crops that were sown into 2016 chickpea stubbles i.e. back to back chickpea. In northern regions, AB was common and severe in 2016, leading to high levels of inoculum carrying over to infect the 2017 crop. As more aggressive isolates evolve, following recommended integrated disease management packages for AB (especially not planting back-to-back chickpea) will reduce growers' risk of expensive AB control or crop failure, slow the rate of pathogen evolution and ensure a profitable outcome.

Desi types

The revised Ascochyta ratings are based on one seasons' trials with a limited number of pathogen isolates – please interpret these ratings accordingly; there may be highly aggressive isolates in some districts which may change the AB management strategy.

Ambar$^{\phi}$. Moderately resistant–Moderately susceptible (MR–MS) to Ascochyta, similar to Genesis™ 509 and Genesis™ 090 in NSW (Moderately susceptible – MS in Vic/SA), superior to PBA HatTrick$^{\phi}$ and PBA Boundary$^{\phi}$; susceptible (S) to phytophthora root rot, so not recommended for northern NSW. Developed by DAFWA and UWA from germplasm bred by NSW DPI. Marketed by Heritage Seeds. EPR is $4.40/tonne inc. GST.

Table 47. Chickpea variety ratings for common chickpea diseases in Australia

Variety	Ascochyta blight ❶	Phytophthora root rot ❷	Botrytis grey mould ❸	Virus ❹	Root-lesion nematode (*Pratylenchus thornei*)		Root-lesion nematode (*Pratylenchus neglectus*)	
					Resistance ❺	Tolerance ❺	Resistance ❺	Tolerance ❺
Desi types								
Ambar	MR–MS	S	S	–	MS	–	MR–MS	–
Jimbour	S	MS–MR	S	S	S	T		T
Kyabra	VS	MS	S	S	VS	–	MR–MS	–
Neelam	MR–MS	S	S	–	MS	–	MR–MS	–
PBA Boundary	MR–S	S	S	S	MS	–	–	–
PBA HatTrick	MS	MR	S	S	MS	–	MR–MS	–
PBA Maiden	MR–MS	S	S	S	MR–MS	–	MR–MS	–
PBA Seamer	MR	MR	S	S	MS	–	MR–MS	–
PBA Slasher	MR–MS	S	S	S	MR–MS	–	MR–MS	–
PBA Striker	MR–MS	S	S	S	–	–	MR–MS	–
Yorker	MS	MR	S	S		MT		–
Kabuli types								
Almaz	MR–MS	VS	S	S	VS	T	MR–MS	–
Genesis™ 090	MR	VS	S	S	MS	T	MR–MS	–
Genesis™ Kalkee	MR–MS	VS	S	S	MS	–	MR–MS	–
PBA Monarch	MS	VS	S	S	MS–S	–	MR–MS	–

Source: NVT chickpea national disease ratings.

– No data.
R Resistant
MR Moderately resistant
MS Moderately susceptible
S Susceptible
VS Very susceptible
T Tolerant
MI Moderately intolerant
I Intolerant

❶ Ascochyta ratings are for northern Australia (NSW) only, not southern Australia (Vic & SA).

❷ Ratings a compilation of NSW (Tamworth) and Qld (Warwick) data.

❸ 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.

❹ Virus ratings could change with different virus species predominating in different areas.

❺ 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.

Table 48. Chickpea variety characteristics

Variety	Plant height	Lodging resis-tance	100 seed weight (g)	Maturity	North		South	
					Yield as a % of PBA HatTrick 2013–2017		Yield as a % of PBA Slasher 2013–2017	
					East 1.81 t/ha	West 1.41 t/ha	East 1.97 t/ha	West 1.63 t/ha
Desi types								
Ambar	MS	VG	16	E	n.d.	n.d.	99 (5)	98 (5)
Jimbour	T	VG	20	M	101 (15)	100 (34)	n.d.	n.d
Kyabra	T	VG	26	M	104 (15)	101 (34)	n.d.	n.d.
Neelam	MT	VG	17	M	n.d.	n.d.	102 (5)	100 (5)
PBA Boundary	T	M	19	M	105 (15)	105 (34)	92 (5)	93 (5)
PBA HatTrick	T	M	20	M	**100 (15)**	**100 (34)**	93 (5)	93 (5)
PBA Maiden	MS	M	24	M	n.d.	n.d.	98 (5)	97 (5)
PBA Seamer	M	VG	23	M	104 (15)	105 (34)	94 (4)	92 (4)
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)	104 (5)

Variety	Plant height	Lodging resis-tance	100 seed weight (g)	Maturity	Yield as a % of Almaz 2013–2017		Yield as a % of Genesis™ 090 2013–2017	
					East 2.26 t/ha	West 1.27 t/ha	East 1.76 t/ha	West n.d.
Kabuli types								
Almaz	MT	G	41	L	**100 (8)**	**100 (15)**	95 (5)	n.d.
Genesis™ 090	M	G	30	M–L	105 (8)	112 (15)	**100 (5)**	**n.d.**
Genesis™ Kalkee	T	VG	45	L	98 (8)	93 (15)	95 (5)	n.d.
PBA Monarch	M	F	42	E	102 (8)	104 (15)	98 (5)	n.d.

Yield results are a combined-across-sites analysis using NVT and PBA data from 2013–2017.

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

Maturity
E early
M medium
L late

Jimbour. Susceptible (S) 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. Marketed by Mt Tyson Seeds. No EPR.

Kyabra[Φ]**.** Very susceptible (VS) 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. Marketed by Heritage Seeds. A seed royalty applies. No EPR.

Neelam[Φ]**.** Moderately resistant–Moderately susceptible (MR–MS) to Ascochyta, similar to Genesis™ 509 and Genesis™ 090, superior to PBA HatTrick[Φ] and PBA Boundary[Φ] in NSW (MS in Vic/SA); S to Phytophthora so not recommended for northern NSW. Marketed by Heritage Seeds. EPR is $4.40/tonne inc.GST.

PBA Boundary[Φ]**.** Moderately susceptible (MS) to Ascochyta, superior to PBA HatTrick[Φ] in NSW (S in Vic/SA); S to Phytophthora, less resistant than PBA HatTrick[Φ] 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[Φ] in southern NSW, but a suitable option if a tall, erect plant type is required. Mid season maturity, equivalent to PBA HatTrick[Φ]. Medium sized desi seed suited to human consumption. Developed by Pulse Breeding Australia (PBA). Marketed by Seednet. EPR is $4.40/tonne inc. GST.

PBA HatTrick[Φ]**.** Moderately susceptible (MS) to Ascochyta, superior to Flipper[Φ] in NSW (S in Vic/SA); MR to Phytophthora, more resistant than Jimbour. High-yielding across 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 human consumption. Developed by PBA. Marketed by Seednet. EPR is $4.40/tonne inc GST.

PBA Maiden[Φ]**.** Moderately resistant–Moderately susceptible (MR–MS) to Ascochyta, less than PBA Slasher[Φ] in NSW (S in Vic/SA); S to Phytophthora, not recommended for northern NSW. Semi-spreading plant type with mid-season maturity, similar to PBA Slasher[Φ]. Large sized desi for southern environments with a yellow–tan seed coat suited to whole seed markets. Developed by PBA. Marketed by Seednet. EPR is $4.40/tonne inc. GST.

PBA Seamer[Φ]**.** Moderately resistant (MR) to Ascochyta, superior to PBA HatTrick[Φ] and PBA Boundary[Φ] in NSW (MS in Vic/SA); MR to Phytophthora, more resistant than Jimbour. High-yielding across growing regions of northern NSW, southern and central Qld; recommended and suited to areas north of Dubbo. Semi-erect plant type with mid-season maturity. Medium-sized desi seed (larger than PBA HatTrick[Φ] and PBA Boundary[Φ]) suited to human consumption. Marketed by Seednet. EPR is $4.40/tonne inc. GST.

PBA Slasher[Φ]**.** Moderately resistant–Moderately susceptible (MR–MS) to Ascochyta, similar to Genesis™ 509 and Genesis™ 090, superior to PBA HatTrick[Φ] and PBA Boundary[Φ] in NSW (MS in Vic/SA); S to Phytophthora, not recommended for northern NSW. High-yielding across all southern and western Australian 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 whole and split seed. Marketed by Seednet. EPR is $4.40/tonne inc. GST.

PBA Striker[Φ]**.** Moderately resistant–Moderately susceptible (MR–MS) to Ascochyta, less than PBA Slasher[Φ] in NSW (S in Vic/SA); S to Phytophthora, not recommended for northern NSW. High-yielding in short season environments in southern and western Australian growing regions. Semi-spreading plant type with earlier flowering and maturity than PBA Slasher[Φ]. Medium-sized desi with tan-brown seed coat suitable for whole and split seed. Marketed by Seednet. EPR is $4.40/tonne inc. GST.

Yorker[Φ]**.** Moderately susceptible to Ascochyta, inferior to PBA HatTrick[Φ] and PBA Boundary[Φ]; MR to Phytophthora, better than PBA HatTrick[Φ]. Suited to drier areas where Phytophthora rather than Ascochyta is the greater risk. Marketed by Seednet. EPR is$3.30/tonne inc. GST.

Kabuli types

Almaz[Φ]**.** Moderately resistant–Moderately susceptible (MR–MS) to Ascochyta, inferior to Genesis™ 090 and Genesis™ 425 in NSW (S in Vic/SA); S to Phytophthora. Medium seed size, 8–9 mm. Introduced from ICARDA, Syria and selected by DAFWA. Marketed by Seednet in eastern Australia. EPR is $7.15/tonne inc.GST.

Genesis™ 090. Moderately resistant (MR) to Ascochyta, equal to Genesis™ 509 in NSW (MS in Vic/SA); broadly adapted; Very susceptible (VS) to Phytophthora, suited only to areas with a low Phytophthora risk. Seed size is smaller than Almaz[Φ], predominantly 7–8 mm. Introduced from ICARDA, Syria and selected by DEDJTR Victoria. Marketed by PB Seeds. EPR is $5.50/tonne inc. GST.

Genesis™ Kalkee. Moderately resistant–Moderately susceptible (MR–MS) to Ascochyta, inferior to Genesis™ 090 and Genesis™ 425 in NSW (MS in Vic/SA); S to Phytophthora. Larger seed size than Almaz[Φ] and Genesis™ 114, predominantly 9 mm. Yield is similar to Genesis™ 114 and Almaz[Φ] in northern and southern NSW. Excellent harvestability with an erect plant habit and good lodging resistance. Introduced from ICARDA, Syria and selected by DEDJTR Victoria and NSW DPI. Marketed by PB Seeds. EPR is $5.50/tonne inc. GST.

PBA Monarch[Φ]**.** Moderately susceptible (MS) to Ascochyta, inferior to Genesis™ 090 and Genesis™ 425 in NSW (S in Vic/SA); S to Phytophthora. Early flowering and early maturing. Medium seed size, 8–9 mm, similar to Almaz[Φ]. Highest yielding medium sized kabuli chickpea. Semi-spreading plant type, which can be prone to lodging. Marketed by Seednet. EPR is $7.15/tonne inc. GST.

Weed control

Chickpea does 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. Sow chickpeas in paddocks with relatively low broadleaf weed seed banks. Chickpea 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.

Plants weakened by herbicide injury are more susceptible to diseases. The most common problems come from residual herbicides applied to preceding cereal crops, such as:

- **Sulfonylurea herbicides** (Group B, e.g. Logran® B-Power, Glean®, Ally®, Eclipse®) applied to preceding cereal crops. Take special note of label instructions concerning crop rotation, rainfall required for breakdown and plantback periods, particularly on high pH and/or compacted soils.
- **Triazine herbicides** (Group C, e.g. atrazine). Seek advice as to potential chickpea crop damage when using triazine herbicides in summer cereals (sorghum and maize) and TT canola, as application rates on different soil types influence the extent of residual herbicide breakdown. Follow label recommendations and avoid spray overlaps.
- **Clopyralid** (Group I, 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 plantback periods, including rainfall requirements.

Isoxaflutole products (e.g. Balance®) can damage GenesisTM 425. Under certain conditions, other varieties can be damaged. 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 throughout the chickpea growing season. Ensure there is no open trench left above the seed at planting.

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 has occurred in many chickpea crops via the main tank, despite decontamination. 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 plantback 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 plantback recommendations.

Insect control

The major insect pest of chickpeas is *Helicoverpa* spp. (heliothis caterpillars). They can reduce yield and and grain quality. 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 control cost. 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 or 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 such as Helicoverpa species and risk of resistance, compatibility with fungicides, cost and harvest withholding period (WHP) when deciding which product to use,

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 root lesion 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***).

Further information on chickpea disease can be found at the **Pulse Australia website**.

Minimising risk of disease in 2018 chickpea crops

After early outbreaks of Ascochyta in June–July 2017, levels of diseases (Ascochyta, Phytophthora, Sclerotinia and Botrytis) in 2017 chickpea crops throughout northern NSW and Queensland overall were low; consequently, there will be lower amounts of inoculum from 2017 to infect 2018 crops. However, dry conditions in 2017 means some Ascochyta inoculum from 2016 (very high levels) and the June–July 2017 outbreaks will have survived to this season.

This section describes strategies that will reduce the risk of each of these diseases. Some of these strategies are based on local and international field experiments; others are based on observations of reduced disease in 2017 crops.

Ascochyta blight, AB (fungus *Phoma rabiei*, previously *Ascochyta rabiei*)

Ascochyta inoculum will be present in four forms:

1. Ascochyta-infected **chickpea residue** being discharged out the back of headers or spread by floods and surface water.
2. Seed internally infected by the fungus (a consequence of pod infection).
3. Seed contaminated externally with infected chickpea residue during harvest and handling.
4. Volunteer chickpea plants infected over summer and autumn.

The following will reduce the occurrence and impact of ascochyta blight in 2018 chickpea crops.

- **Do not grow chickpea crops in paddocks that grew chickpea in the previous year.**
- **Grow varieties with improved AB resistance:** Varieties such as PBA Seamer$^{\Phi}$, PBA Boundary$^{\Phi}$, PBA HatTrick$^{\Phi}$, PBA Slasher$^{\Phi}$ and most Genesis™ varieties will have less disease and require fewer fungicide sprays.
- **Remove volunteers:** Volunteer chickpea plants infected with Ascochyta will provide inoculum even if the volunteer plants are killed with herbicide. Controlling volunteers early will restrict their size and limit the amount of inoculum they can produce.
- **Treat all sowing seed:** Properly treating seed with a registered fungicide will control both internally borne Ascochyta and external contamination.
- **Apply fungicide before the first post emergent rain event, even PBA Seamer$^{\Phi}$:** Crops that received an early preventative Ascochyta fungicide in 2017 had less disease than crops that were not sprayed until after the disease was detected. Even though PBA Seamer$^{\Phi}$ is rated MR to Ascochyta, growers are urged to apply a preventative fungicide because: (a) the probable carryover of inoculum from 2016–2017, and (b) it is a safeguard against changes developing in the Ascochyta pathogen that are more virulent on PBA Seamer$^{\Phi}$.
- **Plant on wider row spacing (66 cm+)**: Wide rows improve airflow through the crop leading to more rapid drying after rain or dew. Canopy closure can also be delayed, which will improve fungicide penetration later in the season.

Applying foliar fungicides

Foliar fungicides provide cost effective Ascochyta management in all varieties including those rated VS e.g. Kyabra. The key to a profitable outcome is spray timing – all registered products are protectants only and need to be applied before rain.

- Ground application of fungicides is preferred. Select a nozzle such as a DG TwinJet or Turbo TwinJet that will produce no droplets smaller than medium (ASAE) and deliver the equivalent of 80–100 L/ha water 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.
- All fungicide sprays must be applied before rain and wherever possible by ground rig with a minimum of 80 L/ha water.

Botrytis grey mould, BGM (fungus *Botrytis cinerea*)

BGM is an airborne foliar disease active only when temperatures warm up towards spring (approx. 15 °C). It is more prevalent in the warmer regions of the north, where significant crop losses can occur in wet winters and springs as occurred in 2016. BGM is controlled with foliar fungicides; **seed treatment is ineffective**. *Botrytis cinerea* is ubiquitous, has a wide host range (over 138 genera in 70 families) and is a good saprophyte, meaning it can survive, grow and sporulate on any dead plant tissue. The fungus readily produces airborne spores and some isolates form sclerotia. This means that inoculum of BGM is **always present** and if conditions favour BGM, it will occur irrespective of what has happened earlier in the chickpea season.

The following will reduce the risk of BGM in 2018 chickpea crops:

- **Paddock selection**: Avoid sowing chickpea next to paddocks where BGM was an issue the previous season. As for ascochyta blight, chickpea should be grown as far away from paddocks in which BGM was a problem as is practically possible. However, under conducive conditions, this practice will not guarantee that crops will remain BGM-free, because of the pathogen's wide host range, ability to colonise dead plant tissue, and the airborne nature of its spores.
- **Sow later**: If long-term weather forecasts suggest a wetter-than-normal season consider sowing in the later part of the sowing window as this will reduce biomass – dense canopies favour BGM development.
- **Plant on wider rows (66 cm +)**: Wide rows improve airflow through the crop leading to more rapid drying after rain or dew. Canopy closure can also be delayed, which will improve fungicide penetration later in the season.
- **Foliar fungicide**: In areas outside central QLD, spraying for BGM is not needed in most years. However, in seasons and situations favourable to the

disease, a preventative fungicide spray immediately before canopy closure, with another application two weeks later will help to minimise BGM development in most years. If BGM is detected in a district or in an individual crop, particularly during flowering or pod fill, a fungicide should be applied before the next rain. None of the fungicides currently registered or under permit for chickpea BGM will eradicate established infections. Consequently, timely and thorough application is critical.

Phytophthora root rot, PRR (fungus-like oomycete *Phytophthora medicaginis*)

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 rainfall 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. Soil inoculum samples collected from commercial fields at the end of 2016 (which had above average rainfall) indicated that Phytophthora inoculum concentrations going into 2017 were, on average, higher than those of the previous two seasons.

The PREDICTA® B soil test can be used to assess PRR risk, and detecting any level of Phytophthora in a paddock makes that paddock a high risk of developing PRR if conditions become conducive. However, not detecting Phytophthora does not mean the PRR risk is low. If considerations other than Phytophthora warrant sowing in a high-risk paddock, choose PBA HatTrick$^{\phi}$ and consider treating seed with metalaxyl. Metalaxyl can be applied in the same operation as other seed dressings. Metalaxyl only provides protection for about eight weeks; crops can still become infected and die later in the season. Do not plant PBA Boundary$^{\phi}$ in any paddock that has had a history of pasture legumes or chickpea with phytophthora root rot.

Phytophthora inoculum will be present in three forms:

1. **Chickpea plants** that had PRR in previous seasons (up to 10 years back).
2. **Other hosts e.g. medics, lucerne,** and other leguminous plants including sulla (*Hedysarum* species) and sesbania (*Sesbania* species) in which Phytophthora can survive and multiply.
3. **Soil and water** containing PRR-infected material and survival structures (oospores, chlamydospores).

The following will reduce the risk of PRR in 2018 chickpea crops:

- **Avoid PRR high-risk paddocks** where annual or perennial medics have been a component of pastures and where PRR has occurred in the past in lucerne or chickpeas; the oospores of *Phytophthora medicaginis* can survive for more than 10 years.
- **Avoid paddocks with areas prone to waterlogging** although the conditions that induce waterlogging might not occur every year.
- **Metalaxyl-based seed dressings are registered for PPR,** but they are relatively expensive and provide only 6–8 weeks protection after sowing.
- **Grow a variety with the highest level of resistance,** particularly in medium–high-risk situations, such as where medics, chickpea or lucerne has been grown in the past 5–6 years.

Sclerotinia, (fungi *Sclerotinia sclerotiorum*, *S. minor*)

In the northern region, Sclerotinia fungi (*S. sclerotiorum* and *S. minor*) infect chickpea plants in two ways:

1. **Sclerotia germinate directly** in or on soil and invade the plant through root or basal stem tissue, producing sclerotia on and within the basal stem tissues
2. **Sclerotia germinate indirectly**, produce apothecia at ground level, which then release airborne ascospores (carpogenic germination) that infect plant parts higher in the canopy.

In most seasons, direct germination is generally only seen because carpogenic germination needs cool, moist conditions. In August–September 2016, Sclerotinia disease was very common in chickpea crops in north-western NSW and southern QLD. Importantly, every case of Sclerotinia involved carpogenic germination, i.e. infection at mid-canopy, meaning that the sclerotia formed on and inside the chickpea stems and was been captured during harvest. This led to problems at receival points because the cylindrical sclerotia formed inside the stems resembled ryegrass ergots, causing some loads to be rejected or docked. Dry conditions across NSW in 2017 reduced the opportunities for infection by ascospores in most districts.

Sclerotinia inoculum will be present from four potential sources:

1. **Sclerotia** spread by floods and surface water.
2. **Sclerotia admixed with chickpea** seed and introduced into 2018 chickpea paddocks during sowing.
3. **Sclerotia in canola residue in paddocks** intended for chickpea in 2018; large sclerotia can survive for up to seven years.
4. **Sclerotia in weed hosts** in paddocks intended for chickpea in 2018.

The following will reduce the risk of Sclerotinia in 2018 chickpea crops:

- grade seed to remove sclerotia
- grow varieties with improved resistance
- avoid paddocks with a history of Sclerotinia
- avoid paddocks with a history of canola
- avoid paddocks with a history of broadleaf weeds.

Root lesion nematode, RLN (*Pratylenchus thornei*, *Pratylenchus 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 high 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 pea, faba bean and lupin. Reduce the risk of losses from RLN by not planting chickpea in paddocks that had susceptible or intolerant cereal varieties in 2017, and by following the recommendations in ***Management of root lesion nematodes in the northern grain region.***

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 frequent virus disease. Prevention is the best option to limit losses, because there is no control. However, prevention measures are often 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 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 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 or Botrytis. Additionally, applying metalaxyl could be warranted if there is a risk of Phytophthora in a paddock, but seed treatment with metalaxyl only provides protection for 6–8 weeks from sowing.

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 kg seed	Seed-borne Ascochyta and Botrytis, damping off, Fusarium
thiram 600 g/L	Thiram® 600	200 mL/100 kg seed	Damping off, seed-borne Botrytis and Ascochyta
thiram 800 g/kg	Thiragranz®	150 g/100 kg seed	Seed-borne Botrytis and Ascochyta, damping off
metalaxyl 350 g/L	Apron® XL 350 ES	75 mL/100 kg 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® B-power, 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; two days 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 can reduce 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, that header settings are optimised for each crop and that they travel at appropriate speeds. Use appropriate harvest strategies to minimise header fires, such as dragging chains behind headers, and blowing dust and debris out of the header with compressed air as frequently as every 30 minutes if required.

Table 50. 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 (due to thinner seed coat).	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 desi variety PBA HatTrick, which combines improved resistance to both Phytophthora and Ascochyta. Avoid kabuli varieties. Avoid paddocks with a history of PRR 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 management has also reduced botrytis grey mould. Pre-emptive spraying might be possible; check current recommendations.
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 eight 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, maintain a 4-year break between broadleaf crops. Avoid sowing 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 spp., *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 and/or broadleaf 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. Controlling aphids on nearby legume pastures may help to prevent virus transmission in both autumn and spring.
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 variety 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 soil areas. Retained stubble may capture herbicide and slowly release after rain, potentially causing damage.	Most persistent in alkaline soils.	Observe label recommendations and avoid spray overlaps. Thoroughly decontaminate spray equipment, especially auto rigs. Be aware of Group C herbicide risk when following sorghum or maize (double crop) and triazine-tolerant (TT) canola. Be careful in flattened high cereal stubble loads.
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 during and after podding, particularly if plants are already moisture stressed (see Pulse Australia publication *Irrigated chickpea management*).

The 2017 harvest proved challenging for many growers due to late rains causing a second flush of growth and podding. When this occurs, timing desiccation is a balance between minimising losses at the bottom of the plant (potential pod and seed loss when overripe/dry) and losses or defects from the top of the plant (killing the new growth resulting in immature/wrinkled seeds, green seeds and higher moisture seeds that can promote mould). Harvesting should then start shortly after desiccation to avoid yield losses. A header that is well set up for the crop should be able to capture the good quality seed without retaining any smaller defective seed caused by this second flush of growth. Contact your header dealer or manufacturer for assistance in optimal header set up.

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 lower in their postharvest 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 chickpea in Australia in October and November are often higher than in December and 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 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.

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

2017–18 Pulse Trading Standards

PA Bulletin, ***Chickpea: High quality seed***

Northern Pulse Bulletin, ***Chickpea: Effective crop establishment***

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***

PA Bulletin, ***Chickpea harvest and seed storage***

PA Bulletin, ***Irrigated chickpea management***

Pulse traders

Crop protection products

Department of Agriculture and Fisheries Qld (DAF)

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 grain growing 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.

Most pulses in southern NSW are grown in acidic soils where pH stratification can affect root growth, nodulation, crop growth and yield potential. To reduce production risk, acidic soil layers need to be identified. Standard sampling depths of 0–10 cm and 10–20 cm can miss detecting acidic layers. Highly acidic layers have been identified at 5–10 cm and 10–15 cm across a range of soil types in central and southern NSW. Soil sampling at 5 cm intervals should identify acidic layers. Incorporating lime to a depth of at least 10 cm is recommended to amend acidity at 5–15 cm.

Good soil and paddock 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 to reduce disease risk. 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. With adequate moisture, it can be sown immediately following maize, sorghum or cotton, provided no residual herbicides that damage faba bean have been applied in the preceding crop.

The optimum temperature range for growth is 15–25 °C, with flowering ideally from July to late September. Flowering could start as soon as June if crops are sown early 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 causes elongating stems to develop a bent stick (hockey stick) appearance, blackened leaf margins and aborted 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, put as much distance as possible to separate crops of different varieties to reduce any out-crossing and varietal contamination.

Introducing beehives 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. Check with machinery manufacturers, but sowing at a slower ground speed will reduce the chance of hose blockages and ensure air seeders have enough airflow to push seed evenly to the sowing boot. Ideally sow faba bean into cereal stubble for maximum nitrogen fixation, rotational benefits and to minimise aphid infestation. Wider sowing row spacing can improve stubble flow.

Faba bean is generally sown 4–6 cm deep, depending on soil moisture, but it can be sown up to 12–13 cm deep if needed. Deep furrow or moisture-seeking techniques can be used to sow on time. The large seed size makes faba bean 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. See Table 51 for the suggested sowing time for different regions.

Sowing rate

Sowing rates for faba bean vary according to seed size, germination percentage, sowing time and region. Over a wide range of plant populations under favourable conditions, faba bean can yield well as it has the ability to compensate and fill in plant rows. Trials conducted in northern and southern NSW under

Table 51. Suggested sowing times

Variety / Week	April				May				June			
	1	2	3	4	1	2	3	4	1	2	3	4
Northern												
Narrabri–Boggabilla												
Walgett–Coonamble												
Liverpool Plains												
Central West												
Dubbo–Warren												
Cowra–Forbes												
Central and Southern												
Temora–Wagga Wagga–Lockhart												
Griffith–Hillston (irrigated)												

Best sowing time

Earlier or later than recommended, yield reduction likely.

Table 52. Sowing density

Plant population target	Plants/m^2
North dryland	15–25
North irrigated	15–20
South dryland	20–35
South irrigated	20–30

Table 53. Sowing rates for faba bean varieties

Sowing rates	Average 100 seed weight (g)	Seed rate (kg/ha) 20 plants/m^2	Seed rate (kg/ha) 30 plants/m^2
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

Note: Calculations based on 100% seed germination and 90% establishment.

Your calculation

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

= 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.

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 20 plants/m^2 plant population 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.

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 past 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 applying molybdenum to acid soils to aid nodulation. Fifty grams of actual molybdenum per hectare applied every 5 years is recommended.

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 54.

Northern NSW

Cairo$^{\Phi}$. Released in 2003 for northern NSW and southern Queensland. 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$^{\Phi}$ and PBA Nasma$^{\Phi}$. Cairo is not generally recommended for southern NSW where Ascochyta and chocolate spot are major constraints. Licensed to Seednet; available through local seed suppliers. The End Point Royalty (EPR) is $3.30/tonne inc. GST.

Doza$^{\Phi}$ Released in 2008 by Pulse Breeding Australia's (PBA) northern faba bean breeding node at Narrabri. It is better adapted to warmer spring temperatures than Barkool, Cairo$^{\Phi}$ and Fiord; higher yielding than Cairo$^{\Phi}$, with improved rust resistance. Smaller seed than Cairo$^{\Phi}$, but more uniform – light-buff colour.

Table 54. Variety characteristics and reactions to disease

Variety	PBR	Maturity	Seed colour	Seed size (g/100 seeds)	Disease			North				South			
					Ascochyta	Chocolate spot	Rust	Yield as % of Cairo		Yield as % of Cairo		Yield as % of Farah		Yield as % of Farah	
								East 2.69 t/ha	Trial no.	West 2.33 t/ha	Trial no.	East 2.47 t/ha	Trial no.	West irrigated 4.02 t/ha	Trial no.
Cairo	yes	mid–late	buff	50–75	VS	VS	MS	**100**	**16**	**100**	**29**	–	–	–	–
Doza	yes	early	light buff	40–60	VS	MS	MR-R	100	18	101	30	–	–	–	–
Farah	yes	mid	light buff	60–75	R–MR	S	S	–	–	–	–	**100**	**14**	**100**	**6**
Fiesta VF	no	mid	buff	60–75	MR–MS	S	S	–				99	14	102	6
Nura	yes	mid	light buff	50–65	R–MR	MS	MS	–	–	–	–	96	14	95	6
PBA Nasma	yes	early	beige to brown	61–79	S	MS	MR	114	18	106	30	106	8	113	4
PBA Rana	yes	mid–late	light buff	75–90	R	MS	MS–MR	–	–	–	–	91	14	99	6
PBA Samira	yes	mid	light buff	60–80	R	MS	MS	–	–	–	–	102	14	109	6
PBA Warda	yes	early	beige to brown	58–70	S	MS	MR–R	108	19	107	36	104	14	110	4
PBA Zahra	yes	mid-late	light buff	65–85	MR	MS	S	–	–	–	–	103	14	112	6

Yield results are a combined across sites analysis using PBA and NVT yield trials from 2013–2017.

– Insufficient data
VS Very susceptible
S Susceptible
MS Moderately susceptible
MR Moderately resistant
R Resistant

Not generally recommended for southern NSW where Ascochyta is a major constraint. Licensed to Seednet; available through local seed suppliers. EPR is $3.63/tonne inc. GST.

PBA NasmaΦ. Released in spring 2015 for northern NSW and southern Queensland and higher yield than PBA Warda Φ. Larger and more uniform seed than Cairo Φ and PBA Warda Φ, making it readily acceptable into the human consumption market. Flowering and maturity time is similar to PBA Warda Φ. Similar to PBA Warda Φ for resistance to chocolate spot and tolerance to frost. Improved resistance to *Bean leafroll virus*. Rust resistance is slightly inferior to Doza Φ, but far superior to Cairo Φ. Susceptible to Ascochyta and is therefore not recommended for southern NSW. Licensed to Seednet. EPR is $3.85/tonne inc. GST.

PBA WardaΦ. Released in 2012. PBA Warda Φ is higher yielding than Doza Φ and best adapted to the northern region's higher rainfall zones. Similar to Doza Φ for earliness, and chocolate spot and rust resistance, with better tolerance to frost and *Bean leafroll virus*. Seed is more uniform and bigger than Doza Φ, making it suitable for human consumption. Licensed to Seednet. EPR is $3.85 /tonne inc. GST.

Southern NSW

Farah$^{\Phi}$. Selected from Fiesta VF with improved resistance to Ascochyta. Similar agronomic characteristics and yield to Fiesta VF. Improved Ascochyta resistance will lower the level of Ascochyta-stained seed compared with Fiesta VF. Reduced environmentally stained seed and improved seed size uniformity. Licensed to Heritage Seeds; available through local seed suppliers. EPR is $3.30/tonne inc. GST.

Nura$^{\Phi}$. Released in 2005 from the southern node of the National Faba Bean Breeding Program. Produced from a cross between Icarus and Ascot and selected for improved resistance over Fiesta VF to both chocolate spot and Ascochyta. Moderate resistance to rust. Later flowering than Fiesta VF, however, is of similar maturity. Suited to the medium to high rainfall areas of southern NSW; not recommended for northern NSW. Shorter in height than Farah$^{\Phi}$ and Fiesta VF and less likely to lodge. Seed is slightly smaller than Farah$^{\Phi}$ and light buff in colour. Licensed to Seednet; available through local seed suppliers. EPR is $3.30/tonne inc. GST.

PBA Rana$^{\Phi}$. Released in 2011. Suited to the higher rainfall, longer season growing areas. Mid–late flowering, with improved resistance to chocolate spot compared with Farah$^{\Phi}$ and resistant to Ascochyta. Large, plump, light-brown seed that is bigger than current varieties. In NSW, it has performed well at longer season or high rainfall sites. Investigate marketing options as PBA Rana $^{\Phi}$ needs to be segregated to achieve a premium for its larger seed size. Licensed to Seednet. An EPR of $3.85 tonne inc. GST.

PBA Samira$^{\Phi}$. Released in spring 2014 Adapted to a wide range of environments in the southern region. It is mid–late flowering, but matures at the same time as Farah$^{\Phi}$ and Fiesta VF. Resistant to Ascochyta, including the new strain that was recently identified in the Mid North of South Australia. Seed is slightly larger than Farah$^{\Phi}$ and Fiesta VF, but of the same colour and should be suitable for co-mingling with other varieties for human consumption. Licensed to Seednet. EPR is $3.85/tonne inc. GST.

PBA Zahra$^{\Phi}$. Released in spring 2015. Selected for the southern region where it has shown very high yield potential and is particularly responsive to high-yielding situations. Resistant to ascochyta blight in most districts in the southern region, although MS–MR to a new pathotype in the Mid North region of South Australia. Less susceptible to chocolate spot and rust than Fiesta and Farah$^{\Phi}$. Flowers at the same time as Nura$^{\Phi}$ and PBA Samira$^{\Phi}$, but can mature slightly later under conducive seasonal conditions. Large, plump seed, similar to PBA Rana$^{\Phi}$. The two varieties could be co-mingled for a large-seeded category into the Middle East market. Licensed to Seednet. EPR is $3.85/tonne inc.GST.

Broad bean

PBA Kareema$^{\Phi}$. Released in 2010. A broad bean that is adapted to the higher rainfall zones of south-eastern South Australia and southern Victoria. 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.

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. Follow-up 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 and adhere 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 preceding 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 FallowBoss Tordon™ applied to previous summer fallows. Under dry conditions the breakdown of these fallow herbicides is reduced and subsequent crops can suffer herbicide injury.
5. **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; do not confuse these with disease symptoms.

Correct boomspray decontamination procedures must be followed to avoid potential 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, plant-back periods and correct spray unit decontamination procedures.

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 when pests need monitoring 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 in faba bean.

The identification of the bean aphid (*Megoura crassicauda*) at Tamworth and on the Liverpool Plains is potentially of great importance to the Australian faba bean industry. A native of north-east Asia (Korea, Japan, Siberia), this aphid species was only described in Australia in 2016 when it was found on broad beans in a Sydney home garden.

Observations during the 2017 season at the Liverpool Plains Field Station show this aphid to have an extremely fast reproduction rate and an ability to create large colonies on faba bean plants in just a few days. Host preference trials at Tamworth are ongoing, but indicate that the aphid has a very limited host range. Fortunately faba bean is its preferred host, but it can survive on a number of vetch species and also feeds and multiplies on field peas. The aphid does not feed on chickpeas, lupins or lucerne. Its risk to the faba bean industry is primarily through feeding damage, but preliminary virus transmission studies have demonstrated its ability to vector a number of non-persistently transmitted viruses such as *Bean yellow mosaic virus* (BYMV) and *Pea seed-borne mosaic virus* (PSbMV).

So far the aphid has not been found in commercial crops, but growers and advisors should report any suspicious aphid activity.

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 warrant control. Early-sown crops can mature before Helicoverpa moth infestation, 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

Table 55. 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 (> 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 year's 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 (such as 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.
Stemphylium blight *Stemphylium* spp.	Large grey–black necrotic lesions restricted to leaves only, often starting from the leaf edge.	Extended periods of leaf wetness.	Survival on crop residue is likely. Seed transmission has been demonstrated.	There is little information on the relative value of different fungicides, however it is likely that fungicide application will help to control stemphylium blight. Growers are advised to continue with normal fungicide programs.
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 persistently transmitted (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 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. Combined infection of BYMV and AMV can be lethal to faba beans.	Seasons or districts with major aphid flights.	These viruses survive in weeds and pastures, particularly in forage legumes. BYMV and AMV are spread by aphids and are 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 these non-persistently transmitted viruses..
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. The western flower thrips is the most effective vector.	No proven control.

Table 55. Disease and crop injury guide – faba bean (continued)

Disease/cause	Symptoms	Occurrence	Survival/spread	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 plantback 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 plantback 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 plantback periods.

- 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, including:

- growing faba bean no more than once in four years in the same paddock
- separating crops by 500 m from the preceding faba bean crops
- reducing disease-infected stubble load by grazing and/or incorporating
- controlling volunteer faba bean
- using clean ascochyta blight lesion-free seed
- growing locally adapted varieties that are the most resistant to the major regional diseases.

Fungicide control

Seven fungicides – mancozeb, carbendazim, chlorothalonil, copper, metiram, tebuconazole and procymidone are all registered. Tebuconazole is available under permit (**PER13752**, expiry 30/06/19). 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, procymidone and tebuconazole have limited curative action and work best when applied before infection occurs. 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 mancozeb efficacy. 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 is effective for disease management.

The recommended program includes an application of mancozeb 4–6 weeks after emergence to control Ascochyta and early chocolate spot. Mancozeb, carbendazim, chlorothalonil or procymidone is then applied for continued 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. rain events). Monitor crops regularly in spring for chocolate spot development, which can be rapid under favourable conditions (i.e. mild temperatures and frequent rain 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 – 4–6 weeks after emergence.

2nd critical period – 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 – 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. An insecticide might also be required during this period.

Disease management (northern NSW)

Rust and chocolate spot are the main diseases in the northern region

To manage both diseases:

- control volunteer faba bean over summer
- select paddocks as far from preceding faba bean crops as possible (preferably at least 500 m).

Apply a spray of mancozeb 4–6 weeks after crop emergence or before significant rain 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 by 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.

During 2016, high incidences of stemphylium blight were noted in several paddocks. Initial research indicates that this disease will only be a problem in years with very high rainfall. Large differences in susceptibility among faba bean genotypes are present with the newly released variety PBA Warda$^{\phi}$ among the more susceptible varieties. Currently no advice can be given on fungicide use to control stemphylium blight.

Spraying just before canopy closure is more 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.

Tebuconazole has excellent action on rust, but limited activity on chocolate spot. It is therefore advisable to only use tebuconazole if rust is detected in the crop. Note that the permit (**PER13752**, expiry 30/06/19) restricts the number of applications to three only in any one season.

At late crop stages, consult your agronomist, as disease levels, seasonal conditions and outlook, stage of crop development, yield potential and grain prices determine the economics of spraying. In Doza$^{\phi}$, PBA Warda$^{\phi}$ and PBA Nasma$^{\phi}$ 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. 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 the viruses they 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 aphid feeding and prevent infection by persistently transmitted viruses such as BLRV. Growers should consult their agronomist if considering either a seed dressing and/or a foliar insecticide. 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 showed windrowed crops had less grain losses than direct heading, but were not always more profitable due to the extra costs of windrowing. In large biomass crops, windrowing faba bean crops can be beneficial as it quickens crop dry-down and allows 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 adjusting according to crop biomass. Large bulky windrows will result in slower dry-down time, delaying harvest. In seasons with low crop biomass, avoid windrowing 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 reduce rotor speed to 400–600 rpm and concave clearance set at 15–35 mm to reduce mechanical damage to the grain. Remove blanking plates and alternative wires from the concave so that the grain is not cracked, as separation can occur at the concave. Use a top sieve of 32–38 mm and a bottom sieve of 16–19 mm.

Grain damaged (during harvest or subsequent auger movement) 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 Saudi Arabia, Indonesia and the United Arab Emirates. Around 10% is retained domestically for stockfeed and some is split for human consumption. 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. This situation has improved somewhat with the release of the larger seeded variety, PBA Nasma$^{\Phi}$. 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.

Domestic uses of faba bean as a source of protein include the aquaculture, pig, poultry and horse industries and hence it 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
Insect and mite control in field crops
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**
- **2017–18 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. It is now commonly used as a brown manure crop providing a double-break crop, and is also grown for hay or silage in a forage mix with oats. 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 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.

Figure 5. Map of NSW showing field pea growing zones

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 pre-sowing 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 56 apply to average to wet years. Grower experience and research trials over the past 15 years clearly show positive yield responses from sowing up to two weeks earlier in dry seasons when disease in spring has not been a problem.

Table 56. Field pea sowing times

Region	May				June			
	1	2	3	4	1	2	3	4
Western zone								
Eastern zone								

Suggested only 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.

Sowing rate

Optimum plant populations vary depending on the height and vigour of the specific variety and on sowing time. Population targets for tall, vigorous, scrambling types such as Morgan, PBA Percy$^{\Phi}$, or Sturt$^{\Phi}$ 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/brown manure establish at least 40–50 plants/m^2 to maximise biomass. For the shorter, less vigorous group of varieties (see Table 58. Variety characteristics and reaction to diseases on page 110) such as PBA Pearl$^{\Phi}$ and PBA Oura$^{\Phi}$, 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$^{\Phi}$, PBA Gunyah$^{\Phi}$, PBA Twilight$^{\Phi}$ and PBA Wharton$^{\Phi}$ should be sown to establish 35–50 plants/m^2.

These establishment targets can only be achieved by considering seed size, germination and sowing conditions when calculating sowing rates. Also, consider the seedbed condition and adjust

accordingly. Use Table 57 to calculate the desired sowing rate based on target density, seed size, germination and estimated establishment percentage of your seed.

Air seeders can reduce germination and establishment, particularly with weather-damaged seed or seed with low moisture content. Larger, round-seeded varieties such as PBA Pearl$^{\Phi}$ are particularly susceptible impact damage from distributor heads and other hard surfaces, as their seed coats are less tightly attached to the cotyledons. Lowering the seeder's air speed 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 57. 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
	Morgan	18	68	90	–	–
	Sturt	19	71	95	–	–
	PBA Percy	23	86	115	–	–
Medium–tall semi-leafless	PBA Pearl, PBA Oura	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 – 80% is a reasonable estimate, unless sowing into adverse conditions.

Sowing depth

Field pea should be sown 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 air seeder bins. Newly inoculated seed is often sticky and does not flow properly, leading to uneven seed flow in the bin,, which causes blocked hoses and patchy establishment across the paddock. The seed will need to dry in the short period before being sown.

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; at high levels little or no additional P will be required.

Select paddocks with a low level of residual nitrogen to encourage nodulation and 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 of the different varieties, refer to Table 58.

There is one new variety release for the 2018 season, PBA Butler$^{\Phi}$.

Kaspa-type dun field pea

Kaspa.$^{\Phi}$ Released in 2002 from the Australian Coordinated Field Pea Improvement Program. 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 with round (no dimples) light brown–red seeds. It flowers seven days later than Parafield. Susceptible to

the new Kaspa strain of downy mildew, but MR to the Parafield strain; Susceptible (S) to bacterial blight, S to powdery mildew, PSbMV and blackspot. Licensed to Seednet. EPR is $2.20/tonne inc. GST.

PBA Butler$^{\Phi}$. Released in 2017 by Pulse Breeding Australia (PBA). Kaspa$^{\Phi}$ seed type variety rated MR–MS to bacterial blight, similar to PBA Oura$^{\Phi}$. Mid–late flowering with early-mid maturity, erect, semi-dwarf, semi-leafless type. Moderately susceptible to black spot and the Kaspa strain of both downy mildew strains, S to the Parafield strain. Whilst broadly adapted, it performs best in medium- to long-season climates. Recommended for bacterial blight-prone regions. Licensed to Seednet. EPR is $2.97/tonne inc. GST.

PBA Gunyah.$^{\Phi}$ Released in 2010 by Pulse Breeding Australia. Higher yielding Kaspa type, adapted to the low and medium rainfall zones of southern and central western NSW. Similar plant type to Kaspa$^{\Phi}$ 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$^{\Phi}$. Longer flowering duration than PBA Twilight$^{\Phi}$ and Kaspa$^{\Phi}$, particularly in shorter growing seasons. Matures earlier than Kaspa$^{\Phi}$. Sugarpod trait, resistant to pod shattering at maturity. Disease resistance similar to Kaspa$^{\Phi}$. Susceptible to powdery mildew, bacterial blight, PSbMV and blackspot, S to the Kaspa strain of downy mildew, but R to the Parafield strain. Produces a dun seed with spherical (non-dimpled) grain, marketed as a Kaspa type to suit Indian subcontinent human consumption requirements. Licensed to Seednet. EPR is $2.75/tonne inc. GST.

PBA Twilight.$^{\Phi}$ Released in 2010 by PBA. Higher yielding Kaspa type adapted to the lower rainfall, short season climates of southern and central western NSW. Similar plant type to Kaspa$^{\Phi}$ 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$^{\Phi}$. Shorter flowering duration than PBA Gunyah$^{\Phi}$ but longer than Kaspa$^{\Phi}$, particularly in shorter growing seasons. Matures earlier than Kaspa$^{\Phi}$. Sugarpod trait, resistant to pod shattering at maturity. Disease resistance similar to Kaspa$^{\Phi}$ S to powdery mildew, bacterial blight, PSbMV and blackspot and the Kaspa strain of downy mildew, but R to the Parafield strain. Produces a dun seed with spherical (non-dimpled) grain, marketed as a Kaspa type to suit Indian subcontinent human consumption requirements. Licensed to Seednet. EPR is $2.75/tonne inc. GST.

PBA Wharton.$^{\Phi}$ Released by PBA in 2013. 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$^{\Phi}$, PBA Gunyah$^{\Phi}$ and PBA Twilight$^{\Phi}$ across all production regions of NSW. Similar plant type to Kaspa$^{\Phi}$ with a semi-leafless erect growth habit and distinctive pink–white flowers. Early to mid-season flowering (similar to PBA Gunyah$^{\Phi}$) and early maturing. Sugar-pod trait, resistant to pod shattering at maturity. Has broader disease resistance than Kaspa$^{\Phi}$ by combining disease resistance to powdery mildew and the viruses PSbMV and BLRV with

Table 58. Variety characteristics and reaction to diseases

Variety	Standing at maturity	Leaf type	Height	Maturity	Shatter resistance	Disease					Viruses		Seed size (g/100 seeds)
						Bacterial blight#	Downy mildew		Powdery mildew	Blackspot	*Pea seed-borne mosaic virus*	*Bean leafroll virus*	
						(*Pseudomonas syringae* pv *syringae*)	Kaspa strain	(Parafield strain)					
Kaspa-type dun field peas													
Kaspa	4	SL	M	8	R	S	S	MR	S	MS	S	S	22
PBA Butler	4	SL	M	5	R	MR	MS	S	S	MS	S	S	22
PBA Gunyah	4	SL	M	5	R	S	S	R	S	MS	S	S	22
PBA Twilight	4	SL	M	4	R	S	S	R	S	MS	S	S	22
PBA Wharton	4	SL	M	5	R	S	S	R	R	MS	R	R	23
Dimpled type dun field peas													
Morgan	3	SL	T	9	MR	MR	S	MR	S	MS	S	S	18
PBA Oura	4	SL	M	5	MR	MR	MR–MS	MR	S	MS	S	MR	22
PBA Percy	2	C	T	5	MR	R	S	S	S	MS	S	S	23
White field peas													
PBA Pearl	5	SL	M	4	MR	MS	S	MS	S	MR–MS	S	R	22
Sturt	2	C	T	5	MR	MR–MS	S	MS	S	MS	S	MS	19

Resistance only demonstrated to the bacterial blight pathovar *Pseudomonas syringae* pv *syringae*.

Disease ratings

Shatter resistance and disease resistance ratings: R = Resistant; MR = Moderately resistant; MS = Moderately susceptible; S = Susceptible; **–** = Unknown or no data available.

Standing: 1–9 (1 = flat on ground, 9 = erect)

Leaf type: C = Conventional; SL = Semi-leafless

Height: T = Tall; M = Medium; S = Short.

Maturity: 1 to 9 (1 = early, 9 = late); less than 5 best for crop-topping.

higher soil boron toxicity tolerance; R to the Parafield strain of downy mildew but S to the Kaspa strain; S to blackspot. Like Kaspa$^{\Phi}$, is S 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). Licensed to Seednet. EPR is $2.86/tonne inc. GST.

Dimpled type dun field pea

Morgan.$^{\Phi}$ Released in 1998 by NSW DPI. 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$^{\Phi}$. MR 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. Licensed to Hart Bros Seeds. No EPR.

PBA Oura.$^{\Phi}$ Released in 2011 by PBA. Broadly adapted across all major field pea production regions; performs relatively well in short growing seasons and low-rainfall environments. 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$^{\Phi}$) 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 the Kaspa strain; S to powdery mildew and PSbMV; MS to blackspot. Produces a medium size, dimpled dun-type grain, coloured light green; similar size to Kaspa$^{\Phi}$. Grain is marketed as Australian dun type, which is exported to the Asian subcontinent to produce dhal (splits) and pea flour; also sold for stockfeed. Licensed to Seednet. EPR is $2.86/tonne inc. GST.

PBA Percy.$^{\Phi}$ Released in 2011 by PBA. 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$^{\Phi}$) and early maturing. Suitable for crop-topping in longer seasons. Lodges at maturity but moderate pod shatter resistance at maturity. Excellent R (better than PBA Oura$^{\Phi}$) to bacterial blight (*P. syringae* pv *syringae*), but S to powdery mildew, blackspot and PSbMV as well as the Kaspa and Parafield strain of downy mildew. Produces a very large, dimpled dun type grain, coloured tan–green. Grain is marketed as Australian dun type, which is exported to the Asian subcontinent for dhal production (splits) and pea flour; also sold for stockfeed. Licensed to Seednet. EPR is $2.86/tonne inc. GST.

Table 59. Field pea yield performance 2013–2017

Variety	North		South			
	Yield as a % of PBA Wharton 2013–2017		Yield as a % of Kaspa 2013–2017			
	West	Trial no.	East	Trial no.	West	Trial no.
	1.79 t/ha		1.62 t/ha		1.38 t/ha	
Kaspa-type dun field pea						
Kaspa	80	10	**100**	**20**	**100**	**26**
PBA Butler	91	8	111	15	116	17
PBA Gunyah	90	8	106	12	107	18
PBA Twilight	91	8	103	12	104	18
PBA Wharton	**100**	**10**	108	20	112	25
Dimpled type dun field pea						
Morgan	85	7	102	13	103	9
PBA Oura	97	10	106	20	116	25
PBA Percy	91	10	101	18	110	19
White field peas						
PBA Pearl	98	10	110	20	122	25
Sturt	90	6	103	17	114	17

Yield results are a combined-across-sites analysis using NSW DPI, PBA and NVT yield trials from 2013–2017.

Number of trials in brackets ( ). n.d. = no data

White pea

PBA PearlΦ. Released in 2012 by PBA. Broadly adapted across all major field pea production regions ; highest yielding variety in the state's south-eastern and south-western production regions. Semi-leafless, semi-dwarf erect growing variety with white flowers. Early to mid-season flowering (10 days earlier than KaspaΦ and similar to SturtΦ) and early maturing (earlier than SturtΦ). Ideally suited to crop-topping due to early maturity. Superior lodging resistance compared with other semi-dwarf varieties. MR to pod shattering S to the Kaspa strain of downy mildew and MS to the Parafield strain. Resistant to BLRV; MS to bacterial blight and MR–MS to blackspot; S to powdery mildew and PSbMV. Produces medium–large spherical white pea seed (larger than SturtΦ) suitable for human consumption or stockfeed markets. Recommended for regions where growers can deliver white pea seed for export or for domestic sale. Licensed to Seednet. EPR is $2.97/tonne inc. GST.

SturtΦ. 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 varieties in the drier production areas of south-western NSW. MS to bacterial blight, black spot and BLRV; S to powdery mildew, PSbMV and the Kaspa strain of downy mildew, MS to the Parafield strain. No EPR.

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 PBA OuraΦ and PBA TwilightΦ that enable crop-topping to be synchronised with maturity. Crop-topping and brown manuring are important tools in integrated weed management. Field pea has the widest range of herbicides available for broadleaf weed control of any pulse crop. There are several 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 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, four 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
- planning sensible crop rotations (not growing field pea in the same paddock more than once every five years)
- eliminating volunteer field pea plants
- 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 machinery, people and animals moving 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, do not use seed harvested from infected crops for sowing. Also note that wind and water can move pea stubble to adjacent paddocks and should be closely monitored, as should movement on stubble baled for hay, as these are a ready source of infective bacteria. Finally, crops having no obvious signs of disease can still carry the bacteria at low levels.

Bacterial blight will often first develop in frost-prone, low-lying areas. 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 frosts.

Operations favouring rapid breakdown of pea trash can greatly reduce the bacterium's survival rate. Controlling volunteer pea plants is equally important to control this disease between seasons. Survival can be up to three years on seed in storage.

The varieties PBA Oura$^{\Phi}$ and PBA Percy$^{\Phi}$ were released in 2011 with significantly improved resistance to *Pseudomonas syringae* pv *syringae*. In the older varieties, Morgan$^{\Phi}$ and Sturt$^{\Phi}$ display the best field tolerance.

Traditionally, major outbreaks of bacterial blight in NSW result from early frosting coinciding with wet conditions. Outbreaks of bacterial blight were widespread in NSW in 2017. Severe and frequent frost events in combination with rainfall in winter favoured development and spread of the disease.

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. Field pea crops sown into a mulch of cereal stubble (soil surface covered by straw) are also more prone to frost injury and are predisposed to developing bacterial blight. If field pea crops are to be sown into cereal stubble, leave the stubble standing.

Kaspa$^{\Phi}$ is one of the most susceptible varieties 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 the bacteria's presence. Under conditions favouring disease development, even very low levels of seed-borne bacterial blight can lead to an epidemic.

Black spot 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 might 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. Dry winter and spring conditions in 2017 kept levels of blackspot low, with few crops developing the disease in southern and central NSW. The highest levels of disease develop in crops sown early, sown adjacent to last year's field pea stubble or with a recent history (past three years) of field pea in the same paddock. The **Black Spot Manager prediction model** can be used to predict spore release for southern NSW. Outputs from the model are available on the **DIPIRD** website.

The impact of black spot 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, black spot 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.

Downy mildew – Warm, dry weather does not favour disease development, but cool and wet conditions favour fast development (5–15 °C and wet for 4–5 days), often when field pea crops are emerging and in the early vegetative stage. Heavy dews will promote spore production, and rain splash is the main means of disease spread 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. Downy mildew can impair wax formation on leaves, rendering field pea plants more susceptible to post emergent herbicides.

Growing resistant varieties is the most effective means of managing the disease. Varieties such as Morgan and Kaspa$^{\Phi}$have useful resistance. 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 a 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. Of the newer varieties only PBA Wharton$^{\Phi}$carries 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 virus infection symptoms 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. Avoid sowing crops early in virus-prone areas so that plants can miss 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 seed-borne 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 distinctive brown ringed markings on the seed. Seed lots with high levels of seed infection have lower levels of plant emergence and seedling vigour. 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%. Of the current varieties, only PBA Wharton$^{\Phi}$has 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 near irrigated lucerne paddocks. Kaspa$^{\Phi}$is highly susceptible to BLRV and should not be grown in virus-prone areas. PBA Pearl$^{\Phi}$and PBA Wharton$^{\Phi}$have good resistance, whilst a number of other breeding lines with good BLRV resistance are in advanced testing.Desiccation and harvest

Desiccation – Early chemical termination of plant growth through desiccation should be strategically timed when field pea pod and seed development has physiologically finished so that grain yield is not compromised. Desiccation advances pea maturity and harvest by up to 10 days, reducing problems caused by uneven ripening and/or late weed growth. However, desiccating seeds that have not yet reached physiological maturity can result in defect grain such as shrivelled grain and green seeds.

Desiccation also doubles 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 and harvest of field pea***.

Harvest – This normally occurs well ahead of the wheat harvest and, to maximise yield, should start as soon as seed moisture falls to 14%. Delayed harvest leads to seed quality loss; harvest clashes with other crops; more severe crop lodging with greater soil contamination; increased pod shattering; pea weevil emergence in the field; problems with late weed growth; and increased vulnerability to late-season 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 past few years has been erratic from drought conditions or wet weather at harvest, which reduced yields. Each type of field pea (dun, white, and blue) has its own markets and end-uses. Dun field pea continues to be the most

Table 60. 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 – four years between pea crops and avoid sowing into paddocks beside 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 – four 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 – four 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 conditions. 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.

robust of the pea types, with both food- and feed-market opportunities, and remain the preferred type to be exported to Asia and the Indian subcontinent. The smooth, non-dimpled Kaspa-type varieties PBA Gunyah$^{\phi}$, PBA Twilight$^{\phi}$ and PBA Wharton$^{\phi}$ can attract a small premium in human consumption export markets, particularly in southern India and in Sri Lanka, 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 overseas market development, 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 reliably supplied.

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 growers need to carefully manage.

The current marketing specifications for the different grades of field peas can be found on the Pulse Australia website.

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
Insect and mite control in field crops
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

2017–18 Pulse Trading Standards

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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 , weeds and insect pests. Benefits include significant nitrogen contribution for subsequent crops, improved soil structure, and alternative 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. More recently, research has identified human health benefits of lupin protein for managing diabetes.

Two species of lupin, narrow-leaf (*Lupinus angustifolius*) and albus (*L. albus*), are widely grown. Narrow-leaf lupin tolerates moderately acid soils (pH_{Ca} 4.5–5.5) 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. In acid soils sampling at 5 cm intervals is recommended to identify the location of acidic layers, followed by testing every 3–5 years to monitor pH trends and to provide confidence in determining lime rates. Incorporation of adequate rates of lime to a depth of 10 cm is recommended to amend acidity at 5–15 cm depth.

Albus lupin is less tolerant of acid soils than narrow-leaf lupin (but more tolerant 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 narrow-leaf lupin under high rainfall conditions. A lupin anthracnose biosecurity zone is in place in southern NSW for 2018, following the detection of the disease in spring 2016. See the **NSW DPI website** for more information.

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, which minimises 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 has 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$^{(\dagger)}$ 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 harvesting, 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 61. Suggested sowing times for narrow-leaf and albus lupin

	April				May			
Week	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$^{\phi}$, Rosetta$^{\phi}$ and Murringo$^{\phi}$ 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 62. Sowing rates (kg/ha) based on 100% germination and 80% establishment

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 – 80% is a reasonable estimate, unless sowing into adverse conditions.

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 63.

Narrow-leaf lupin

Jenabillup$^{\phi}$. Released in 2007 by the Western Australian Department of Agriculture and Food (DAFWA). High yielding, medium–tall, early flowering variety. Jenabillup$^{\phi}$ has moderate resistance to *Bean yellow mosaic virus* (BYMV) infection. BYMV can cause significant damage in eastern states when seasons are suitable, such as in 2014. Jenabillup$^{\phi}$ has performed very well in NSW. Jenabillup$^{\phi}$ has moderate resistance to anthracnose and is intolerant of metribuzin herbicide. It is also moderately susceptible to phomopsis stem infection. Commercialised by Seednet, protected by PBR. The End Point Royalty (EPR) is $2.53/tonne inc. GST.

Mandelup$^{\phi}$. Released in 2004 by DAFWA. High yielding, early maturing variety with good early vigour. Suited to the low–medium rainfall

Table 63. 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[1] seed transmission	BYMV[1]	Anthracnose resistance	Yield as a % of Mandelup 2013–2017				Yield as a % of Mandelup 2013–2017			
											East 1.68 t/ha	Trial no.	West 2.18 t/ha	Trial no.	East 2.32 t/ha	Trial no.	West 1.00 t/ha	Trial no.
Narrow-leaf																		
Jenabillup	early	G	MG	14	MR	R	MS	MS-MR	MR	MS	90	3	91	7	99	29	93	3
Jindalee	mid–late	G	G	13	MR	MR	R	SS	S	MS	77	3	78	7	89	29	85	3
Mandelup	very early	G	MP	14	MS	R	R	MS	MS	MR	**100**	**3**	**100**	**7**	**100**	**29**	**100**	**3**
PBA Barlock	early	VG	G	13	MS	R	MR	MR	MS	R	98	3	98	7	102	29	100	3
PBA Bateman	very early	G	MP	14	MS	R	R	MS–MR	MS	MR	n.d.	1	102	3	110	13	n.d.	1
PBA Gunyidi	very early	VG	G	13	MS	R	R	MS–MR	MS–MR	MR	107	3	99	7	105	29	100	3
PBA Jurien	early	G	G	13	MS	R	R	MS-MR	MS	R	99	3	102	7	104	25	104	3
Quilinock	early	G	MP	16	MS	R	MS–MR	MR	–	VS	75	3	92	7	94	28	90	3
Wonga	early–mid	G	MG	13	MS	S	R	R	MS	R	90	3	89	7	94	29	93	2

Albus											Yield as a % of Luxor 2012–2016#				Yield as a % of Luxor 2012–2016#			
											East 1.90 t/ha	Trial no.	West 1.96 t/ha	Trial no.	East 2.44 t/ha	Trial no.	West t/ha	Trial no.
Luxor	early–mid	G	G	35	R	R	R	Immune	n.d.	VS	**100**	3	**100**	6	**100**	33	–	–
Murringo	early–mid	G	G	32	R	MR	I	Immune	n.d.	VS	99	3	99	6	98	32	–	–
Rosetta	mid	G	G	35	R	MR	R	Immune	n.d.	VS	96	3	93	6	98	33	–	–

Yield results are a combined across sites analysis using NVT, NSW DPI and PBA yield trials from 2013–2017.

Albus lupin trials discontinued 2012–2016
[1] Data from Pulse Breeding Australia
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
I Intermediate

zones of NSW. Has a tendency to lodge in very high productivity situations and not generally recommended for the higher rainfall zones. Mandelup$^{\Phi}$ is the earliest maturing variety currently available and therefore the most suitable for crop topping. Marketed by Heritage Seeds, protected by PBR. EPR is $2.53/tonne inc. GST.

PBA Barlock$^{\Phi}$. Released in 2013 by Pulse Breeding Australia (PBA) in Western Australia, to replace Mandelup$^{\Phi}$ and Tanjil in all WA lupin-growing zones. Compared with Mandelup$^{\Phi}$, PBA Barlock$^{\Phi}$ 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$^{\Phi}$. Resistant (R) to anthracnose. Tolerant to metribuzin (equal to Mandelup$^{\Phi}$). Moderately resistant (MR) to phomopsis stem blight. Commercialised by Seednet, protected by PBR. EPR is $2.75/tonne inc. GST.

PBA Bateman.$^{\Phi}$ New release (coded WALAN2533). Limited seed availability for 2018. It offers significant yield improvements over current varieties, particularly in the eastern cropping zones of NSW where virus infection from *Cucumber mosaic virus* and *Bean yellow mosaic virus* can cause significant yield loss in susceptible varieties when seasonal conditions are conducive to high aphid numbers. Marketed by Seednet. EPR is $2.86/tonne inc. GST.

PBA Gunyidi$^{\Phi}$. Released in 2011 by PBA in Western Australia, as a replacement for all varieties in the medium and low rainfall zones of WA. PBA Gunyidi$^{\Phi}$ has superior resistance to pod shatter and good lodging resistance, allowing later harvest without incurring significant shatter losses. Resistant (R) to phomopsis stem blight. Moderately resistant (MR) to anthracnose. Tolerance to the herbicide metribuzin is equivalent to Mandelup$^{\Phi}$, but is more susceptible to damage from Eclipse®. Commercialised by Seednet, protected by PBR. EPR is $2.75/tonne inc. GST.

PBA Jurien$^{\Phi}$. Released in 2015 by PBA in Western Australia. PBA Jurien$^{\Phi}$ 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$^{\Phi}$) 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 when sown early and when conditions suit high biomass levels. Commercialised by Seednet, protected by PBR. EPR is $2.75/tonne inc. GST.

Albus lupin

Luxorϕ. Released in 2005 by NSW DPI. Higher yielding than Kiev Mutant or Ultra. Resistant to pleiochaeta root rot (the cause of many seedling deaths in older varieties). Luxorϕ is seven days later flowering than Ultra, but earlier flowering than its sister line Rosettaϕ. Suited to the medium–low rainfall zones of NSW. Commercialised by Seednet, protected by PBR. EPR is $3.08/tonne inc. GST.

Murringoϕ**.** New release (coded WWK338). Released by NSW DPI in 2017. Murringoϕ is an ealy–mid flowering albus lupin. It has moderate resistance to pleiochaeta root rot and Phomopsis. Murringoϕ is susceptible to anthracnose. Marketed by Seednet. EPR is $3.52/tonne inc. GST.

Rosettaϕ. Released in 2005 by NSW DPI. Higher yielding than Kiev Mutant or Ultra in longer season environments. Rosettaϕ is moderately resistant (MR) to pleiochaeta root rot (less resistant than Luxorϕ), much better than Kiev Mutant, slightly better than Ultra. Later flowering and taller than Luxorϕ, it is especially suited to higher rainfall areas. Commercialised by Seednet, protected by PBR. EPR is $3.08/tonne inc. GST.

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 herbicide results.

Herbicide damage from both residual herbicides applied before cereal crops and from in-crop herbicides has caused yield losses in lupin crops. 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 B-Power®) 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, 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 than narrow-leaf lupin.
3. **Clopyralid** (e.g. Lontrel®) applied to preceding cereal crops and in fallow tank mixes. 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 the 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 as necessary.

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 Jenabillupϕ appear to have more resistance to aphid attack than other varieties. Uniform plant density, early canopy closure and retaining 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 was detected for the first time in commercial lupin crops in NSW in 2016. Currently the disease is confined to a small number of properties in southern NSW with restrictions in place. Lupin production can continue for the remainder of NSW outside the restriction zone. Wonga, PBA Jurienϕ and PBA Barlockϕ are resistant (R)

whilst PBA Gunyidi$^{\phi}$ (MR–R) and Mandelup$^{\phi}$ (MR) are slightly more susceptible. All other narrow-leaf and albus lupin varieties are susceptible to anthracnose.

The disease is specific to lupin species only and does not affect any other pulse species including field pea, faba bean, chickpea or lentil. The fungus survives on infected lupin stubble and can be carried on, or within, infected seed, which is the main means of disease spread. Infected seed will give rise to infected seedlings the following year and initiate the disease. The fungus does not survive in the soil.

Symptoms of the disease include a distinct bending and twisting of stems into a shepherd's crook. The bending of stems is due to lesions formed of within the crook of the bend causing collapse down one side. Within the lesion are bright pink/orange spore masses that spread the disease within the crop. Lesions can also later form on developing pods. Symptoms become most obvious when crops enter the reproductive phase and start flowering and podding. The disease attacks the soft plant tissue at the growing points (including stem tips, flowering spikes and pods) and works downwards into the crop canopy. Anthracnose will develop in patches or 'hotspots' within the crop. As the disease is spread through rainsplash of spores, patches of deformed plants will form within the crop as the disease spreads following rain.

A five-point management plan is recommended for all lupin producers in NSW to prevent the disease from establishing and spreading.

1. Treat seed for sowing with a fungicide seed treatment containing thiram.
2. Separate this year's lupin crop away from last year's lupin stubble.
3. Control volunteer lupins.
4. Control machinery and people movement into and out of lupin crops.
5. Apply a foliar fungicide at 6–8 weeks post emergence (with a grass spray) using fungicides containing mancozeb or chlorothalonil, and a follow up at pre-canopy closure.

Growers are encouraged to inspect lupin crops regularly and report any unusual disease symptoms to their nearest NSW DPI or LLS office. Early detection will prevent the disease from establishing in NSW and protect the lupin industry.

Restrictions remain in place on the movement of lupin material and machinery 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 2016 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 PRR 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$^{\phi}$ is rated R and Rosetta$^{\phi}$ 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. The fungus that causes the disease infects lupin plants in winter, but doesn't express in plants until maturity. Summer rain 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 and 2016, outbreaks of the disease were mainly found on albus lupin varieties, particularly Rosetta(ф), 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 the pod set stage. Outbreaks of this disease were rare in 2017 in southern NSW due to below average rainfall and drier soil conditions. The disease can occur in individual plants or patches within a crop. Occurrence of the disease can be 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. Outbreaks of the disease were rare in southern and central NSW in 2017, driven by below average rainfall and dry crop canopies. 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.

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.

Recent research is showing lupin proteins used in human diets are a blood sugar stabiliser and will aid in reducing the effects of diabetes.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***
Lupin anthracnose (https://www.dpi.nsw.gov.au/biosecurity/plant/insect-pests-and-plant-diseases/lupin-anthracnose).

Pulse Australia (PA) website for:

Variety Management Packages (VMP) for all new varieties
2017–18 Australian Pulse Trading Standards

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Table 64. 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 'Shepherd's crook' syndrome. Dark lesions with pale-pink centres on stems, leaves and pods.	Detected in a small number of crops in southern NSW. Currently under surveillance in NSW.	Seed-borne and on trash. Spread by rain splash, machinery and animal movement.	Narrow leaf varieties with improved resistance are available. Resistance in albus lupin is poor. 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, greyish-brown 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.	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 narrow-leaf lupin seed. Follow best management practices including retaining standing cereal stubble and weed control. In high-risk areas, grow albus lupin.

Grain insects – options for control

Table 65. 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 clean empty storage surfaces and equipment such as grain driers, 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)	Spray surfaces using a slurry (10–20% depending on product) with a centrifugal pump or venturi-type sand blaster with continuous agitation. Alternatively 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. Header/harvesters can be treated with 2.5 kg of dry dust. Refer to label for instructions Always wear a disposable dust mask/respirator and goggles for safety. 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/L per 10m^2	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™ 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 66. Fumigants for 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 dose on total volume of silo. 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 2018

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.

Do you know what is eating at your profits?
– common stored grain insect pests of NSW

Lesser grain borer – *Rhyzopertha dominica*

Figure 6. Key features: dark brown, pellet shaped, 3 mm long, eyes and mouth parts tucked underneath A

Rust-red flour beetle – *Tribolium castaneum*

Figure 7. Key features: red brown, 3–4 mm long, three larger segments at end of antennae A

Rice weevil – *Sitophilus oryzae*

Figure 8. Key features: dark brown to black, 2–4 mm long, long weevil snout A

Saw-toothed grain beetle – *Oryzaephilus surinamensis*

Figure 9. 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*

Figure 10. Key features: brown, small, 2 mm long, fast moving, keen to hide, long thin antennae A

India meal moth – *Plodia interpunctella*

Figure 11. 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

Table 67. 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 (including malting barley, rice and maize)	Conserve™ Plus (100 g/L Spinosad and 100 g/L S-Methoprene) 500 mL in 50 L of water		Ensure treatment is acceptable to buyer. Conserve™ Plus should NOT be applied to any cereal grain to be sold into markets designated Pesticide Residue Free (PRF). Durum wheat is assumed to have a PRF delivery requirement, as it is regularly sold into European markets, which have low MRLs for grain protectant compounds. Apply at the rate of 1 L diluted spray per tonne of grain for up to nine months protection. One application per parcel of grain. To control *Sitophilus* spp. (eg. Rice weevil) tank mix with a compatible product suitable for your grain type. (see product labels).
Protect cereal grain except malting barley, rice and maize	Conserve™ 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) (Note: ConserveTM On-Farm is being phased out in preference to ConserveTM Plus.)		Ensure treatment is acceptable to buyer. Conserve™ On-Farm should NOT be applied to any cereal grain to be sold into markets designated PRF. Durum wheat is assumed to have a PRF delivery requirement, as it is regularly sold into European markets, which have low MRLs for grain protectant compounds. K-Obiol® and Conserve™ 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™) 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.
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 ❶	
Protect malting barley	K-Obiol® Combi 2.0 L ❷ Fenitrothion 1.2 L, PLUS IGR (methoprene) at rates indicated above. Conserve™ Plus ❷ (see directions 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.

❶ A premixed formulation of Reldan® and methoprene.

❷ When using K-Obiol® Combi or Conserve™ Plus to control *Sitophilus* spp. (e.g. rice weevil). Fenitrothion needs to be added at 1.2 L.

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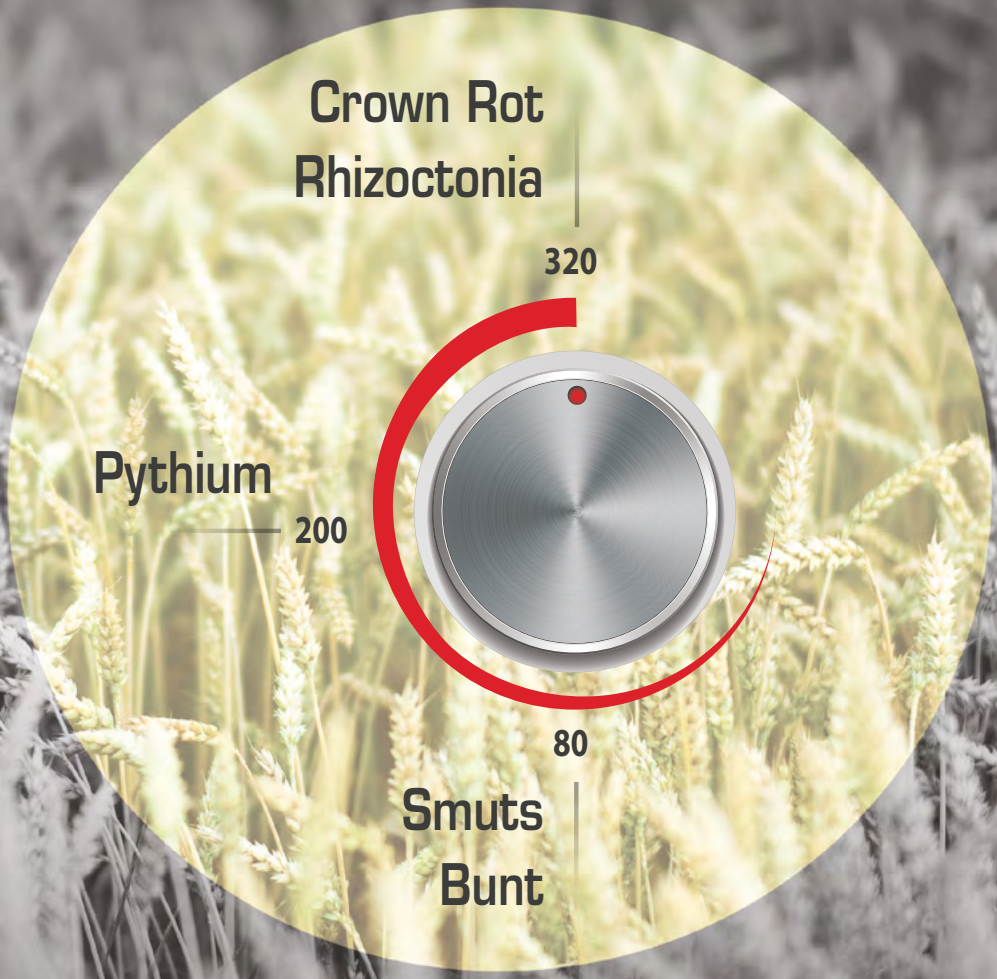

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Seed dressings

Table 68. Cereal seed dressings – 2018: Control of seed-borne disease (page 1 of 3)

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 to avoid them building up in seed crops, or causing grain delivery issues.

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 ($) [1]	Smuts controlled: B – bunt; C – covered smut; L – loose smut				F – wheat flag smut		Diseases suppressed								
								Wheat	Wheat	Wheat				Wheat/ Barley	Barley			Grazing withholding period (weeks)
				Wheat	Barley	Oats	Triticale	Seed-borne flag smut	Soil-borne flag smut	Septoria tritici	Stripe rust	Leaf rust	Take-all	Rhizoctonia	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.																		
Flutriafol 100 g/kg + cypermethrin 4 g/kg	Armour® C SD – FMC (Cheminova)	100 g	2.86	BL	CL	–	–	F	F	✓	✓	–	–	–	✓	✓	–	4
Flutriafol 25 g/kg + cypermethrin 4 g/kg	Veteran™ C SD – NuFarm	100 g	2.49	BL	CL	CL	L	F	F	–	–	–	–	–	–	–	–	4
Tebuconazole 25 g/kg + triflumuron 4 g/kg	Conquest Veto T – Conquest Agrichemicals	100 g	2.28	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	4
Triadimenol 150 g/kg + cypermethrin 4 g/kg	Triadimenol 150+® SD – 4 Farmers	100 g	2.82	BL	CL	CL	–	F	F	–	✓	–	–	–	✓	✓	–	5
		150 g	4.22	BL	CL	CL	–	F	F	–	✓✓	–	–	–	✓✓	✓✓	–	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 [3]	125 mL	3.66	B	C	CL	–	F[3]	–	–	–	–	–	–	–	–	–	7
		250 mL	7.33	BL	CL	–	L	F	–	–	–	–	–	–	–	–	–	7
Carboxin 200 g/L + thiram 200 g/L	Vitavax® 200 FF ST –Arysta LifeScience [3]	250 mL	8.11	B	C	CL	–	F[3]	–	–	–	–	–	–	–	–	✓	7
		375 mL	12.17	B	C	–	–	F	–	–	–	–	–	–	–	–	✓✓	7
		500 mL	16.23	BL	CL	–	L	F	F	–	–	–	–	–	–	–	✓✓✓	7
Difenoconazole 92 g/L + metalaxyl-M 23 g/L	Dividend® FSD – Syngenta [6]	100 mL	4.66	B	C	–	–	F	F	–	–	–	–	–	–	–	–	6
		130 mL	6.05	BL	CL[9]	–	–	F	F	–	–	–	–	–	–	–	✓	6
		260 mL	12.11	BL	CL[9]	–	–	F	F	–	–	–	–	✓[9]	–	–	✓✓	6
Difenoconazole 66.2 g/L + metalaxyl-M 16.5 g/L + Sedaxane 13.8 g/L	Vibrance® – Syngenta	180 mL	7.26	BL	CL	L	BL	F	F	–	–	–	–	–	–	–	✓	6
		360 mL	14.52	BL	CL	L	BL	F	F	–	–	–	–	✓[8]	–	–	✓✓	6
Difenoconazole 36.9 g/L + thiamethoxam 30.7 + metalaxyl-M 9.5 g/L + Sedaxane 8 g/L	Vibrance® Extreme– Syngenta	325 mL	6.61	BL	CL	L	BL	F	F	–	–	–	–	–	–	–	✓	6
		650 mL	13.23	BL	CL	L	BL	F	F	–	–	–	–	✓[8]	–	–	✓✓	6

✓ Affords useful suppression in early crop growth stages. ✓✓, ✓✓✓ and ✓✓✓✓ affords extended suppression.

[1] Prices quoted are GST inclusive at February 2018 and approximate only. Prices will vary depending on pack size purchased and special marketing arrangements.

[3] Also controls seed-borne flag smut in triticale. There is no registered seed treatments for cereal rye.

[6] Also provides control of pythium root rot.

[8] Suppresses Rhizoctonia root rot in oats.

[9] Suppression only.

Read label before using pesticides.

Treated seed must not be used for animal or human consumption.

Caution: Observe stock withholding periods on crops produced from treated seed.

Table 68. Cereal seed dressings – 2018: Control of seed-borne disease (continued page 2 of 3)

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 ($) [1]	Smuts controlled: B – bunt; C – covered smut; L – loose smut				F – wheat flag smut		Diseases suppressed									
								Wheat	Wheat	Wheat				Wheat/ Barley	Barley				Grazing withholding period (weeks)
				Wheat	Barley	Oats	Triticale	Seed-borne flag smut	Soil-borne flag smut	Septoria tritici	Stripe rust	Leaf rust	Take-all	Rhizoctonia	Scald	Powdery mildew	Seed-borne net blotch		
Fluquinconazole 167 g/L	Jockey® Stayer® – Bayer CropScience [2]	300 mL	19.26	BL	CL [5]	–	–	F	F	✓	✓✓✓	✓	–	–	✓✓✓ [5]	✓✓ [5]	–	6, 12 [10]
		450 mL	28.88	BL	–	–	–	F	F	✓✓	✓✓✓✓	✓✓	✓	–	–	–	–	6, 12 [10]
Flutriafol 6.25 g/L	Vincit® C Zinc FSD – FMC (Cheminova)	400 mL	748	BL	CL	CL	L	F	F	–	–	–	–	–	–	–	–	4
Flutriafol 25 g/L + cypermethrin 4 g/L	Vincit® C FSD – FMC (Cheminova) Veteran® C – NuFarm	100 mL	2.40	BL	CL	CL	L	F	F	–	–	–	–	–	–	–	–	4
Flutriafol 100 g/L + cypermethrin 4 g/L	Arrow® C FSD – NuFarm	100 mL	2.53	BL	CL	–	–	F	F	✓	✓	–	–	–	✓	✓	–	4
Flutriafol 6.25 g/L + imidacloprid 180 g/L	Veteran® Plus – NuFarm [4]	400 mL	9.70	BL	CL	CL	L	F	F	–	–	–	–	–	–	–	–	9
Flutriafol 6.25 g/L + metalaxyl-M 15 g/L + imidacloprid 180 g/L	PONTIAC® Seed Treatment – NuFarm [4]	400 mL	10.78	BL	CL	CL	L	F	F	–	–	–	–	✓ [9]	–	–	–	9
Fluxapryroxad 333g/L	Systiva – BASF	150 mL	33.17	B	L	–	–	–	–	–	–	–	–	✓ [9]	✓✓✓	✓✓✓	✓✓✓	4
Ipconazole 20 g/L + cypermethrin 4 g/L	Rancona® C – Arysta LifeScience	100 mL	4.46	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	6
Ipconazole 25 g/L + metalaxyl 20 g/L	Rancona® Dimension – Arysta LifeScience	80 mL	4.30	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	10
		320 mL	17.20	BL	CL	–	–	F	F	–	–	–	–	✓	–	–	–	10
Penflufen 240 g/L	EverGol® Prime – Bayer CropScience	40 mL	6.82	BL	CL	CL	–	F	F	–	–	–	–	✓	–	–	–	5
		80 mL	13.54	BL	CL	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 12.5 g/L + imidacloprid 360 g/L	Hombre® Ultra – Bayer CropScience [4] Proguard® Ultra – Arysta LifeScience [4]	200 mL	6.54	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	9

✓ Affords useful suppression in early crop growth stages. ✓✓, ✓✓✓ and ✓✓✓✓ affords extended suppression.

[1] Prices quoted are GST inclusive at February 2018 and approximate only. Prices will vary depending on pack size purchased and special marketing arrangements.

[2] Rate of product varies for disease controlled, check label.

[4] *Barley yellow dwarf virus*. Hombre® Ultra and ProGuard® Ultra provide early season control of BYDV.

[5] Plus Raxil® T with Jockey® Stayer® at 100 mL/100 kg seed.

[8] Suppresses Rhizoctonia root rot in oats.

[9] Suppression only.

[10] Withholding period – Livestock producing milk for human consumption 12 weeks.

Read label before using pesticides.

Treated seed must not be used for animal or human consumption.

Caution: Observe stock withholding periods on crops produced from treated seed.

Table 68. Cereal seed dressings – 2018: Control of seed-borne disease (continued page 3 of 3)

				Smuts controlled: B – bunt; C – covered smut; L – loose smut				F – wheat flag smut		Diseases suppressed								
								Wheat	Wheat	Wheat				Wheat/ Barley	Barley			
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 ($) ❶	Wheat	Barley	Oats	Triti-cale	Seed-borne flag smut	Soil-borne flag smut	Sep-toria tritici	Stripe rust	Leaf rust	Take-all	Rhizoctonia	Scald	Powdery mildew	Seed-borne net blotch	Grazing withhold-ing period (weeks)
Tebuconazole 25 g/L + triflumuron 4 g/L	Raxil® T FSD – Bayer CropScience	100 mL	2.28	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	4 Farmers Imid-Triadimenol Seed Dressing – 4 Farmers Australia ❹	400 mL	8.96	BL	CL	CL	–	F	F	✓	✓✓	–	–	–	✓✓	✓✓	–	9
Triadimenol 150 g/L + triflumuron 4 g/L	Baytan® T FSD – Bayer CropScience	100 mL	2.62	BL	CL	CL	–	F	F	–	✓	–	–	–	✓	✓	–	5
		150 mL	3.93	BL	CL	–	–	F	F	✓	✓✓	–	–	–	✓✓	✓✓	–	5
Triticonazole 25 g/L + cypermethrin 4 g/L	Premis® Pro C – BASF	100 mL	3.47	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®– Syngenta❼	200 mL/ha	14.07	–	–	–	–	–	–	–	✓✓	–	–	✓	–	–	–	6
		300 mL/ha	21.10	–	–	–	–	–	–	–	–	–	–	✓✓	–	–	–	6
		400 mL/ha	28.14	–	–	–	–	–	–	–	✓✓✓✓	–	–	✓✓✓	–	–	–	6
Flutriafol 250 g/L	Innova® Flutriafol 250 – Syngenta	200 mL/ha	5.82	–	–	–	–	–	–	–	✓✓	–	–	–	✓	✓	–	4
		400 mL/ha	11.65	–	–	–	–	–	–	✓	✓✓✓✓	–	✓	–	✓✓	✓✓	–	4
Flutriafol 500 g/L	Intake® HiLoad Gold NuFarm ❷	100 mL/ha	2.58	–	–	–	–	–	–	✓	✓✓	–	–	–	✓	✓	–	4
		200 mL/ha	5.16	–	–	–	–	–	–	✓	✓✓✓	–	✓	–	✓✓	✓✓	–	4
		400 mL/ha	10.33	–	–	–	–	–	–	✓	✓✓✓✓	–	✓	–	✓✓	✓✓	✓	4
Penflufen 240 g/L	EverGol® Prime – Bayer CropScience ⓮	60 mL/ha	10.23	BL	CL	CL	–	F	F	–	–	–	–	✓✓	–	–	–	5
		120mL/ha	20.46											✓✓✓				
Triadimefon 500 g/kg	Triad® 500 WP – Adama	200 g/ha	3.62	–	–	–	–	–	–	–	–	✓	–	–	–	–	–	Not stated⓬
Triadimefon 500 g/kg	Triadimefon 500 WG – FMC (Cheminova)	200 g/ha	5.81	–	–	–	–	–	–	–	✓✓	✓	–	–	–	✓	–	Not stated⓫
Triadimefon 500 g/kg	Triadimefon 500 DRY – 4 Farmers	200 g/ha	3.62	–	–	–	–	–	–	–	✓✓	✓	✓	–	–	✓	–	Not stated⓫

✓ Affords useful suppression in early crop growth stages. ✓✓, ✓✓✓ and ✓✓✓✓ affords extended suppression.

❶ Prices quoted are GST inclusive at February 2018 and approximate only. Prices will vary depending on pack size purchased and special marketing arrangements.

❷ Rate of product varies for disease controlled, check label.

❹ *Barley yellow dwarf virus*. Provide early season control of BYDV.

❼ Also provides control of pythium root rot and suppression of yellow spot.

⓫ Do not mix leaves treated with this product with feed intended for animal consumption.

⓬ Feed treated with this product must not be used for animal consumption, poultry feed or mixed with animal feed.

⓭ Southern NSW.

⓮ In furrow application must be combined with a seed treatment of 40 mL/100 kg of EverGol® Prime for control.

Read label before using pesticides.

Treated seed must not be used for animal or human consumption.

Caution: Observe stock withholding periods on crops produced from treated seed.

PONTIAC®
SEED TREATMENT

SEED TREATMENT WITH GRUNT

Pontiac turbocharges your seed treatment by targeting smuts, bunts, soil pathogens and early sucking pests.

- ✔ Unique formulation containing two fungicides and a systemic insecticide
- ✔ Ideal fit for Integrated Pest Management (IPM) and preservation of beneficial insects
- ✔ Use in wheat, barley, oats and triticale
- ✔ Controls stored grain pests

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Table 69. Cereal insecticide seed dressings for aphid and *Barley yellow dwarf virus* (BYDV) control 2018

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 ❷	Approx. cost to treat 100 kg of seed ($) ❶	Aphid feeding damage suppression (wheat aphid and corn aphid)	Reduces spread of BYDV	Grazing withholding period (weeks)
Imidacloprid 360 g/L + tebuconazole 12.5 g/L	Hombre® Ultra– Bayer CropScience Proguard® Ultra – Arysta LifeScience	200 mL	6.54	✓	✓	9
Imidacloprid 180 g/L + triadimenol 56 g/L	4 Farmers Imid-Triadimenol Seed Dressing – 4 Farmers Australia	400 mL	8.96	✓	✓	9
Imidacloprid 180 g/L + flutriafol 6.2 g/L	Veteran® Plus – NuFarm	400 mL	10.44	✓	✓	9
Imidacloprid 180 g/L + flutriafol 6.25 g/L + 15 g/L Metalaxyl	Pontiac® – NuFarm	400 mL	11.29	✓	✓	9
Imidacloprid – 600 g/L	Gaucho® 600 – Bayer CropScience Senator® 600 RED– NuFarm	120–240 mL	4.98–9.96	✓	✓	9
Lambda-cyhalothrin 37.5 g/L +Thiamethoxam 210 g/L	Cruiser® Opti – Syngenta	165–330 mL	22.78–45.56	✓	✓	8

✓ Affords useful suppression in early crop growth stages.

❶ Prices quoted are GST inclusive at February 2018 and approximate only. Prices will vary depending on pack size purchased and special marketing arrangements.

❷ Rate of product varies for length of disease control and risk level, check label.

Table 70. Canola and pulse seed dressings – 2018

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 chickpea 125–150 g lupin	2.25 1.85–2.25	20 kg	–	Seed-borne botrytis, ascochyta blight	–	–	Seed-borne anthracnose
Flowable liquids									
Dimethoate 400 – Adama	dimethoate (400 g/L)	150 mL (field pea) 150 mL (lupin) 330 mL (canola)	1.50 1.50 3.30	5–200 L	Redlegged earth mite, lucerne flea	–	Redlegged earth mite, lucerne flea	–	Redlegged earth mite, lucerne flea
Gaucho® 600 Red Flowable – Bayer Crop Science	imidacloprid (600 g/L)	300 mL (lupin) 400 mL (canola) 120 mL (faba bean) 60 mL (field pea)	11.80 15.75 5.75 2.35	1–200 L	Redlegged earth mite, blue oat mite, aphids	–	Aphids	Aphids	Redlegged earth mite, blue oat mite
Emerge ™ Flowable Seed Treatment – Syngenta	imidacloprid (600 g/L)	300 mL (lupin) 400 mL (canola)	12.80 17.05	1 & 10 L	Redlegged earth mite, blue oat mite, aphids	–	–	–	Redlegged earth mite, blue oat mite
Cosmos® – BASF	fipronil (500 g/L)	400 mL	310.75	5–1000 L	Redlegged earth mite	–	–	–	–
Cruiser® Opti - Syngenta	thiamethoxam (240 g/L) + lambda-cyhalothrin (37.5 g/L)	500–1000 mL	69.00–138.05	–	Green peach and grey cabbage aphid	–	–	–	–
		1000 mL	138.05		Suppression of: redlegged earth mite, lucerne flea				
Jockey® Stayer® – Bayer CropScience	fluquinconazole (167 g/L)	2 L	128.40	5–1000 L	Blackleg (suppression)	–	–	–	–
Apron® XL 350 ES – Syngenta	metalaxyl-M (350 g/L)	75 mL	35.20	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	82.55–161.10	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	8.40	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	139.20	5–1000 L	Wireworm, cutworm, aphids, lucerne flea, redlegged earth mite, blue oat mite	–	–	–	–
Thiram 600 Flowable Fungicide – Crop Care	thiram (600 g/L)	200 mL (chickpea) 170–200 mL (lupin)	3.15 2.65–3.15	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	2.35–11.65	5–1000 L	–	–	–	–	Brown leaf spot
Sumisclex® Broadacre – Sumitomo	procymidone (500 g/L)	100 or 200 mL	4.00 or 8.05	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	5.15	5–1000 L	Blackleg				

* Wettable granule formulation.

Prices quoted are GST Inclusive at 30 January 2018 and approximate only. Prices will vary depending on pack size purchased, seed treatment services and special marketing arrangements.

Table 71. Cereal foliar fungicides – 2018 currently registered products (NSW) – winter cereals

(page 1 of 3) 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	$45.35	Barley – addition of Adigor® at 200 mL/100 L improves disease control at lower rates	400–800 mL (wheat) $18.14–$36.28	400–800 mL (wheat) $18.14–$36.28	200–800 mL (wheat & barley [7]) $9.07–$36.28	–	–	–	400–800 mL (wheat) $18.14–$36.28	–	200–800 mL (barley) $9.07–$36.28	400–800 mL (wheat & barley) $18.14–$36.28	Yes
Azoxystrobin 80g/L + Epiconazole 31.25 g/L	Tazer Xpert	Nufarm	3		$24.73	Plus Banjo 1%v/v for some diseases. When using Banjo adjuvant lower rates of Tazer Xpert can be used. Refer to label.	1000–2000 mL (wheat) $24.73–$49.46	1000– 2000 mL (wheat & barley) $24.73–$49.46	1000– 2000 mL (wheat) 500–2000 mL (barley) $12.37–$49.46	–	1000 mL (wheat) $24.73	1000–2000 mL (wheat) $24.73–$49.46	1000–2000 mL (wheat) $24.73–$49.46	1000–2000 mL (barley) $24.73–$49.46	1000–2000 mL (barley) $24.73–$49.46	1000–2000 mL (wheat) 1000–2000 mL (barley) $24.73–$49.46	Yes
Azoxystrobin 75 g/L + Epoxiconazole 75 g/L	Radial®	Adama Australia	6 + ESI	6	$30.83	–	420–840 mL (wheat) $12.95–25.90	420–840 mL (wheat) $12.95–25.90	420–840 mL (wheat & barley) $12.95–25.90	–	420–840 mL (wheat) $12.95–25.90	420–840 mL (wheat) $12.95–25.90	420–840 mL (wheat) $12.95–25.90	420–840 mL (barley) $12.95–25.90	420–840 mL (barley) $12.95–25.90	420–840 mL (wheat & barley) $12.95–25.90	Yes
Azoxystrobin 120 g/L + tebuconazole 200 g/L	Veritas®	Adama Australia	3 +ESI	6	$24.41	–	315–630 mL (wheat) $8.63–$17.27	315–630 mL (wheat) $8.63–$17.27	315–630 mL (wheat & barley [7]) $8.63–$17.27	–	630 mL (wheat) $17.27	315–630 mL (wheat) $8.63–$17.27	315–630 mL (wheat) $8.63–$17.27	315 mL (barley) $8.63	315–630 mL (barley [9]) $8.63–$17.27	315–630 mL (barley) $8.63–$17.27	Yes
Epoxiconazole 125 g/L	Opus® 125	BASF	6 + ESI	6	$21.97	200 mL/100 L Chemwet may assist in certain conditions	250–500 mL (wheat) $5.49–$10.99	–	500 mL (wheat) 250–500 mL (barley) $5.49–$10.99	–	–	250–500 mL (wheat) $5.49–$10.99	–	250 mL (barley) $5.49	250–500 mL (barley [6]) $5.49–$10.99	250 mL (wheat & barley) $5.49	Yes
Fenbuconazole 240 g/L	Indar®	Dow Agro-Sciences	2 + ESI	NR	$19.80	500 mL/100 L Uptake Spraying Oil	150–300 mL (wheat) $2.97–$5.94	–	–	–	–	–	–	–	–	–	No
Flutriafol 250 g/L	Various	–	7-W 10-B	7-W 10-B	$29.11	200 mL/100 L BS1000®	250–500 mL (wheat) $7.28–$14.56	–	250–500 mL (wheat) $7.28–$14.56	–	250–500 mL (wheat) $7.28–$14.56	250–500 mL (wheat) $7.28–$14.56	–	–	–	250–500 mL (barley) $7.28–$14.56	Yes
Flutriafol 500 g/L	Intake® Combi Sapphire	NuFarm	7-W 10-B	7-W 10-B	$27.50	200 mL/100 L BS1000®	125–250 mL (wheat) $3.44– $6.88	–	125–250 mL (wheat) $3.44– $6.88	–	125–250 mL (wheat) $3.44– $6.88	125–250 mL (wheat) $3.44– $6.88	–	–	–	125–250 mL (barley) $3.44– $6.88	Yes
Flutriafol 500 g/L	Jubilee® Loaded	Adama Australia	7-W 10-B	7-W 10-B	$27.95	200 mL/100 L BS1000®	125–250 mL (wheat) $3.49–$6.99	–	125–250 mL (wheat) $3.49–$6.99	–	125–250 mL (wheat) $3.49–$6.99	125–250 mL (wheat) $3.49–$6.99	–	–	–	125–250 mL (barley) $3.49–$6.99	Yes

Table 71. Cereal foliar fungicides – 2018 currently registered products (NSW) – winter cereals (continued; page 2 of 3)

Active and concentration	Examples of commercial trade names: Product	Manufacturer	WHP (weeks) W – wheat B – barley: Grazing	Harvest	Cost/L ❶	Adjuvant (as per label)	Diseases controlled ❷: Stripe rust	Stem rust	Leaf rust	Crown (leaf) rust	Septoria tritici blotch	Septoria nodorum blotch	Yellow spot	Barley scald	Net blotch	Powdery mildew	Registered for aerial application
Propiconazole 250 g/L ❿	Tilt®250 EC	Syngenta	1	4	$14.31	Not required	250–500 mL (wheat) $2.15–$7.15	500 mL (wheat & oats) $7.15	150–500 mL (wheat) $2.15–$7.15	250–500 mL (oats) $3.58–$7.15	250–500 mL (wheat & oats ❹) $3.58–$7.15	150–500 mL (wheat) $2.15–$7.15	250–500 mL (wheat) $3.58–$7.15	500 mL (barley) $7.15	250–500 mL (barley) $3.58–$7.15	150–500 mL (wheat & barley) $2.15–$7.15	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 ❹) $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 ❺) $8.65	85–285 mL (wheat & barley) $2.58–$8.65	Yes
Propiconazole 500 g/L	Throttle®500	Nufarm	1	4	$20.10	Not required	125 mL or 250 mL (wheat) $2.51–$5.03	250 mL (wheat & oats) $5.03	75–250 mL (wheat) 125–250 mL (barley) $1.51–$5.03	125–250 mL (oats) $2.51–$5.03	125–250 mL (wheat & oats ❹) $2.51–$5.03	75–250 mL (wheat) $1.51–$5.03	125–250 mL (wheat) $2.51–$5.03	250 mL (barley) $5.03	125–250 mL (barley) $2.51–$5.03	75–250 mL (wheat & barley) $1.51–$5.03	Yes
Propiconazole 250 g/L + cyproconazole 80 g/L	Tilt® Xtra	Syngenta	3 + ESI	6	$39.66	Not required	250–500 mL (wheat) $9.91–$19.83	500 mL (wheat) $19.83	150–500 mL (wheat & barley ❸) $5.95–$19.83	–	250–500 mL (wheat) $9.91–$19.83	150–500 mL (wheat) $5.95–$19.83	250–500 mL (wheat) $9.91–$19.83	500 mL (barley) $19.83	250 or 500 mL (barley) $9.91–$19.83	150–500 mL (wheat & barley) $5.95–$19.83	Yes
Propiconazole 250 g/L + tebuconazole 250 g/L	Cogito®	Syngenta	2	5	$31.93		125 – 250 mL (wheat) $3.99–$7.98	125–250 mL (wheat) 250 mL (oats) $3.99–$7.98	125–250 mL (wheat & barley) $3.99–$7.98	125–250 mL (oats) $3.99–$7.98	125–250 mL (wheat & oats ❹) $3.99–$7.98	125–250 mL (wheat) $3.99–$7.98	125–250 mL (wheat) $3.99–$7.98	250 mL (barley) $7.98	125–250 mL (barley) $3.99–$7.98	125–250 mL (wheat & barley) $3.99–$7.98	Yes
Prothioconazole 210 g/L + tebuconazole 210 g/L	Prosaro® 420 SC ❽	Bayer CropScience	2	5	$81.98	Various(adjuvants required for some diseases) – As per label directions	150–300 mL (wheat & triticale) $12.30–$24.59	150–300 mL (wheat) 300 mL (oats) $12.30–$24.59	150–300 mL (wheat & barley) 300 mL (oats) $12.30–$24.59	300 mL (oats) $24.59	–	150–300 mL (wheat, oats) $12.30–$24.59	150–300 mL (wheat) $12.30–$24.59	150–300 mL (barley) $12.30–$24.59	150–300 mL (barley) $12.30–$24.59	150–300 mL (wheat & barley) $12.30–$24.59	Yes
Pyraclostrobin 85 g/L + epoxiconazole 62.5 g/L	Opera®	BASF	3 + ESI	NR	$31.80	Non-ionic surfactant (not specified)	500 mL (wheat) $15.90	500 mL (wheat) $15.90	500–1000 mL (wheat) 500 mL (barley) $15.90–$31.80	–	500 mL (oats) $15.90	500 mL (wheat) $15.90	–	500 mL (barley) $15.90	500–1000 mL (barley) $15.90–$31.80	500 mL (wheat) 500–1000 mL (barley) $15.90–$31.80	Yes

❶ Indicative costs only: significantly Lower prices are often obtained for bulk purchases of commonly used products.

❷ Body of table shows rate mL/ha, g/ha and associated cost $/ha for registered products.

❸ Rate on barley is 250–500 mL.

❹ Propiconazole and propiconazole + tebuconazole is registered for suppression of Septoria leaf blotch in oats.

❻ Net form of net blotch only.

❼ Rate on barley is 200–800 mL.

❽ Prosaro® 420 is registered for the control of Fusarium head blight.

❾ Suppression only.

❿ Various formulations and active ingredient concentrations of propiconazole and tebuconazle are available.

+ 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.

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.

Seed dressings

Table 71. Cereal foliar fungicides – 2018 currently registered products (NSW) – winter cereals (continued; page 3 of 3)

Active and concentration	Examples of commercial trade names		WHP (weeks) W – wheat B – barley		Cost/L ❶	Adjuvant (as per label)	Diseases controlled ❷										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	
Tebuconazole 430 g/L ❿	Various	–	2	5	$16.45	1% D-C-Trate or equivalent may improve results	145–290 mL (wheat) $2.39–$4.77	145–290 mL (wheat & oats) $2.39–$4.77	145–290 mL (wheat) $2.39–$4.77	145–290 mL (oats) $2.39–$4.77	290 mL (wheat) $4.77	145–290 mL (wheat) $2.39–$4.77	145–290 mL (wheat) $2.39–$4.77	145 mL (barley) $4.77	–	145–290 mL (barley) $2.39–$4.77	Yes
Tebuconazole 225 g/L + flutriafol 75 g/L	Impact Topguard®	FMC (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	–	–	1370 g/ or 2750 kg (wheat)	1370 g or 2750 g (wheat & oats)	1370 g or 2750 g (wheat)	1370 g or 2750 g (wheat & oats)	2750 g (wheat)	1370 g or 2750 g (wheat)	1370 g or 2750 g (wheat)	1370 g (barley)		1370 g or 2750 g (barley)	No
Triadimefon 125 g/L	Triadimefon 125	Genfarm	Not stated, see footnote ⓬	4	$6.60	Not required	500 mL or 1000 mL (wheat) $3.30–$6.60	–	–	–	–	–	–	1000 mL (barley) $6.60	–	1000 mL (barley) $6.60	Yes
Triadimefon 500 g/kg	Ospray Triadimefon 500WG	FMC (Cheminova)	Not stated, ⓫	4	$18.08	Not required	125–250 g (wheat) $2.26–$4.52	–	125–250 g (wheat) $2.26–$4.52	–	125–250 g (wheat – southern NSW only) $2.26–$4.52	–	–	–	–	250 g (barley) 125–250 g (wheat) $2.26–$4.52	Yes

❶ Indicative costs only: significantly Lower prices are often obtained for bulk purchases of commonly used products.

❷ Body of table shows rate mL/ha, g/ha and associated cost $/ha for registered products.

⓫ Do not mix leaves treated with this product with feed intended for animal consumption.

⓬ 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.

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 72. Canola and pulse foliar fungicides – 2018

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								
Spin Flo® – Nufarm	carbendazim (500 g/L) ❶	28 days	28 days	500 mL	21.50			Botrytis grey mould		Chocolate spot	
Bravo® Weather Stik – Syngenta	chlorothalonil (720 g/L)	7 days	Do not graze	1.4–2.3 L	16.20	5–200 L	–	–	–	Chocolate spot, rust	–
Barrack® 720 – Crop Care	chlorothalonil (720 g/L)	14 days	14 days	1.4–2.3 L (faba bean)	14.10	5–200 L	–	Ascochyta blight	–	Chocolate spot, rust	–
Unite® 720 – Nufarm				1.0–2.0 L (chickpea)		5–1000 L					
Echo® 900 Fungicide – Sipcam	chlorothalonil (900 g/kg)	14 days	14 days	1.2–1.9 kg (faba bean) 0.8–1.6 kg (chickpea)	18.90	1–20 kg	–	Ascochyta blight	–	Chocolate spot, rust	–
Rovral® Liquid – FMC	iprodione (250 g/L)	42 days	42 days	2.0 L	17.55	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	11.05	20 kg	–	Ascochyta blight, botrytis grey mould, rust	Ascochyta blight (blackspot), botrytis grey mould	Ascochyta blight, chocolate spot, Cercospora, rust	Anthracnose, botrytis grey mould
Fortress® 500 – Crop Care	procymidone (500 g/L) ❷	Canola not required	9 weeks	1.0 L (canola)	37.35	5–10 L	Sclerotinia stem rot	–	–	Chocolate spot	–
Sumisclex® Broadacre – Sumitomo		Faba beans 9 days	Not stated	0.5 L (faba bean)		20 L					
Prosaro® 420 SC – Bayer CropScience	prothioconazole (210 g/L) + tebuconazole (210 g/L)	Not required	14 days	375–450 mL/ha	81.55	5–20 L	Blackleg, Sclerotinia stem rot	–	–	–	–
Aviator® Xpro™ – Bayer	Prothioconazole (150 g/L) + bixafen (75 g/L)	Not required	28 days	Canola Blackleg 550–650 mL/ha Sclerotinia stem rot 550–800 mL/ha Chickpea Ascochyta blight 400–600 mL/ha	59.90	10 L	Blackleg, Sclerotinia stem rot	Ascochyta blight	–	–	–
Imtrade 430 SC Fungicide	tebuconazole (430 g/L)	3 days PER13752 21 days	3 days PER13752 14 days	145 mL	14.75	5–1000 L	–	–	Powdery mildew	Cercospora, rust (PER13752, expiry 30/06/19)	–
Triadimefon 125EC – FMC	triadimefon (125 g/L)	14 days	Not stated	500 mL	6.70	5–1000 L	–	–	Powdery mildew	–	–

❶ Health warnings are in place for potential effects on male fertility.
❷ Health warnings are in place for women of child bearing age. Prices quoted are GST Inclusive at 30 January 2018 and approximate only.
Prices will vary depending on pack size purchased.

Seed dressings

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