Department of Primary Industries
Department of Regional NSW

NSW GOVERNMENT

Winter crop variety sowing guide 2023

NSW DPI MANAGEMENT GUIDE

Peter Matthews, Don McCaffery and Leigh Jenkins

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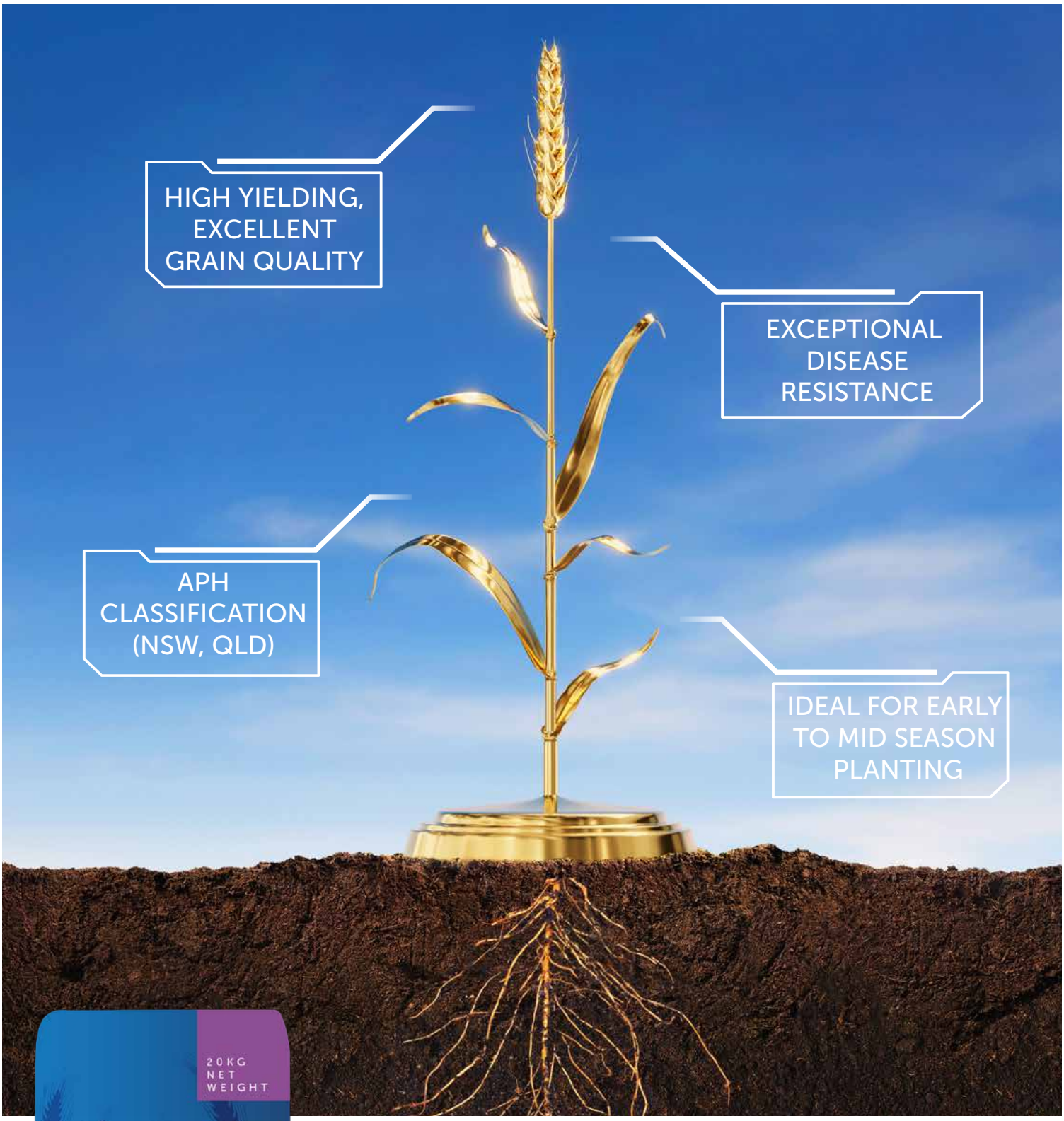

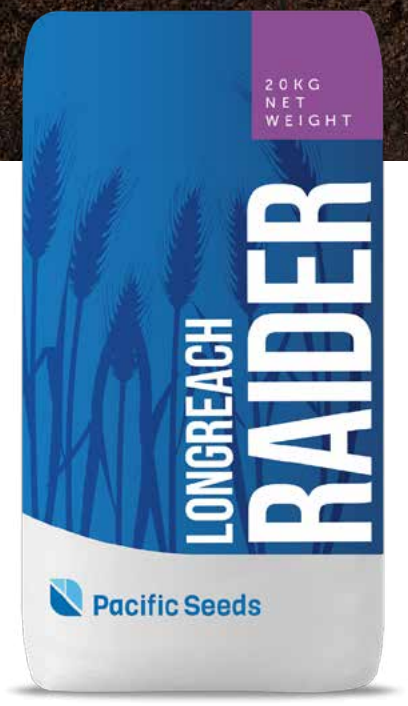

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Introduction

Welcome to the 2023 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 water limited yield potential, and matching the end product of both variety choice and management to available markets. This guide is updated with new variety and technical information, based on the latest research and development results from both NSW DPI and industry programs, including National Variety Trial data for comparative grain yield and disease ratings.

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. Also, sharply rising crop input costs, especially for fertilisers during 2021 and 2022, and continuing volatility, puts emphasis on making the best possible decisions on paddock selection, crop and variety choice and nutrient management strategies. These factors all contribute to the winter crop producer's need for careful planning and management to optimise productivity and profitability beyond the current year.

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 (February 2023). 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 the Department of Regional New South Wales or the user's independent adviser.

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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.

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

Front cover: Sowing faba bean, Walgett, north-western NSW.

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.

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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 guide's format, results are presented for all crop types on both a separate yearly regional mean basis (2018, 2019, 2020, 2021 and 2022) and on a combined regional mean basis. The yearly regional mean values presented in the guide have been extracted from the NVT database and values are only shown for a variety when the variety was present at sites in that year. The yearly or regional mean values shown in the *Winter crop variety sowing guide* are not adjusted for trial accuracy, but are filtered for VAF >25%. On the NVT website (www.nvtonline.com.au), within the 'Long-term yield reporter' web tool, you are able to filter on accuracy and VAF. The default accuracy and VAF values on the NVT long-term yield reporter web tool are set at ≥0.8 and ≥25% respectively. Users can change the default values of accuracy and VAF filters in the web tool, depending on their risk acceptance, using the slide tool option. 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 performances 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 variety's performance across the state, go to the NVT website. The 'Long term yield reporter' tool allows users to view data in yield-based groupings and/or seasonal outcome across states, regions or selected trials down to a single site level.

You can also access individual trial results for 2022 by using the interactive map on the NVT website home page and selecting the site of interest.

Highlights and changes 2023

Cereal diseases

Rusts: The 2022 stripe rust epidemic was the worst seen in NSW since the disease was first detected over 40 years ago in Australia, with yield losses in crops of susceptible varieties when not controlled by foliar fungicides.

Three main stripe rust pathotypes caused damage to wheat crops:

- 239 E237 A– 17+ 33+
- 198 E16 A+ J+ T+ 17+
- 238 E191 A+ 17+ 33+.

The pathotype 134 E16 A+ 17+ was also detected in NSW but at low levels.

These pathotypes are all likely to be present in the 2023 season given the good rainfall through summer and autumn that will carry over stripe rust on the 'green bridge' of volunteer wheat.

Updated stripe rust resistance ratings for the 2023 season are a combined rating of the major pathotypes present during 2022. The single rating displays the most susceptible rating, or 'worst case', for varieties to the stripe rust pathotypes present last year. Growers and agronomists are urged to check current resistance ratings, develop a stripe rust management plan, and actively monitor crops throughout the season for any signs of stripe rust or any other rust species. If rust is found, samples should be submitted to the National Cereal Rust Survey (see Industry information on page 80) before applying a fungicide to the crop if required.

Septoria tritici blotch: After three consecutive seasons conducive to disease development, heavy stubble loads, combined with more susceptible varieties being grown, septoria tritici blotch inoculant levels have built up in southern and central NSW. During 2022, it often occurred in areas where the disease was not usually considered an issue and, in many cases, caused yield losses. Septoria tritici blotch is carried over on wheat stubble, so avoid sowing wheat on wheat. The disease is airborne, so wheat stubble in neighbouring paddocks can be a source of inoculum for the 2023 wheat crop. In the medium to high rainfall areas choose varieties with good resistance to septoria tritici blotch, consider stubble management practices, fungicide seed dressings and foliar fungicides to protect this year's crop.

Fusarium crown rot (FCR) and fusarium head blight (FHB): Fusarium crown rot was widely detected across NSW in 2022 wheat crops. Growers are urged to test for FCR inoculum levels in paddocks using the PreDicta® B test or NSW DPI stubble testing service (**contact Steven Simpfendorfer on 0439 581 672** for protocols) before sowing. This is particularly important if the paddock has a cereal crop history, cereal stubble is present, or if growers are considering sowing durum crops, which are very susceptible to FCR.

Fusarium head blight was also common in crops across NSW, particularly those with a high FCR infection level. Check the germination and vigour of all seed lots for this year using commercial seed testing services. If FHB is suspected as being present, free *Fusarium* grain testing is available, send 200–250 g seed samples to **Steven Simpfendorfer, NSW DPI, 4 Marsden Park Rd, Tamworth, NSW 2340.**

Bunts and smuts in cereals: The wet spring conditions in 2022 favoured smut and bunt development in cereals. Growers are encouraged to ensure all sowing seed is treated with an effective seed dressing. Both feed and malt barley have a **nil tolerance** for smut-contaminated grain.

Varietal changes

New varieties with limited data available

The *Winter crop variety sowing guide* contains information on commercially available crop varieties that might be suited to NSW, it does not include all varieties available and might not include outclassed varieties, interstate released varieties or niche market varieties. Consult either the owners or commercial licensees of new varieties for further information. Yield performance data is available from the NVT website on varieties included and tested in NVT trials across NSW.

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

Wheat: Five new spring hard wheat varieties will be available for the 2023 season: Brumby$^{\Phi}$, Jillaroo$^{\Phi}$, BASF Kingston$^{\Phi}$, BASF Reilly$^{\Phi}$ and LongReach Anvil CL Plus$^{\Phi}$. One new longer season soft wheat variety, Scotch, was also released for the medium to high rainfall production zones. One new long-season winter wheat was released, a white-grained feed wheat RGT Waugh$^{\Phi}$ for the high rainfall zone of NSW.

The variety characteristics and reactions to diseases for wheat is in Table 19. Diseases and crop injury guide – wheat (page 24) lists the 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: Four new feed barley varieties: Combat$^{\Phi}$, Fandaga$^{\Phi}$, Titan AX$^{\Phi}$ and Zena CL$^{\Phi}$ were released for NSW. Check before growing any new barley variety that local segregation is available for that variety, or if short-term on-farm storage is required before delivery to a buyer.

Oat: One new longer season milling oat, Koala, was released with limited seed available for the 2023 season.

Triticale: One new triticale variety, Woomera, has been released in South Australia, however there are no grain yield testing results for NSW.

Canola: There are 16 new releases for 2023:

- Outlaw$^{\Phi}$ is a new open-pollinated (OP) conventional variety, the first since AV-Garnet was released in 2007.
- ATR Swordfish$^{\Phi}$, Bandit TT$^{\Phi}$ and Renegade TT$^{\Phi}$ are 3 new OP TT varieties.
- DG Torrens® TT$^{\Phi}$, HyTTec® Velocity$^{\Phi}$, InVigor® T 4511$^{\Phi}$ and RGT Baseline™ TT are 4 new TT hybrids.
- DG Hotham® TF, Nuseed® Eagle TF, Nuseed® Hunter TF and the specialty type VICTORY® V55-04 TF are 4 new Truflex® hybrids.
- Hyola® Regiment XC is a new TruFlex® + Clearfield® hybrid.
- Hyola® Solstice CL and RGT CLAVIER™ CL (winter type) are 2 new Clearfield hybrids.
- Pioneer® PY520 TC is a new TT + Clearfield® hybrid.

Chickpea: There are no new chickpea variety releases for 2023. CBA Captain$^{\Phi}$ (released in 2020) continues to perform strongly as a high-yielding medium-sized desi type suited to both northern and southern chickpea growing regions in NSW. However, chickpea sowings were severely constrained in 2022 by very wet conditions throughout the preferred sowing window, and poor price signals pre-sowing relative to previous years. Many chickpea crops also succumbed to wet seasonal conditions preventing timely fungicide applications for ascochyta blight control, or other in-crop diseases such as phytophthora root rot and sclerotinia, which are difficult to control in most seasons, but especially under waterlogged conditions.

The key issue for 2023 chickpea crops will be sourcing high quality seed for planting. Late rains in 2022 not only delayed harvest, resulting in potentially weather-damaged seed, but also contributed to ascochyta blight pod and seed infection. Consequently, seed treatment with a fungicide will be imperative when sowing chickpea crops in 2023. It is recommended that selecting varieties with better Ascochyta resistance and using a preventative fungicide at the initial seedling stage of disease infection will be critical.

Faba bean: FBA Ayla$^{\Phi}$ (released in 2021) has proven to be well suited to northern NSW and southern Queensland and is higher yielding than all other varieties in northern NSW. It has larger seed than PBA Warda$^{\Phi}$, but smaller than PBA Nasma$^{\Phi}$, enabling easier sowing for growers while still retaining market preference. PBA Amberley$^{\Phi}$ (released in 2019) has proven to be a very popular variety for southern NSW due to its excellent disease resistance package.

Very wet conditions in late winter and spring of 2022 favoured chocolate spot disease development in southern NSW and rust in northern NSW. Disease proved difficult to control with poor conditions for fungicide application. Hence it is highly likely that inoculum levels will be high in 2023. In addition, wet conditions causing seed-borne infections during podding might compromise grain quality. As with chickpea seed, sourcing quality sowing seed could prove difficult in 2023.

Field pea: The two new field pea varieties released in 2021 have performed consistently well in NVT yield testing. PBA Taylor$^{\Phi}$ is a high-yielding variety marketable as a Kaspa-type for human consumption that is resistant to *Pea seed-borne mosaic virus* and *Bean leafroll virus*. PBA Noosa$^{\Phi}$ is the first blue pea with high grain yield, shatter resistant pods and improved resistance to bleaching. While developed to suit niche marketing opportunities, it offers yield advantages similar to mainstream Kaspa-type varieties such as PBA Wharton$^{\Phi}$.

As with other pulse crops in 2022, wet conditions favoured widespread disease development in field pea crops. There were reports of high levels of downy mildew during early crop establishment and blackspot disease later in the growing season. Rapid spread of these diseases due to the favourable conditions mean it is highly likely that there will be high levels of disease inoculum in paddocks in 2023.

Lentil: Four new lentil varieties were released in 2022. GIA Lightning$^{\Phi}$ and GIA Thunder$^{\Phi}$ are both imidazolinone (IMI) herbicide tolerant lentils. GIA Sire$^{\Phi}$ is a dual-herbicide-tolerant lentil to IMI and also clopyralid soil residues. GIA Metro$^{\Phi}$ is the first dual-herbicide-tolerant lentil to both IMI and metribuzin herbicides.

Lupin: The narrow-leaf lupin Lawler$^{\Phi}$ is a new release for NSW that has performed well in central and southern NSW NVT trials. Growers should continue to test their seed for *Cucumber mosaic virus* (CMV) and *Bean yellow mosaic virus* (BYMV) as it was present in many crops in 2022. Farmer-retained sowing seed with both narrow-leaf (CMV) and albus lupins (BYMV) can be sent for virus testing to Joop van Leur, NSW DPI, 4 Marsden Park Road, Calala NSW 2340.

GO TO PAGE
NVT site (www.nvtonline.com.au)

Wheat

Variety choice

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.

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 classified according to their suitability for the 2 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. Wheat varieties can be broadly classified into a series of maturity groupings based on differences in phenology (flowering time):

- Spring wheats: Very quick, quick, mid, slow, very slow
- Winter wheats: Quick, mid and slow.

The suggested sowing windows in this guide have been developed to support variety selection across NSW production regions, to maximise grain yields and minimise climatic risk at key crop stages. The sowing windows for different varieties have been developed from consultation with wheat breeders, knowledge of key phenology genes, regional agronomic research on variety sowing time responses and performance in National Variety Trials (NVT).

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.

Optimal flowering periods (OFP) have been identified for locations across NSW and underpin the suggested sowing windows for different varieties. The OFP aims to balance the risks of frost at flowering, moisture stress and heat stress during grain filling. If varieties are sown within the optimum sowing period to match the local OFP, they can produce their highest yields. Understanding your flowering risk will help growers make variety choices for your farm to suit sowing time preferences or opportunities.

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.

TIPS AND TRICKS

1. Sow at least 2 different varieties each year. This spreads the risk of frost and disease damage.
2. Sowing towards the earliest part of the recommended sowing window usually results in higher yields.

The best sowing date varies and is influenced locally by topography, local climatic conditions and soil types so the suggested sowing dates might need to be extended (earlier or later) based on local conditions.

Conservation tillage techniques (no till, minimum till) as well as using moisture-seeking sowing tynes can assist growers to sow on time.

More detailed regional research reports from this project can be found for southern NSW (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/southern-nsw-research-results)

and northern NSW (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/ngrt-results)

Sowing date response of wheat varieties

A recent research project – 'Optimising grain yield potential of winter cereals in the Northern Grains Region' a joint investment by NSW Department of Primary Industries and GRDC under the Grains Agronomy and Pathology Partnership (GAPP) – investigated wheat phenology responses to sowing time in NSW, highlighting the importance of understanding your OFP and how varieties differ in their development and maturity.

The flowering time and grain yield responses to sowing date for some representative wheat phenology groups from Wagga Wagga are presented in Figure 1 and Figure 2 and highlight the importance of selecting the right sowing time for a variety to target your region's OFP. While every season is different, matching a variety's maturity to the correct sowing window minimises production risk and maximises the grain yield potential over the 4 seasons studied. The shading represents the OFP (blue) and the suggested sowing window (green) to achieve OFP for those varieties and presents flowering date and yield responses across four contrasting seasons at Wagga Wagga (2017–2020). For the winter wheat EGA_Wedgetail[Φ] (Figure 1), sowing in early–late April provided the best chance of flowering in the OFP for the Wagga Wagga region and maximised grain yield. Delayed sowing resulted in later flowering and a grain yield penalty. Conversely, sowing a quick variety such as Vixen[Φ] (Figure 2) in early April resulted in earlier flowering, increased exposure to frost, and a yield penalty, however, when sown in late May grain yield was maximised and flowering aligned with the OFP.

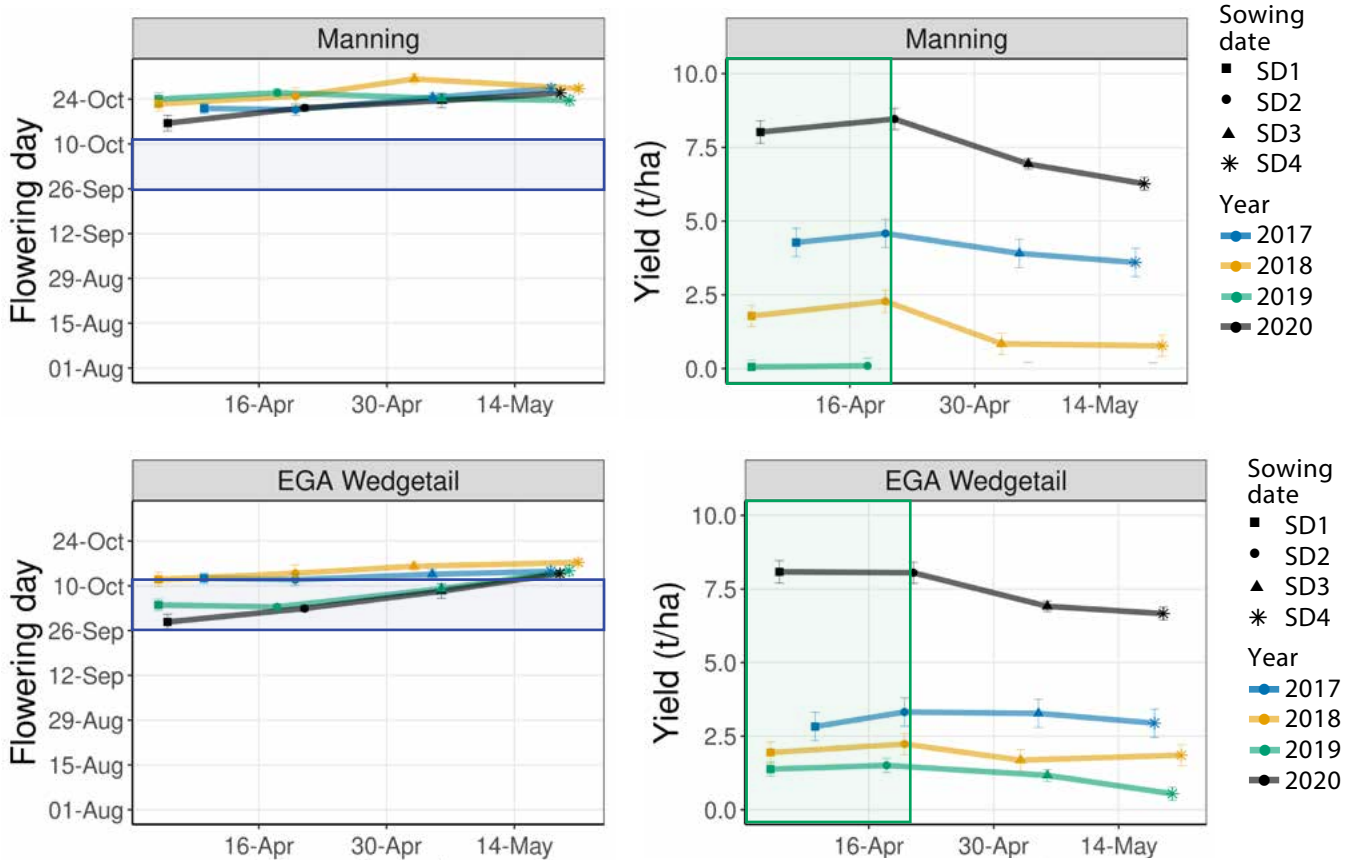

Figure 1. Flowering date and grain yield response of (a) Manning[Φ] and (b) EGA_Wedgetail[Φ] to 4 different sowing dates at Wagga Wagga from 2017 to 2020. The green shaded box indicates the suggested sowing window for the representative variety grouping, e.g. long season very slow winter wheat and mid winter wheat, not specific varieties.

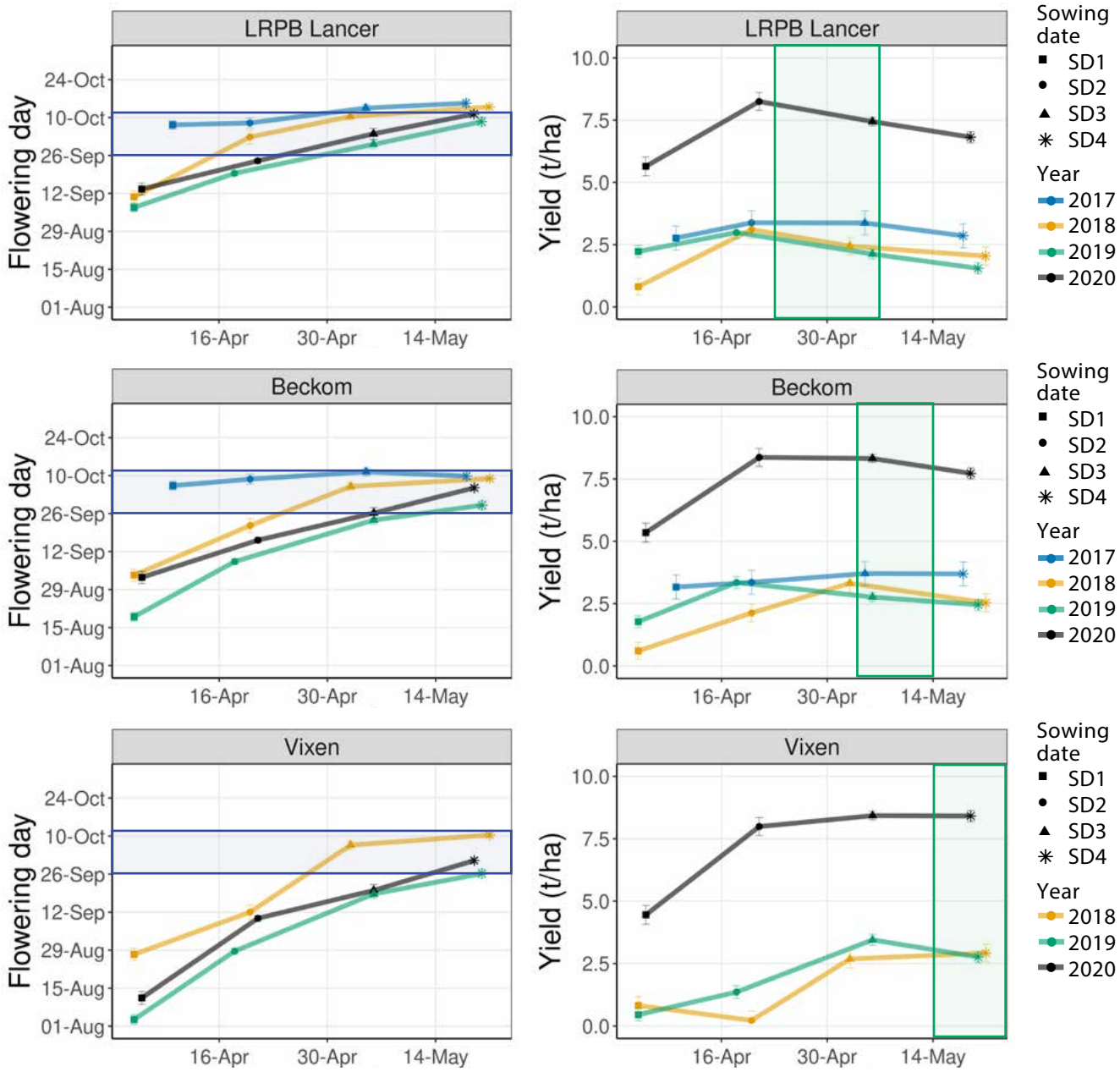

Figure 2. Flowering date and grain yield response of (a) LRPB Lancer(ᵻ), (b) Beckom(ᵻ) and (c) Vixen(ᵻ) to 4 different sowing dates at Wagga Wagga from 2017 to 2020. The green shaded box indicates the suggested sowing window for the representative variety grouping, e.g. mid-slow spring wheat, mid spring wheat and a quick spring wheat not specific varieties.

Disclaimer

The predictions displayed demonstrate the performance of a genotype in an environment where these predictions are composed of both the genotype effect and the environment mean. The environment mean reflects the expected average performance of all the genotypes tested in each environment where an environment is defined as the combination of site, year and sowing date. The possible range of variation around the expected performance of each variety in each environment is displayed in the graphs using small, vertical (error) bars. The vertical error bar for each variety by environment combination denotes the 95% confidence interval.

Acknowledgements

Dr Felicity Harris, Senior Lecturer, Crop Science, Wagga Wagga, Charles Stuart University and Michael Mumford, Biometrician Toowoomba, Queensland Department of Agriculture and Fisheries.

Sowing rates and plant populations

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

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

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

Table 1. Wheat sowing rates (kg/ha) for various plant populations (plants/m^2) and 1000 seed weight (grams) for different rainfall regions in NSW.

1000 seed weight (grams)	Target wheat plant population for grain only crops (plants/m^2) #													
	Rainfall													
	Low					Medium				High and irrigation				
	50	60	70	80	90	100	110	120	130	140	150	160	170	180
20	14	17	19	22	25	28	31	33	36	39	42	44	47	50
22	15	18	21	24	28	31	34	37	40	43	46	49	52	55
24	17	20	23	27	30	33	37	40	43	47	50	53	57	60
26	18	22	25	29	33	36	40	43	47	51	54	58	61	65
28	19	23	27	31	35	39	43	47	51	54	58	62	66	70
30	21	25	29	33	38	42	46	50	54	58	63	67	71	75
32	22	27	31	36	40	44	49	53	58	62	67	71	76	80
34	24	28	33	38	43	47	52	57	61	66	71	76	80	85
36	25	30	35	40	45	50	55	60	65	70	75	80	85	90
38	26	32	37	42	48	53	58	63	69	74	79	84	90	95
40	28	33	39	44	50	56	61	67	72	78	83	89	94	100
42	29	35	41	47	53	58	64	70	76	82	88	93	99	105
44	31	37	43	49	55	61	67	73	79	86	92	98	104	110
46	32	38	45	51	58	64	70	77	83	89	96	102	109	115
48	33	40	47	53	60	67	73	80	87	93	100	107	113	120
50	35	42	49	56	63	69	76	83	90	97	104	111	118	125
52	36	43	51	58	65	72	79	87	94	101	108	116	123	130
54	38	45	53	60	68	75	83	90	98	105	113	120	128	135
56	39	47	54	62	70	78	86	93	101	109	117	124	132	140
58	40	48	56	64	73	81	89	97	105	113	121	129	137	145
60	42	50	58	67	75	83	92	100	108	117	125	133	142	150

Seeding rates (kg/ha) calculated on a 90% germination and 80% establishment basis.

Figure 3. Wheat samples of various sizes.

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 the 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.

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 as part of the National Variety Testing program, which is funded by GRDC.

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NVT website (www.nvtonline.com.au).

Table 2. 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
Check varieties	
Federation (long)	9.5
Whistler (short)	6.0

Table 3. 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
Coolah	6.6
Cutlass	7.1
DS Darwin	5.6
DS Faraday	6.1
DS Pascal	5.8
EGA_Burke	6.1
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
RGT Accroc	6.6
RGT Calabro	6.5
SF Adagio	6.2
SF Moskito	6.7
SQP Revenue	6.4
Sunlamb	6.3
Sunmax	6.0
Suntime	6.2
Sunzell	6.4
Trojan	6.9
Wylah	6.1
Check varieties	
Federation (long)	9.5
Whistler (short)	5.7

Table 4. 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
Baxter	7.1
Beckom	6.4
Buchanan	6.6
Chara	6.3
Cobra	6.6
Condo	6.5
Corack	6.8
Crusader	6.7
Dart	7.2
Diamondbird	6.6
DS Darwin	5.6
EGA_Gregory	6.4
EGA_Wylie	6.9
Ellison	7.0
Elmore CL Plus	7.1
Emu Rock	6.5
Grenade CL Plus	6.6
Impala	5.7
Janz	7.0
Justica CL Plus	6.7
Kord CL Plus	6.7
Livingston	6.6
LRPB Oryx	6.0
Mace	6.9
QAL2000	7.2
QALBIS	6.7
Reliant	6.6
Scepter	6.6
Shield	6.6
Spitfire	7.1
Sunguard	7.0
Sunlin	6.7
Sunmate	7.1
Suntop	7.1
Sunvale	7.0
Tenfour	6.6
Check varieties	
Federation (long)	9.8
Whistler (short)	5.9

Grain quality – pre-harvest sprouting and falling numbers

Pre-harvest grain sprouting is a major issue for growers in years where rain is combined with cool temperatures during grain filling, resulting in significant grain downgrading. Wetting of mature grain produces an enzyme called alpha-amylase, which affects baking quality; its level is determined by a falling number test.

In 2021 and 2022, this was a major issue for growers with a significant proportion of the NSW wheat crop downgraded from pre-harvest sprouting, low test weights and low falling numbers. Figure 4 shows an example of grain affected by pre-harvest sprouting. The minimum falling numbers for the major wheat classification grades are shown in Table 5 below. Additional delivery grades for wheat with low falling numbers, can be found on the Grain Trade Australia (GTA) website.

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Grain Trade Australia (http://www.graintrade.org.au)

Wheat grain quality - falling number and pre harvest sprouting resistance (http://www.agric.wa.gov.au/wheat/wheat-grain-quality-falling-number-and-pre-harvest-sprouting-resistance)

Table 5. Minimum falling number values for main wheat classification grades.

Wheat classification grade	Minimum falling number (sec)	Comments
Australian Prime Hard (APH1™ & APH2™)	350	
Australian Hard (H1™ & H2™)	300	AUH2™ delivery grade 250
Australian Premium White (APW1™ & APW2)	300	
Australian Standard White (ASW1™)	300	
Australian General Purpose (AGP1™)	200	
Soft wheat (SFT1™ & SFT2)	300	
Durum (DR1™ & DR2)	300	DR3 delivery grade 200
Feed (FED1™)	Not applicable	No minimum number

Source Grain Trade Australia.

There are several factors that affect pre-harvest sprouting and falling number:

- **Varietal choice** – a number of attributes of a variety can help to maintain falling numbers including:
  - grain dormancy
  - physical characteristics such as the angle of the head as the crop matures
  - ear waxiness
  - absence of awns
  - how tightly the grain is held by the glumes
  - the variety's susceptibility to late-maturity alpha-amylase (LMA).
- **Environment** – rain is a major issue. Its intensity, frequency and duration combined with associated temperatures can be problematic. Stresses before grain maturation and rain in the lead up to maturation can also influence the grain's susceptibility to sprouting during later rain events. Expression of LMA can occur in different environments, with some varieties suited to northern NSW having increased LMA expression when grown in southern regions.
- **Crop maturity stage** – the susceptibility of a variety to environmental conditions changes in relation to maturation stage. Grain dormancy wears off over time, so the longer the grain is exposed to rainfall, the higher the risk of pre-harvest sprouting.

Managing the risk of pre-harvest sprouting is limited to selecting varieties with a tendency to have high falling numbers and varieties with low susceptibility to LMA, ensuring a variety's maturity is suited to your growing environment and timely harvest.

Figure 4. Wheat grain showing pre-harvest sprouting damage.

Falling number index

Researchers from the Department of Primary Industries and Regional Development (DPIRD) of Western Australia have developed a falling number index (FNI). The FNI rates varieties for their ability to maintain falling number under varying conditions. The FNI uses a combination of data from the field, laboratory and through artificial sprouting to determine the risk of a variety exhibiting low falling number, on a scale of 1–9; the higher the rating the more likely a variety is to maintain falling number. Table 6 shows the FNI for selected varieties commonly grown in NSW, from those screened in Western Australia. More information can be found in *Wheat grain quality - falling number and pre harvest sprouting resistance*.

Table 6. Falling number index for selected varieties grown in NSW that have been screened by DPIRD.

Variety	Falling number index rating
Catapult	6
Corack	4
Cutlass	4
DS Pascal	7
Emu Rock	2
Illabo	5
LRPB Cobra	2
LRPB Trojan	5
Mace	5
Razor CL Plus	4 ❶
Rockstar	2
Scepter	5
Sheriff CL Plus	4
Vixen	3

❶ Provisional rating based on a single year of data and limited data, treat with caution.

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Northern NSW – Wheat variety performance

Yield performance experiments from 2018–2022.

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 2018–2022. Further results can be found on the NVT website.

Table 7. Long season varieties (North): Compared with EGA_Wedgetail = 100%.

North east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% EGA_Wedgetail (t/ha)	–	1.81	4.70	4.36	3.76	3.95	
Anapurna ❶	–	95	129	119	143	125	6
BigRed ❶	–	–	–	117	146	126	3
DS Bennett ❶	–	97	97	106	94	100	6
EGA_Wedgetail ❶	**–**	**100**	**100**	**100**	**100**	**100**	**6**
Illabo ❶	–	106	105	113	121	111	6
Longsword ❶	–	113	105	105	109	106	6
LRPB Kittyhawk ❶	–	–	112	102	117	108	5
LRPB Nighthawk	–	102	109	109	124	111	6
Manning ❶	–	75	123	91	89	102	6
Naparoo ❶	–	71	92	92	97	91	6
RGT Accroc ❶	–	93	123	114	121	117	6
RGT Cesario ❶	–	–	–	115	133	123	3
RGT Waugh ❶	–	–	–	108	–	121	2
Severn ❶	–	–	–	108	125	111	3
Sunlamb	–	101	–	–	–	100	1

❶ Winter wheat

Table 8. Early season variety trial results Northern NSW (sown before 15 May): Compared with EGA_Gregory = 100%.

North east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% EGA_Gregory (t/ha)	2.44	1.40	4.41	5.20	4.34	3.85	
Catapult	–	–	–	114	91	110	9
Coolah	108	113	109	110	100	108	20
Coota	–	117	112	114	97	110	17
DS Bennett ❶	104	100	–	–	–	105	2
DS Faraday	101	90	99	99	102	99	20
EG Titanium	101	114	102	102	93	100	20
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**20**
EGA_Wedgetail ❶	87	46	81	97	125	95	17
Illabo ❶	88	80	87	103	116	99	15
Longsword ❶	–	142	92	103	92	98	12
LRPB Flanker	98	104	99	101	102	101	20
LRPB Gauntlet	94	108	–	–	–	97	6
LRPB Kittyhawk ❶	96	–	89	97	106	95	14
LRPB Lancer	98	119	101	105	96	102	20
LRPB Nighthawk	103	67	98	108	114	104	20
LRPB Raider	–	–	111	112	109	110	14
LRPB Stealth	–	115	107	108	99	106	17
Rockstar	–	–	112	115	95	110	14
Scotch ❷	–	–	–	–	118	104	4
Sunflex	108	111	109	–	103	109	15
Sunmax	107	87	104	105	97	102	20
Feed wheats							
RGT Zanzibar	102	81	101	117	130	112	20
Severn ❶	94	–	–	107	109	101	10

❶ Winter wheat
❷ Soft/biscuit wheat variety.

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

North west							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% EGA_Gregory (t/ha)	**1.89**	**1.55**	**4.06**	**5.76**	**4.80**	**3.95**	
Catapult	–	133	115	117	107	113	19
Coolah	107	110	109	111	108	109	23
Coota	–	113	110	116	109	112	19
DS Faraday	102	93	100	98	99	99	23
EG Titanium	101	110	100	104	98	101	23
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**23**
EGA_Wedgetail ❶	91	38	59	94	119	94	15
Illabo ❶	–	–	64	102	120	99	8
Longsword	–	–	73	106	110	100	10
LRPB Flanker	97	101	99	100	103	101	23
LRPB Gauntlet	95	100	–	–	–	97	7
LRPB Kittyhawk ❶	102	–	72	97	103	93	12
LRPB Lancer	98	108	94	107	105	103	23
LRPB Nighthawk	107	66	85	106	115	104	23
LRPB Raider	–	–	112	111	110	110	16
LRPB Stealth	–	110	105	110	107	107	19
Rockstar	–	–	110	118	111	114	16
Sunflex	108	106	106	–	112	111	18
Sunmax	110	89	97	107	102	103	23

❶ Winter wheat.

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

North east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% EGA_Gregory (t/ha)	**1.90**	**1.50**	**4.61**	**4.86**	**4.40**	**3.73**	
Beckom	111	119	105	112	119	111	22
Boree	–	–	100	116	98	107	15
Calibre	–	–	–	113	106	111	9
Condo	94	103	98	98	122	102	22
Coolah	111	113	104	110	110	108	22
Coota	–	120	104	111	93	106	18
DS Faraday	103	100	102	100	101	101	22
EG Titanium	105	112	97	103	100	101	22
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**22**
Elmore CL Plus	104	111	96	101	104	101	22
Jillaroo	–	–	–	113	94	108	9
LRPB Flanker	100	100	101	102	103	102	22
LRPB Hellfire	111	115	101	100	103	103	22
LRPB Impala ❷	108	111	101	105	–	106	16
LRPB Mustang	103	120	98	104	106	103	22
LRPB Oryx ❷	100	114	96	104	122	104	14
LRPB Raider	–	–	105	110	111	108	15
LRPB Reliant	108	108	105	101	106	104	22
LRPB Spitfire	99	107	93	95	101	96	22
Rockstar	–	–	99	113	94	104	15
Scepter	110	123	105	115	109	110	22
Sunblade CL Plus	–	123	108	113	123	114	18
Suncentral	–	113	105	106	127	109	18
Sunchaser	103	109	101	99	122	105	22
Sunmaster	–	–	108	111	132	114	15
Sunprime	107	119	100	103	105	103	22
Suntop	105	113	101	103	119	106	22
Vixen	102	125	98	115	93	105	22
Feed wheats							
Borlaug 100	106	104	108	97	123	106	22
SEA Condamine	103	100	107	96	119	104	22

❷ Soft/biscuit wheat variety.

Table 11. Main season variety trial results Northern NSW (sown after 14 May): Compared with EGA_Gregory = 100%.

North west							
Variety	Yearly group mean					Regional mean	Number of trials
	2018	2019	2020	2021	2022		
% EGA_Gregory (t/ha)	**1.78**	**1.34**	**3.95**	**5.48**	**4.98**	**4.08**	
Beckom	103	109	108	107	117	110	27
Boree	–	–	110	109	110	109	21
Calibre	–	–	–	111	112	113	14
Condo	89	96	99	100	118	105	27
Coolah	106	105	106	105	108	106	27
Coota	–	119	111	106	98	105	24
DS Faraday	102	101	101	101	100	101	27
EG Titanium	100	98	101	97	94	97	27
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	100	27
Elmore CL Plus	98	97	100	95	100	98	27
Jillaroo	–	–	–	108	100	108	14
LRPB Flanker	101	101	101	102	105	102	27
LRPB Hellfire	102	109	105	98	97	100	27
LRPB Impala ❷	102	100	102	–	117	105	20
LRPB Mustang	94	109	106	102	102	103	27
LRPB Oryx ❷	–	–	–	–	118	104	7
LRPB Raider	–	–	105	109	108	107	21
LRPB Reliant	102	110	105	104	101	104	27
LRPB Spitfire	94	95	97	91	96	94	27
Rockstar	–	–	108	108	107	107	21
Scepter	104	116	111	109	112	111	27
Sunblade CL Plus	–	112	111	110	117	112	24
Suncentral	–	106	107	108	121	111	24
Sunchaser	94	100	102	101	112	105	27
Sunmaster	–	–	110	111	123	114	21
Sunprime	98	112	107	101	101	103	27
Suntop	96	101	103	102	110	105	27
Vixen	99	120	111	107	107	108	27
Feed wheats							
Borlaug 100	99	113	105	106	121	110	27
SEA Condamine	99	110	104	104	118	108	27

❷ Soft/biscuit wheat variety.

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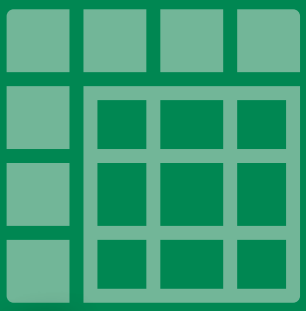

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Suggested sowing times – Northern NSW

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 vary 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 12. Suggested sowing times Northern NSW.

	March				April				May				June				July		
Variety **Weeks**	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Slopes																			
Anapurna ❶, Mackellar ❶, Manning ❶, RGT Accroc ❶ RGT Cesario ❶, RGT Waugh ❶	>	★	★	★	★	★	★	★	<										
DS Bennett ❶		>	★	★	★	★	★	★	★	<									
EGA_Wedgetail ❶, Illabo ❶, Kittyhawk ❶, Naparoo ❶ Severn ❶		>	>	★	★	★	★	★	★	<									
Sunlamb				>	★	★	★	★	<										
Longsword ❶				>	★	★	★	★	★	<									
Sunmax					>	★	★	★	<	<									
Lancer, Raider, Stealth, Sunflex, Valiant CL Plus						>	★	★	★	★	<								
Coota, Coolah, DS Faraday, EG Titanium, EGA_Gregory, Flanker, Gazelle, Mitch, RGT Zanzibar, Rockstar, Scotch, Sheriff CL Plus,							>	★	★	★	<								
Beckom, Boree, Elmore CL Plus, Impala, Oryx, Reliant, Scepter, Sunblade CL Plus, Sunmaster, Suntop									>	★	★	★	★	<					
Calibre, Condo, Hellfire, Jillaroo, LG Gold, Mustang, Spitfire, Suncentral, Sunchaser, Sunprime, Vixen											>	★	★	★	★	<	<		
Plains																			
EGA_Wedgetail ❶, Illabo ❶, Kittyhawk ❶, Longsword ❶, Naparoo❶, Sunlamb				>	★	★	★	★	<										
Sunmax						>	★	★	★	<									
Raider, Sunflex, Valiant CL Plus						>	>	★	★	★	★	<	<						
Coota, Coolah, DS Faraday, EG Titanium, EGA_Gregory, Flanker, Gazelle, Lancer, Mitch, Rockstar, Sheriff CL Plus, Stealth								>	★	★	★	<							
Beckom, Gauntlet									>	★	★	★	<						
Boree, Elmore CL Plus, Impala, Oryx, Reliant, Scepter, Sunblade CL Plus, Sunmaster, Suntop									>	★	★	★	★	<	<				
Calibre, Condo, Emu Rock, Hellfire, Jillaroo, LG Gold, Mustang, Spitfire, Suncentral, Sunchaser, Sunprime, Vixen											>	★	★	★	★	<			

> Earlier than ideal, but acceptable.

★ Optimum sowing time.

< Later than ideal, but acceptable.

❶ Winter wheat sowing window can be extended earlier, provided crops are grazed to delay reproductive development.

Note: For durum suggested sowing times see Table 21. Suggested sowing times, Durum wheat varieties. on page 38.

Southern NSW – Wheat variety performance

Yield performance experiments from 2018–2022.

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 2018–2022. Further results can be found on the NVT website.

Table 13. Long season varieties (southern): Compared with EGA_Wedgetail = 100%.

South east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% EGA_Wedgetail (t/ha)	**5.30**	**2.75**	**5.55**	**6.52**	**5.48**	**5.40**	
Anapurna [1]	–	90	126	131	162	134	14
BigRed [1]	–	–	–	130	166	133	8
DS Bennett [1]	110	110	107	114	111	111	15
EGA_Wedgetail [1]	**100**	**100**	**100**	**100**	**100**	**100**	**15**
Illabo [1]	99	110	114	117	119	115	15
Longsword [1]	97	105	106	103	100	103	15
LRPB Kittyhawk [1]	96	–	103	101	113	104	13
LRPB Nighthawk	97	100	108	110	119	110	15
Manning [1]	114	66	110	107	141	115	15
Naparoo [1]	97	90	91	95	105	96	15
RGT Accroc [1]	113	93	124	131	155	132	15
RGT Cesario [1]	–	–	124	128	160	131	12
RGT Waugh [1]	–	–	124	124	167	131	12
Severn [1]	97	–	–	109	120	110	9
Sunlamb	101	104	–	–	–	102	3

[1] Winter wheat.

Table 14. Early season variety trial results (sown before 15 May): Compared with EGA_Gregory = 100%.

South east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% EGA_Gregory (t/ha)	**2.73**	**1.40**	**5.26**	**5.87**	**5.32**	**4.41**	
Catapult	117	139	119	110	96	111	24
Coolah	107	106	115	109	107	110	24
Coota	–	137	114	104	95	107	22
Cutlass	109	115	115	113	108	112	24
DS Bennett [1]	108	86	–	–	–	124	7
DS Faraday	99	105	99	98	100	100	24
DS Pascal	103	97	121	114	117	115	24
EG Titanium	104	109	106	100	96	101	24
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**24**
EGA_Wedgetail [1]	99	79	110	108	112	107	24
Illabo [1]	101	87	121	116	122	116	24
Longsword [1]	107	112	117	113	112	114	24
LRPB Flanker	101	97	106	105	107	105	24
LRPB Kittyhawk [1]	102	–	111	108	108	107	19
LRPB Lancer	102	109	111	101	101	104	24
LRPB Nighthawk	102	84	118	115	119	115	24
LRPB Raider	–	–	115	111	110	111	17
LRPB Stealth	–	109	112	105	108	108	22
LRPB Trojan	111	132	114	104	96	108	24
Rockstar	–	132	129	117	110	120	22
Scotch [2]	–	–	–	118	122	120	11
Sheriff CL Plus	–	132	115	105	97	108	22
Sunflex	112	108	124	–	111	117	18
Valiant CL Plus	–	–	126	118	114	118	17
Feed wheats							
BigRed [1]	–	–	–	139	156	136	11
RGT Zanzibar	109	100	136	132	138	131	24
Severn [1]	101	–	–	117	123	116	13

[1] Winter wheat.
[2] Soft/biscuit wheat variety.

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

South west ❶							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% EGA_Gregory (t/ha)	6.67	2.95	5.21	5.35	4.83	4.78	
Catapult	111	134	114	122	101	115	29
Coolah	102	121	107	113	107	110	29
Coota	–	131	111	118	101	113	27
Cutlass	106	113	112	115	109	111	29
DS Bennett ❶	98	116	–	–	–	116	8
DS Faraday	102	101	–	–	–	101	8
DS Pascal	100	126	109	116	117	114	29
EG Titanium	101	117	101	106	98	104	29
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**29**
EGA_Wedgetail ❶	94	107	100	104	108	104	29
Illabo ❶	98	119	109	115	120	113	29
Longsword ❶	106	117	112	116	113	113	29
LRPB Flanker	100	103	103	104	106	104	29
LRPB Kittyhawk ❶	95	–	100	106	104	104	23
LRPB Lancer	102	128	103	111	105	109	29
LRPB Nighthawk	97	113	107	112	116	110	29
LRPB Raider	–	–	108	112	110	110	21
LRPB Stealth	–	119	107	111	110	110	27
LRPB Trojan	110	131	110	117	102	113	29
Rockstar	–	141	119	129	114	123	27
Scotch ❷	–	–	–	120	123	118	14
Sheriff CL Plus	–	130	111	117	102	113	27
Sunflex	103	130	112	–	110	115	22
Valiant CL Plus	–	–	114	122	114	117	21
Feed wheats							
BigRed ❶	–	–	–	122	145	122	14
RGT Zanzibar	106	120	124	128	136	126	29

❶ Winter wheat.
❷ Soft/biscuit wheat variety.

Table 16. Main season variety trial results – Southern (sown after 14 May): Compared with EGA_Gregory = 100%.

South east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% EGA_Gregory (t/ha)	2.65	1.10	5.45	5.80	5.67	4.31	
BASF Kingston	–	–	–	–	107	115	5
BASF Reilly	–	–	–	–	107	113	5
Beckom	119	154	117	115	112	117	25
Boree	–	–	117	107	99	113	17
Brumby	–	–	–	115	109	118	11
Calibre	–	–	114	112	104	117	17
Condo	102	140	110	110	110	111	25
Coolah	105	99	111	107	105	107	25
Coota	–	130	111	102	92	104	23
Corack	113	155	115	110	107	114	14
DS Faraday	102	101	102	–	–	101	25
EG Titanium	107	105	97	99	95	98	25
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**25**
Elmore CL Plus	100	100	104	105	103	103	25
Emu Rock	107	152	–	–	–	106	8
Hammer CL Plus	–	–	99	103	97	104	17
LRPB Anvil CL Plus	–	–	–	105	95	109	11
LRPB Cobra	99	114	116	–	–	109	14
LRPB Flanker	102	101	104	104	105	104	25
LRPB Hellfire	105	128	100	101	96	102	25
LRPB Impala ❷	102	135	102	–	–	109	14
LRPB Mustang	106	135	105	103	99	105	25
LRPB Oryx ❷	–	145	107	111	111	112	20
LRPB Parakeet	–	130	95	103	100	101	23
LRPB Raider	–	–	109	107	104	107	17
LRPB Reliant	103	133	94	100	98	100	25
LRPB Spitfire	93	112	97	101	96	99	25
Razor CL Plus	103	161	107	107	98	108	25
Rockstar	–	165	121	113	105	117	23
Scepter	116	172	118	113	106	116	25
Sunblade CL Plus	–	130	118	116	111	116	23
Suncentral	–	122	119	114	112	116	23
Sunchaser	103	126	105	105	104	106	25
Sunmaster	–	122	123	120	119	121	23
Sunprime	105	141	101	102	97	103	25
Suntop	103	106	–	110	107	109	19
Vixen	119	190	120	108	97	114	25

❶ Winter wheat.
❷ Soft/biscuit wheat variety.

Table 17. Main season variety trial results – Southern (sown after 14 May): Compared with EGA_Gregory = 100%.

South west ❸							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% EGA_Gregory (t/ha)	**4.25**	**2.69**	**4.47**	**5.25**	**5.20**	**4.48**	
Ballista	–	137	112	117	113	116	34
BASF Kingston	–	–	–	–	107	114	9
BASF Reilly	–	–	–	–	107	112	9
Beckom	110	134	114	115	111	115	38
Boree	–	–	114	117	104	114	27
Brumby	–	–	–	117	110	116	18
Calibre	–	–	114	118	106	116	27
Condo	104	108	106	106	111	108	38
Coolah	103	118	107	107	105	107	38
Coota	–	133	109	110	93	107	34
Corack	109	122	112	–	–	112	20
DS Faraday	101	101	–	–	–	101	11
EG Titanium	102	120	100	103	92	101	38
EGA_Gregory	**100**	**100**	**100**	**100**	**100**	**100**	**38**
Elmore CL Plus	101	115	102	103	101	103	38
Emu Rock	105	121	–	–	–	106	11
Hammer CL Plus	–	–	102	106	97	104	27
LRPB Anvil CL Plus	–	–	–	113	99	109	18
LRPB Cobra	103	130	110	109	103	109	31
LRPB Flanker	101	101	102	102	105	103	38
LRPB Hellfire	103	119	102	104	95	103	38
LRPB Impala ❷	101	110	100	–	–	105	20
LRPB Mustang	105	117	106	106	99	105	38
LRPB Oryx ❷	104	114	104	107	111	108	10
LRPB Parakeet	100	112	96	102	99	101	36
LRPB Raider	–	–	106	107	103	107	27
LRPB Reliant	102	108	98	101	96	100	38
LRPB Spitfire	99	116	97	101	95	100	38
Razor CL Plus	105	130	106	109	99	107	38
Rockstar	–	141	115	119	108	117	34
Scepter	111	139	114	117	107	115	38
Sunblade CL Plus	–	139	113	114	109	115	34
Suncentral	–	126	114	113	113	114	34
Sunchaser	104	106	105	103	104	104	38
Sunmaster	–	136	117	114	117	118	34
Sunprime	104	116	102	105	97	103	38
Suntop	103	122	–	106	106	108	29
Vixen	112	139	116	119	102	115	38
Feed wheats							
RGT Zanzibar	104	123	114	111	128	117	31

❷ Soft/biscuit wheat variety.
❸ Includes irrigated trials.

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Medicago littoralis

Powdery mildew resistant, SU residue tolerant strand medic

Seeding Rate	**kg/ha**
Dryland	10-15
High Rainfall/Irrigation	15-20

Seed Treatment
Goldstrike LongLife®

Usage
Regenerating annual pastures

Features & Benefits
Excellent early vigour and winter production
Tolerant to SU herbicide residue and resistant to powdery mildew
Good adaptation to alkaline sandy loam in low rainfall
Palatable at all growth stages

Emperor Barrel Medic

Medicago truncatula

Late maturing barrel medic with Powdery Mildew resistance

Seeding Rate	**kg/ha**
Dryland	10-15
High Rainfall/Irrigation	15-20

Seed Treatment
Goldstrike LongLife®

Usage
Grazing and hay production

Features & Benefits
Powdery Mildew resistant
Excellent dry matter production and grazing recovery
Good grazing tolerance
Product developed in collaboration with MLA, S&W & SARDI

Penfield Barrel Medic

Medicago truncatula

Early maturing spineless barrel medic with SU herbicide residue tolerance

Seeding Rate	**kg/ha**
Dryland	10-15
High Rainfall/Irrigation	15-20

Seed Treatment
Goldstrike LongLife®

Usage
Grazing and hay production

Features & Benefits
Spineless barrel medic
SU herbicide residue tolerance
First medic variety with elite combination of spineless trait and SU herbicide residue tolerance in a barrel medic
Product developed in collaboration with MLA, S&W & SARDI

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Suggested sowing times – Southern NSW

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 vary 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 18. 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																			
Anapurna ❶, Mackellar ❶, Manning ❶, RGT Accroc ❶, RGT Cesario ❶, RGT Waugh ❶	>	★	★	★	★	★	★	★	<										
BigRed ❶, DS Bennett ❶		>	★	★	★	★	★	★	★	<									
EGA_Wedgetail ❶, Illabo ❶, Kittyhawk ❶, Naparoo ❶, Severn ❶		>	>	★	★	★	★	★	★	<									
Nighthawk, Sunlamb				>	★	★	★	★	<										
Longsword ❶				>	★	★	★	★	★	<									
Sunmax					>	★	★	★	<										
Cutlass, DS Pascal, Sunflex, Valiant CL Plus						>	★	★	★	★	<								
Catapult, Coolah, Coota, DS Faraday, EG Titanium, EGA_Gregory, Flanker, Gazelle, Lancer, RGT Zanzibar, Raider, Rockstar, Scotch, Sheriff CL Plus, Stealth							>	★	★	★	★	<							
Beckom, BASF Kingston, Brumby, Sunblade CL Plus, Sunmaster, Suntop, Trojan								>	★	★	★	<							
Boree, BASF Reilly, Calibre, Corack, DS Tull, Elmore CL Plus, Impala, Oryx, Parakeet, Reliant, Scepter, Sunchaser									>	★	★	★	★	<					
Anvil CL Plus, Condo, Emu Rock, Hammer CL Plus, Hellfire, Mustang, Razor CL Plus, Spitfire, Suncentral, Sunprime, Vixen										>	★	★	★	★	<				
Plains																			
DS Bennett ❶			>	★	★	★	★	<	<										
EGA_Wedgetail ❶, Illabo ❶, Kittyhawk ❶, Nighthawk, Sunlamb				>	★	★	★	★	<	<									
Longsword ❶				>	★	★	★	★	★	<									
Sunmax					>	★	★	★	<										
Cutlass, DS Pascal, Raider, Sunflex, Valiant CL Plus						>	★	★	★	★	<								
Catapult, Coolah, Coota, DS Faraday, EG Titanium, EGA_Gregory, Flanker, Gazelle, Lancer, Rockstar, Scotch, Sheriff CL Plus, Stealth							>	★	★	★	★	<							
Beckom, BASF Kingston, Brumby, Boree, Elmore CL Plus, Mace, Reliant, Scepter, Sunblade CL Plus, Sunmaster, Suntop, Trojan								>	★	★	★	<							
Ballista, BASF Reilly, Calibre, Cobra, Corack, DS Tull, Hammer CL Plus, Impala, Oryx, Parakeet, Sunchaser									>	★	★	★	<	<					
Anvil CL Plus, Condo, Emu Rock, Hellfire, Mustang, Razor CL Plus, Spitfire, Suncentral, Sunprime, Vixen									>	>	★	★	★	★	<				

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

❶ Winter wheat sowing window can be extended earlier, provided crops are grazed to delay reproductive development.

Note: For durum suggested sowing times see Table 21, Suggested sowing times, Durum wheat varieties. on page 38.

Table 19. Wheat varietal characteristics and reaction to diseases (page 1 of 3)

Variety	Maximum quality classification		Resistances and tolerances																		Origin	Year of release
	Northern zone	Southeastern zone	Crown rot	Common root rot[4]	Leaf rust[8]	Stem rust	Stripe rust[5,6]	Powdery mildew[9]	Septoria tritici blotch	Yellow leaf spot	RLN *P. thornei* resistance	RLN *P. thornei* tolerance	RLN *P. neglectus* resistance	RLN *P. neglectus* tolerance	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance		
Bread wheat																						
Ballista	AH	AH	S	MS	S	MR	MS–S	S–VS	S–VS	MS	MR–MS	MI	S	MT–MI	MR–MS	MR–MS [1]	MS–S [1]	MR [1]	–	AGT	2020
BASF Kingston	NYC	NYC	S	–	S	S	MS–S	S	S	MS–S	MR–MS	MT–MI	S	MT–MI	R	S [1]	–	MR [1]	–	BASF	2022
BASF Reilly	NYC	NYC	S	–	MS–S	MR	MS	S	S	S	MS–S	MT–MI	MS	MT–MI	R	MR [1]	–	MR–MS [1]	–	BASF	2023
Beckom	AH	AH	S	MS–S	MS–S	MR–MS	MR–MS	MS–S	S	MS–S	MS–S	T–MT	S	MT–MI	R	MR–MS	MS–S	MR–MS	T–MT	AGT	2015
Boree	APH	APH	S	–	S	MR	S–VS	S–VS	S–VS	MR–MS	MS–S	MI–I	S	I	MS–S	–	–	–	–	AGT	2021
Brumby	NYC	NYC	S	–	S–VS	MR	MS	R & S	S	MR–MS	MS	MI	MR–MS	T–MT	MR–MS	–	–	–	–	InterGrain	2022
Calibre	FEED	APH	S	–	S	MR	S	S	S	MR–MS	MS–S	MI	S	MT	MR–MS	–	–	–	–	AGT	2021
Catapult	AH	AH	MS–S	MS	S	MR	S	S	MS–S	MR–MS	MS	MT	S	MI–I	R	MS–S	MS–S	MR–MS	MT	AGT	2019
Condo	AH	AH	S	MS–S	S	MR	MS	MS	S	MS	MS	T–MT	S	MT	MR	MS	S	MR–MS	MT	AGT	2014
Coolah	APH	APH	MS–S	S	R–MR	MR	MS–S	MS–S	MS–S	MS–S	MS	MT	S	MT	S	S	S	MR–MS	MT	AGT	2016
Coota	APH	APH	MS–S	MS	MR	R–MR	S	S	S	MS–S	MS	MT–MI	MR	MI	MR	MR [1]	MS–S [1]	MR [1]	–	AGT	2020
DS Bennett	FEED	ASW	VS	S	S–VS	MS	S	R	MS–S	MR–MS	S	–	S	–	S	MS–S	–	–	–	S&W Seed Co.	2018
DS Faraday	APH	APH	MS–S	S	R [8]	R–MR	MS	–	MS–S	MS–S	MS–S	MT	S	MT–MI	MS	MS–S	–	–	–	S&W Seed Co.	2016
DS Pascal	AH	APW	S	MS	MS	MS–S	MR–MS	R–MR	MS–S	MS	S	I–VI	S	MT–MI	S	MS	–	–	–	S&W Seed Co.	2015
EG Titanium	APW	FEED	MS–S	–	MS	MS	MR	S	MS–S	MS–S	MS–S	MT–MI	MS–S	MT–MI	R	MS–S	–	–	–	EPG Seeds	2020
EGA_Gregory	APH	APH	S	MS–S	R–MR[8]	MR	MS	MR–MS	MS–S	S	MS–S	MT	S	MT	S	MS–S	S	MS–S	MT	EGA	2004
EGA_Wedgetail	AH	APH	S	–	MS–S	MR–MS	MS	MR–MS	MS–S	MS–S	VS	MI–I	S	MI–I	S	MS	S	MR	T–MT	EGA	2002
Emu Rock	APW	AH	MS–S	MS	S–VS	MS	S–VS	MS–S	S	MS	S	I–VI	MS–S	MI	S	MS–S	–	MR	–	InterGrain	2011
Hammer CL Plus	FEED	AH	MS–S	MS–S	S	MR	MS	S	MS–S	MR–MS	S	I	MS–S	MT–MI	MR–MS	MR–MS[1]	MS–S [1]	MR–MS [1]	–	AGT	2020
Illabo	AH	APH	S	MS–S	S	MR–MS	MR–MS	R	MS–S	MS	MS–S	MI–I	MS–S	VI	MR–MS	MR–MS	MS [1]	MR [1]	MT [1]	AGT	2018
Jillaroo	AH	FEED	S	–	S	MS	MS–S	S–VS	S	MR–MS	MS [1]	I	S	I	MS	–	–	–	–	InterGrain	2022
Longsword	AWW	AWW	MS–S	MS	MR[8]	MR	R & S	S	MS	MR–MS	MR–MS	MI	MR–MS	VI	MR–MS	MS	–	MR–MS [1]	MT–T	AGT	2018
LRPB Anvil CL Plus	NYC	NYC	MS–S	–	S–VS	MR	S	VS	VS	MS–S	S	VI	MS–S	MI–I	MR–MS	–	–	–	–	LongReach	2022
LRPB Cobra	APW	AH	S	MS	MR[8]	MR	S	MS–S	MS–S	MR–MS	MS–S	MI	MS–S	MT–MI	MS	MS–S	S	R–MR	MT	LongReach	2011
LRPB Flanker	APH	APH	MS–S	MS–S	R–MR[8]	MR	MR–MS	MS–S	MS–S	MS–S	MS–S	MT	S	MT	S	MS	S	S	–	LongReach	2015
LRPB Hellfire	APH	APH	MS–S	MS–S	MS–S	MR	MR–MS	S	S	MS–S	MS–S	MI	MS–S	MT–MI	MS	MS–S	MS–S [1]	MR [1]	MT–MI [1]	LongReach	2019
LRPB Kittyhawk	APH	APH	S–VS	S	MR	MR–MS	MR	MS	MR–MS	MR–MS	S	I	S	MI	S	MR–MS	S	MR	MT–MI	LongReach	2016
LRPB Lancer	APH	APH	MS–S	S	R–MR[8]	R	R–MR	R	MS	MS	MS	T–MT	S	MT–MI	S	MR–MS	MS–S [1]	MR	MI–I	LongReach	2013
LRPB Mustang	APH	APH	MS–S	MS	MS–S	MR–MS	MR	MS–S	S	MS–S	MS–S	MT–MI	S	MI	MR	MS	–	MR[1]	–	LongReach	2017
LRPB Nighthawk	NYC	AH	MS–S	MS–S	MS–S	R–MR	MR–MS	S–VS	MS	MS	MS	MI	MS–S	I–VI	MS	MS	S [1]	R–MR [1]	MI [1]	LongReach	2019
LRPB Raider	APH	APH	S	–	R–MR	R–MR	MR	MS–S	S	MS–S	MS	MT	MS–S	MT–MI	S	MS [1]	MS–S [1]	MR–MS [1]	MI [1]	LongReach	2021
LRPB Reliant	APH	AH	MS	MS–S	R–MR	R	MR	MR	MS–S	S	MS–S	T–MT	S–VS	MT–MI	MS–S	MS	S	MS [1]	MI [1]	LongReach	2016
LRPB Spitfire	APH	APH	MS	MS–S	S	MR	MR	MS–S	S	S	MS	MT–MI	MS–S	MI	MS	MS–S	MS	MR–MS	MT–MI	LongReach	2010
LRPB Stealth	APH	APH	MS–S	MS–S	R–MR[8]	R	R–MR	MS	MS–S	MS	S	MT–MI	MS–S	MT–MI	S	R–MR [1]	MS–S [1]	MR–MS [1]	MI [1]	LongReach	2020
LRPB Trojan	ASW	APW	MS	MS	MR[8]	MR–MS	S	S	S	MS–S	MS–S	MI	MS–S	MT	MS	MS	S	MR–MS [1]	MT–MI	LongReach	2013
Mace	AH	AH	S	MS	S	MR–MS	S–VS	MS–S	S–VS	MR–MS	MS	MT	MS	MI–I	MR–MS	MR–MS	MS–S	MR–MS	MT	AGT	2007

Table 19. Wheat varietal characteristics and reaction to diseases (page 2 of 3).

Variety	Maximum quality classification		Resistances and tolerances																	Origin	Year of release
	Northern zone	South-eastern zone	Crown rot	Common root rot❹	Leaf rust❽	Stem rust	Stripe rust ❺❻	Powdery mildew ❾	Septoria tritici blotch	Yellow leaf spot	RLN *P. thornei* resistance	RLN *P. thornei* tolerance	RLN *P. neglectus* resistance	RLN *P. neglectus* tolerance	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance		
Razor CL Plus	FEED	ASW	S	MS–S	S	MR–MS	MS	S	S–VS	MS–S	MS	MI	S	MT	MR	MS	MS ❶	MR	MT	AGT	2018
Rockstar	APH	APH	S	MS–S	S	MR–MS	S	S–VS	S	MR–MS	MS	MI	MR–MS	I	MS–S	MS–S ❶	–	MR ❶	–	InterGrain	2019
Scepter	AH	AH	MS–S	MS	MS–S	MR–MS	MS–S	S–VS	S	MR–MS	MS–S	MT	S	MT–MI	MR–MS	MS	MS–S	MR	MT	AGT	2015
Sheriff CL Plus	APW	APW	S	MS	S–VS	MS	S	S–VS	S	MR–MS	MR–MS	I	MR–MS	MT–MI	MS	MS	–	MR ❶	–	InterGrain	2018
Sunblade CL Plus	APH	APH	S	S	MS–S	MS	MR–MS	S–VS	S	MS–S	MR–MS	MT	MS–S	MI	MS–S	MR ❶	S ❶	MR–MS ❶	–	AGT	2020
Suncentral	APH	APH	MS–S	MS	R–MR	MR–MS	MS–S	S–VS	S	MS–S	MR–MS	MT	MR–MS	MI	S	R–MR ❶	S ❶	MR–MS ❶	–	AGT	2020
Sunchaser	APH	APH	MS–S	MS–S	R	MR	R–MR	VS	MS–S	MS	MS–S	MT	MS–S	MT–MI	MS–S	MR–MS	MS–S ❶	MR–MS	–	AGT	2019
Sunflex	APH	AH	MS–S	S❶	R–MR & S	MR	MR–MS	S	S–VS	MS	MS–S	MI	S	MI	MS	MS–S	MS–S ❶	MR ❶	–	AGT	2020
Sunmaster	APH	APH	S	MS	R–MR❽	MS	MR–MS	S	S	MS–S	MS	T–MT	MR–MS	MT–MI	MS–S	R–MR ❶	S ❶	MR–MS ❶	–	AGT	2020
Sunmax	APH	APH	MS–S	MS–S	MS	MR–MS	R–MR	S	MS–S	MS–S	MS	MI	S	MT	MR–MS	MR–MS	MS–S ❶	MR–MS	T–MT	AGT	2016
Sunprime	APH	APH	S	MS–S	MR❽	MS	MS	–	S	MS–S	S	MT	S	MT–MI	MS	MS–S	MS–S ❶	MR–MS	MT❶	AGT	2018
Suntop	APH	APH	MS–S	MS	MR	MR–MS	MR–MS	S	MS–S	MS–S	MR–MS	T–MT	S	MT	S	MS–S	S	MR–MS	MT	AGT	2012
Valiant CL Plus	NYC	NYC	S	–	S	MR	MS–S	VS	MS–S	MR–MS	S ❶	I–VI	S	MI–I	MS–S ❶	–	–	–	–	InterGrain	2020
Vixen	AH	APH	S	MS	S–VS	MR–MS	S–VS	S–VS	S	MR–MS	MS	I	MR–MS	I	MS–S	MS–S	–	MR ❶	–	InterGrain	2018
Feed wheat																					
Anapurna	FEED	FEED	S–VS	MS–S	MS	MS–S	R–MR	R–MR	MR–MS	MR–MS	S ❶	–	MS	–	MR–MS	S ❶	MR ❶	R–MR ❶	–	AGT	2020
BigRed	FEED	FEED	S ❶	–	MR–MS	S	R–MR	R–MR	MR	MR	MS	–	MS	–	S	–	–	–	–	AGF Seeds	2021
Borlaug 100	FEED	FEED	MS–S	–	MR	MR	S–VS	–	MS–S	MR–MS	MS	T	S	T	MS	MS–S	–	–	–	Rebel Seeds	2018
Manning	FEED	FEED	VS	S–VS	MS–S	MR	R–MR	MS	MR–MS & S	MR–MS	S	–	MS–S	–	S	S	–	–	–	CSIRO	2013
RGT Accroc	FEED	FEED	S–VS	–	S–VS	MS	R–MR	MS–S	MS	MR–MS	MS–S	–	S	–	S	MR–MS	–	R–MR	–	RAGT	2016

– Insufficient data

❶ Data relating to these varieties is based on limited testing and is to be considered provisional information.

NYC No grain quality classification in NSW currently.

❹ GRDC NVT have discontinued with screening for these diseases, ratings shown in the guide are 2020 ratings.

❺ Varieties with a second rating separated by a '&' show the reaction to different pathotypes if they are present in the region.

Stripe rust

❻ The stripe rust rating shown are the most susceptible reaction of the variety to the pathotypes currently present in NSW (198 E16 A+ J+ T+ 17+, 239 E237 A– 17+ 33+, 238 E191 A+ 17+ 33+ ,134E16A+17+, 134E16A+17+ 27+ and 64E0A-).

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

Leaf rust

❽ (Warning) May be more susceptible to alternate pathotypes.

Powdery mildew

❾ (Warning) Ratings are a concensus rating based on 2018 to 2022 ratings.

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.

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.

Stripe rust ratings – what do they mean?

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

Figure 5. Stripe rust ratings.

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 2 forms of resistance.

1. **Seedling [All stage resistance (ASR)] 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 (all stage) 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 19. Wheat varietal characteristics and reaction to diseases (page 3 of 3).

Variety	Maximum quality classification		Resistances and tolerances																	Origin	Year of release
	Northern zone	South-eastern zone	Crown rot	Common root rot❹	Leaf rust❽	Stem rust	Stripe rust ❺❻	Powdery mildew ❾	Septoria tritici blotch	Yellow leaf spot	RLN *P. thornei* resistance	RLN *P. thornei* tolerance	RLN *P. neglectus* resistance	RLN *P. neglectus* tolerance	CCN resistance	Black point	Sprouting	Lodging	Acid soils tolerance		
RGT Cesario	FEED	FEED	VS	–	R–MR ❶	R	R–MR	R–MR	MR–MS	MR	MS–S	–	MR–MS	–	MS–S ❶	–	–	–	–	RAGT	2021
RGT Waugh	FEED	FEED	S	–	S	MS	R–MR	R	MR–MS	MR–MS	MS–S	–	MS	–	MS	–	–	–	–	RAGT	2022
RGT Zanzibar	FEED	FEED	S	S	S–VS	VS	MR–MS	MR	MS–S	MS	MS ❶	MI	S	I–VI	MS–S	MR–MS	–	–	–	RAGT	2017
SEA Condamine	FEED	FEED	MS–S	–	R–MR ❽	MR–MS	MS–S	–	VS	MS–S	MS	MT	S	MT	S	MR–MS	–	–	–	SEA and UQ	2018
Severn	FEED	FEED	S	–	MR–MS	MS	R–MR	R–MR	MS–S	MR–MS	MR–MS	–	S	–	MS–S ❶	MR	–	–	–	S&W Seeds	2021
Durum																					
Bitalli	FEED	ADR	S–VS	MS	MR	R–MR	MR–MS	S	MS–S	MR–MS	R–MR	MI–I	MS–S	MI	MS–S	MS	–	–	–	AGT	2019
Caparoi	ADR	ADR	VS	–	R–MR	MR	MS	S	MR–MS & S	MR	MR	MT	MS	MI	MR–MS ❶	MS–S	MR	MR–MS	VI	NSW DPI	2008
DBA Bindaroi	ADR	FEED	S–VS	MS–S	MR	MR	MS	S–VS	MS	MR–MS	MR	MT–MI	MR–MS	MI	MS	MR–MS	–	–	–	DBA	2017
DBA Lillaroi	ADR	ADR	S–VS	MS–S	R–MR	R–MR	MS	MS	S	MR–MS	R–MR	MT	MR–MS	MI	S	MS	–	–	–	DBA	2014
DBA Mataroi	ADR	FEED	S–VS	–	MR	MR	MS	S	MS–S	MR–MS	R–MR	MI	MS	MT	MR–MS	MR–MS	–	–	–	DBA	2021
DBA Vittaroi	ADR	ADR	S–VS	MS–S	R–MR	MR	MS	MR–MS	MS–S	MR–MS	MR	MI	MS	I	S	MS–S	–	MR	–	DBA	2017
Westcourt	ADR	ADR	VS	MR–MS	R–MR	R–MR	MR	S	S	MR–MS	MR	MT	MS	MI	MS–S	MS–S	–	MS	–	AGT	2019
Noodle wheat																					
LRPB Parakeet	NYC	ANW	MS–S	MR–MS	R	MR	MR	S–VS	S–VS	MS–S	S	MI–I	MR–MS	MT	MS	MS	S ❶	MR–MS ❶	MT–MI	LongReach	2019
Soft domestic																					
LRPB Impala	ASFT	ASFT	MS–S	MS–S	S–VS	MR	MR–MS	R	S–VS	MS–S	S	MI–I	S–VS	MT–MI	MS–S	MS	MS–S	MR–MS	MT–MI	LongReach	2011
LRPB Oryx	ASFT	ASFT	MS–S	MS–S	R–MR ❽	MR	MS	–	S–VS	MS–S	MS–S	I–VI	MS–S	MI–I	S	MS	–	–	–	LongReach	2018
Scotch	NYC	NYC	S	–	MR ❶	MS–S	MR–MS ❶	MR	S ❶	MR–MS	S	MT–MI	MS	MT–MI	MS	–	–	–	–	LongReach	2022

– Insufficient data

❶ Data relating to these varieties is based on limited testing and is to be considered provisional information.

NYC No grain quality classification in NSW currently.

❹ GRDC NVT have discontinued with screening for these diseases, ratings shown in the guide are 2020 ratings.

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

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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.

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.

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 timetables.

Caution: these varietal descriptions should be read in conjunction with the current disease ratings in Table 19.

Refer to the chapter on Durum on page 37 for notes on durum varieties.

Milling wheat varieties

BallistaΦ. Australian Hard quality in NSW. Ballista^{Φ} is suited to the low rainfall and Mallee regions of NSW, showing yield improvements over Scepter^{Φ}. Quick-mid maturity variety, slightly quicker than Mace^{Φ}. AGT.

BeckomΦ. 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.

BoreeΦ. Australian Prime Hard quality in NSW. A mid season spring wheat with maturity between Beckom^{Φ} and Scepter^{Φ}. Broadly adapted and suits a range of pH, soil types and environments. High yield potential, medium plant height with good straw strength. AGT.

CatapultΦ. Australian Hard quality in NSW. Catapult^{Φ} is a mid late-maturing variety. Yield potential is highest when sown from late April to early May, but has shown good flexibility maintaining a similar yield potential to Scepter^{Φ} when sown or emerging later in May. Catapult^{Φ} has tolerance to acid soils, produces large and consistent grain size, resulting in low screenings and high test weight. AGT.

CalibreΦ. Australian Prime Hard quality in southern NSW. High yielding, quick mid-maturity spring wheat, slightly quicker than Scepter^{Φ}. Calibre^{Φ} is derived from Scepter^{Φ} and has shown the similar adaption to growing regions of southern NSW. Good sprouting tolerance, similar to Scepter^{Φ} and with a longer coleoptile length than many commonly grown varieties. AGT.

CondoΦ. 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.

CoolahΦ. Australian Prime Hard quality in NSW. It is a high yielding variety 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.

CootaΦ. Australian Prime Hard quality in NSW. Coota^{Φ} is a high yielding mid slow-maturing variety suited to the end of April to the beginning of May sowing window. It exhibits very low screenings, high test weights and good blackpoint resistance. Short plant height, it has shown good resistance to lodging. AGT.

DS BennettΦ. **Note** – Winter wheat on page 33. Australian Standard White quality in southern NSW. It is a high yielding winter wheat, with photoperiod sensitivity, which generally flowers 7–10 days later than EGA_Wedgetail^{Φ}. The sowing window for DS Bennett^{Φ} is from mid March until early May. Suited to both grazing and grain production, or straight grain production. DS Bennett^{Φ} is a tall, awnless wheat suited to the high and medium rainfall zones of NSW. S&W Seed Company.

DS FaradayΦ. Australian Prime Hard quality in NSW. This is a main season variety with a maturity similar to EGA_Gregory^{Φ}. DS Faraday^{Φ} has shown a yield improvement over EGA_Gregory^{Φ} in northern NSW environments. It has improved tolerance over EGA_Gregory^{Φ} to pre-harvest sprouting to manage the risk in a wet harvest. S&W Seed Company.

DS PascalΦ. Australian Premium White quality in southern NSW and Australian Hard quality in northern NSW. It 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. S&W Seed Company.

EG TitaniumΦ. Australian Premium White quality in northern NSW. An early–mid season variety that is targeted for early planting, but also has a flexible sowing time in the medium to higher rainfall areas. Good early plant vigour and harvestability. EPG Seeds.

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

EGA_WedgetailΦ. **Note** – Winter wheat on page 33. 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.

Elmore CL PlusΦ. Australian Hard quality in NSW. A mid maturing variety with Clearfield® Plus technology, which provides tolerance to label rates of Intervix® herbicide. Check current herbicide registrations for registered product rates and adhere to recommended plant growth stages for application timing. Has an adaptation pattern similar to Janz, providing an alternative strategy for in-crop weed control. AGT.

Emu RockΦ. Australian Hard quality 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.

Hammer CL PlusΦ. Australian Hard quality in southern NSW. A high yielding, quick-mid maturing variety tolerant to Clearfield® Intervix® herbicide. Closely related to widely adapted variety Mace[Φ] with similar adaption. Good physical grain package, with low screenings and high-test weight. Check current herbicide registrations for registered product rates and adhere to recommended plant growth stages for application timing. AGT.

IllaboΦ. **Note** – Winter wheat on page 33. Australian Prime Hard quality in southern NSW and Australian Hard quality in northern NSW. An EGA_Wedgetail[Φ] alternative suited to grazing and grain production, with higher grain yield potential. Mid fast winter maturity, Illabo[Φ] is 2–3 days quicker to maturity than EGA_Wedgetail[Φ]. Improved black point resistance over EGA_Wedgetail[Φ]. Tolerant of acid soils. AGT.

LongReach CobraΦ. 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 FlankerΦ. Australian Prime Hard quality in NSW. High yielding EGA_Gregory[Φ] type adapted to NSW where EGA_Gregory[Φ] 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_Gregory[Φ]. Reliable grain package with good test weights and sound for screenings. Pacific Seeds.

LongReach GauntletΦ. 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 HellfireΦ. Australian Prime Hard quality in NSW. Mid-quick maturing higher yielding main season variety with yield and protein accumulation similar to LRPB Spitfire[Φ]. Good grain package with large grain, high protein and low screenings. Medium plant height with good standability. Good early vigour. Pacific Seeds.

LongReach KittyhawkΦ. **Note** – Winter wheat on page 33. Australian Prime Hard 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 LancerΦ. Australian Prime Hard 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. Pacific Seeds.

LongReach MustangΦ. Australian Prime Hard quality in NSW. A high- yielding variety suited to NSW and QLD, with a reliable grain package similar to other prime hard main season varieties. Maturity similar to LRPB Spitfire[Φ]. Compact canopy with good straw strength maximises harvest efficiency and ease of stubble management. Pacific Seeds.

LongReach NighthawkΦ. Australian Hard quality in southern NSW. Slow maturing spring wheat with a unique set of maturity holds that allows it to be planted earlier in areas that don't suit the traditional winter wheat types. Demonstrated high yields throughout the late March to late April sowing window while maintaining yield in later sowings. Medium tall plant height with good standability. Pacific Seeds.

LongReach ParakeetΦ. Australian Noodle classification in southern NSW. Mid quick-maturing noodle wheat to suit main season planting windows with a similar maturity to LRPB LincolnΦ. Well suited to dry land and supplementary irrigation wheat production systems in NSW. Pacific Seeds.

LongReach RaiderΦ. Australian Prime Hard quality in NSW. A shorter, higher tillering capacity Longreach ReliantΦ plant type, which is showing high and stable yield performance across both early and main season planting dates. Slow spring maturity, best suited to mid April to early May sowing times across NSW. Bred by LongReach Plant Breeders and released by Pacific Seeds.

LongReach ReliantΦ. 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_GregoryΦ and LRPB CrusaderΦ. Tillering ability similar to EGA_GregoryΦ and tightly packed heads like LRPB CrusaderΦ. Reliable grain package with good grain size and test weight like EGA_GregoryΦ. Pacific Seeds.

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

LongReach StealthΦ. Australian Prime Hard quality in NSW. Mid-slow spring maturing variety similar to LRPB LancerΦ, adapted to the low–medium rainfall regions of NSW and QLD. The result of a dedicated cross to improve crown rot resistance in APH germplasm, LRPB StealthΦ shows improved crown rot tolerance and demonstrated yield stability in tough conditions. Medium plant height with similar growth and yield accumulation pattern as LRPB LancerΦ. Good black point resistance with a long coleoptile. Pacific Seeds.

LongReach TrojanΦ. 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.

LongswordΦ. **Note** – Winter wheat on page 33. Australian White wheat quality. LongswordΦ is a winter type and requires vernalisation as with other winter wheats. It has MaceΦ as a parent and is relatively quick to mature once vernalisation requirements have been met. The quicker maturity makes it suitable for low–medium rainfall environments in which traditional longer season winter wheats would not normally be grown. Most suited to April sowings and can be grazed, given its winter growth habit. Good physical grain package with low screenings and high test weights. AGT.

MaceΦ. 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.

Razor CL PlusΦ. Australian Standard White quality in southern NSW. High yielding early maturity variety tolerant to Clearfield® Intervix® herbicide, slightly quicker than its parent MaceΦ, similar in maturity to CorackΦ. Check current herbicide registrations for registered product rates and adhere to recommended plant growth stages for application timing. Good physical grain package, with low screenings and high test weight. AGT.

RockstarΦ. Australian Prime Hard quality in NSW. RockstarΦ is a high yielding mid–late flowering variety, with a similar flowering time to LRPB TrojanΦ. It has excellent yield stability across its sowing window, and very good lodging tolerance. RockstarΦ has good grain size, good test weight and has a moderate plant height, reducing stubble loads in high yielding environments. InterGrain.

ScepterΦ. Australian Hard quality in NSW. A mid maturing variety with high and stable yields across NSW. Medium plant type with good lodging resistance and a robust physical grain quality package. Moderately tolerant to acid soils with good pre-harvest sprouting tolerance. AGT.

Sheriff CL PlusΦ. Australian Premium White quality in NSW. A high yielding mid-late flowering wheat suited to late April to early May sowing, with moderate plant height and good physical grain characteristics, including good grain size and test weight. Sheriff CL PlusΦ incorporates the Clearfield® Plus technology, which provides tolerance to label rates of Intervix® herbicide. InterGrain.

Sunblade CL PlusΦ. Australian Prime Hard quality in NSW. First APH quality Clearfield® variety released for NSW, tolerant to Clearfield® Intervix® herbicide. Higher yielding alternative to Elmore CL PlusΦ with improved disease resistance. Derived from SuntopΦ with a similar maturity. Sunblade CL PlusΦ has a slightly shorter plant height compared with SuntopΦ with similar lodging resistance. Displays a similar or slightly smaller grain size to SuntopΦ. Check current herbicide registrations for registered product rates and adhere to recommended plant growth stages for application timing. AGT.

SuncentralΦ. Australian Prime Hard quality in NSW. SuncentralΦ is a quick mid-maturity variety comparable to LRPB SpitfireΦ and 4 days quicker than SuntopΦ. Higher yielding variety suited to later planting opportunities in northern NSW. Good ability to maintain yield in the presence of crown rot and RLN (*P. Thornei*) tolerance. AGT.

SunchaserΦ. Australian Prime Hard quality in NSW. SunchaserΦ is a high yielding alternative in the main season sowing window. SunchaserΦ has an improved grain package compared with SuntopΦ producing significantly lower screenings losses whilst maintaining high test weight. SunchaserΦ has improved disease resistance profile over SuntopΦ and features a moderately long coleoptile. AGT.

SunflexΦ. Australian Prime Hard quality in northern NSW and Australian Hard quality in southern NSW. SunflexΦ is a slow maturity variety best planted in the mid to late April window in NSW, up to one week earlier than CoolahΦ and LRPB LancerΦ. SunflexΦ exhibits a moderately long coleoptile and is adapted to the medium–high rainfall zones of NSW. SunflexΦ has a moderately short plant height and good lodging resistance consistently producing large grain with low screening losses. AGT.

SunlambΦ. 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_WedgetailΦ, and a few days earlier than NaparooΦ. Moderately intolerant of acid soils. AGT.

SunprimeΦ. Australian Prime Hard quality in NSW. Early maturing variety, similar to LRPB SpitfireΦ, SunmateΦ and LRPB MustangΦ. High yielding variety across NSW. Derived from a cross with EGA_GregoryΦ, similar adaptation across NSW, but with a quicker maturity and shorter plant height. Good physical grain package, including moderate to low screenings and high test weight. Good tolerance to RLN (*P. Thornei*). Moderately tolerant of acid soils. AGT.

SunmasterΦ. Australian Prime Hard quality in NSW. SunmasterΦ is a replacement variety for SuntopΦ, with similar maturity and planting window. SunmasterΦ has a shorter plant type than SuntopΦ, with good lodging tolerance. It has demonstrated consistently higher yield potential than SuntopΦ, with slightly lower screenings and similar test weight. SunmasterΦ has shown improved yield over SuntopΦ in AGT crown rot trials. AGT.

SunmaxΦ. Australian Prime Hard quality in NSW. It is a slow maturing spring wheat, slower in maturity than SunzellΦ, but quicker than the older variety Sunbrook. Best suited to a mid April sowing. It has proven to be a reliable early-sown option for the northern region for grain-only crops. Avoid sowing later than its preferred sowing window to limit the risk of excessive screenings. It has acid soils tolerance and improved lodging tolerance over EGA_GregoryΦ. AGT.

SuntopΦ. 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 environments. It is quicker maturing than EGA_GregoryΦ, similar in maturity to Janz. AGT.

Valiant CL PlusΦ. A high yielding slow maturity Clearfield® tolerant spring wheat with a similar maturity to CutlassΦ. Potential AH (pending classification in southern NSW). Valiant CL PlusΦ best performance has been observed when sown earlier. It has good grain size, test weight and a moderate plant height, and a longer coleoptile. InterGrain.

VixenΦ. Australian Hard quality in northern NSW and Australian Prime Hard quality in southern NSW. An early–mid maturity variety, similar in maturity to LRPB SpitfireΦ. Suited to sowing from mid May onwards in southern NSW. High yield potential, with very good lodging resistance and strong physical grain characteristics. It has good grain size and produces low screenings. VixenΦ has a short–moderate plant height, providing reduced stubble loads in high yielding environments. InterGrain.

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

BrumbyΦ. A potential APW wheat (pending classification in southern NSW) released in 2022. It is a mid maturing variety suited to sowing in early May. The variety has shown extremely low powdery mildew infection levels in high pressure disease environments in recent seasons. InterGrain.

JillarooΦ. Australian Hard classification northern NSW. A high yielding, quick mid-maturing spring wheat suited to northern NSW and southern Queensland. It features a moderate plant height with semi-erect growth habit. Jillaroo^{Φ} seed will be commercially available for 2023. InterGrain.

BASF KingstonΦ. It has a short plant height and good straw strength with a compact head resulting in outstanding lodging resistance and lower stubble residues to manage the following year. Similar maturity/days to heading as Scepter^{Φ}, followed by a slower finish, which has shown to result in a minimal yield penalty from an earlier sowing window. Potential AH variety for southern NSW. Seed available for the 2023 season. Bred by BASF and will be marketed by Seednet.

BASF ReillyΦ. The variety is bred from brand new genetics to Australia and has a synthetic parent. Potential AH classification for southern NSW. Medium height plant type bred with a capacity to thrive in low–medium rainfall environments. Similar maturity/days to heading as Scepter^{Φ} followed by a faster finish, which has shown to result in yield stability in tough conditions. Seed available for the 2023 season. Bred by BASF and will be marketed by Seednet.

LongReach Anvil CL PlusΦ. Quick maturity, two-gene imidazolinone-(IMI) tolerant wheat that can be sprayed at label rates of registered IMI herbicides. Good early vigour providing good weed competition. LRPB Anvil CL Plus^{Φ} has good grain size and is well suited to low–medium rainfall production systems providing a fast-maturing IMI-tolerant variety choice to growers. AH classification SA/Vic with southern NSW classification expected Autumn 2023. Bred by GIA, developed by LongReach Plant Breeders and released by Pacific Seeds.

Soft wheat varieties

LongReach GazelleΦ. Biscuit wheat. Australian Soft quality in NSW. Mid–late season maturity, similar to QAL2000^{Φ} and slightly quicker than Yenda^{Φ}. 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 ImpalaΦ. Biscuit wheat. Australian Soft quality in NSW. Quick to main season maturity, similar to Lincoln^{Φ} and Ventura^{Φ}. 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 OryxΦ. Biscuit wheat. Australian Soft quality in NSW. Early-mid maturing variety, marginally quicker to mature then LRPB Impala^{Φ}, suited to main season planting in dryland and supplementary irrigation soft wheat systems. LRPB Oryx^{Φ} has demonstrated reduced canopy heights over its parent LRPB Impala^{Φ}, improving harvest efficiencies and stubble management for growers. Improved leaf rust resistance over LRPB Impala^{Φ}. Good soft wheat grain package with low screenings, low protein accumulation and good test weight. Pacific Seeds.

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

ScotchΦ. Mid–slow spring maturing soft wheat (ASFT) well suited for high yielding soft wheat production systems. Outyielding QAL2000^{Φ} in southern NSW trials. Medium–short plant height with good straw strength and a well-rounded disease package, suited to irrigated production systems. Seed available for 2023 sowing season. Bred by LongReach Plant Breeders. Marketed by Waratah Seeds.

Feed wheats

AnapurnaΦ. **Note** – Winter wheat on page 33. Awned, red-grained winter feed wheat. Suitable for very early sowing and graze and grain production. Anapurna^{Φ} is a high yielding wheat suited to the high rainfall zones of NSW and is similar in maturity to RGT Accroc. Excellent standability. AGT.

BigRed[Φ]. An awned, high yielding red grained feed winter wheat. Mid slow-maturity for the medium to high rainfall zones and irrigation. Suitable for dual-purpose(grazing) applications when sown early. AGF seeds.

Borlaug 100[Φ]. Feed quality in NSW. A mid season variety released for its high yield potential in northern NSW and Queensland regions, where there are strong livestock feed grain markets. Performs well under dry conditions. Strong straw strength and low screenings. Rebel Seeds.

Manning[Φ]. Awnless. Winter wheat. White-grained feed wheat. Long season dual-purpose grazing and grain variety, released to replace Mackellar[Φ]. High yield potential in high rainfall or under irrigated production. 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[Φ], but lower grain recovery. AGT.

RGT Accroc[Φ]. 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. RAGT.

RGT Cesario[Φ]. Awnless red-grained winter wheat. Multipurpose feed grain quality wheat suited to grazing, silage and grain production. Suited to the high rainfall zone of NSW. Suitable for sowing late February to early April for early grazing. Excellent standability. Similar maturity to RGT Accroc[Φ]. RAGT.

RGT Zanzibar. Red wheat, feed grain quality, suited to the medium–high rainfall zone. Suitable for sowing late April to early May. Maturity is similar to Suntop[Φ] and EGA_Gregory[Φ]. Good standability. RAGT.

S**EA Condamine**. Feed quality in NSW. It is a tall, robust, quick maturing variety with a relatively short grain filling period, which combines high yield potential, large grain size, good straw strength and standability. Its high yield potential is demonstrated particularly in north-western NSW, south-western and central Queensland, particularly in late-sowing applications where its quick maturity and short grain filling period are an advantage. SEA Condamine expresses late-maturity alpha-amylase (LMA), and so cannot receive an Australian milling classification, and was released as a feed variety. Seed is available through Shepherd Grain. Seed Exchange Australia.

Severn[Φ]. Awnless winter wheat. A forage winter wheat ideal for grazing, silage and hay production. It is best suited to early sowing in eastern and southern areas and exhibits prolific tillering. It has white grain with tolerance to pre-harvest sprouting and is acceptable to feed markets. Severn is tall with good standability. S&W Seed Company.

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

RGT Waugh[Φ]. Slow, white-grained winter wheat suited to the medium to high rainfall zone. Suitable for sowing late February to early April for early grazing. Very high yield potential. Excellent standability. RAGT.

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 77.

Acknowledgments

Variety characteristics and reaction to diseases table

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

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Table 20. Diseases and crop injury guide – wheat (page 1 of 3).

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Foliar diseases				
Yellow spot *Pyrenophora tritici repentis*	Tan coloured leaf lesions with a yellow border. Lesions eventually join (coalesce), 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). Sow varieties with improved levels of resistance. Foliar fungicides applied as a preventative before rain events as they have poor curative activity.
Septoria tritici blotch *Zymoseptoria tritici*	Angular leaf lesions with minute black spots (pycnidia) contained within lesion margin; leaf death.	Common in the south and occurs in medium to high rainfall regions in most seasons. Increased prevalence in lower rainfall cropping regions of NSW with the wetter conditions of 2021 and 2022.	Initially airborne spores (ascospores) from infected stubble, then rain-splashed spores (conidia) within crop from infected leaves. Has a long latent period (approx. 28 days).	Wheat stubble removal, crop rotation (avoid wheat-on-wheat). Sow varieties with improved levels of resistance. Seed and foliar fungicides. Fungicide reduced sensitivity has developed in New South Wales, Victoria and Tasmania with some Group 3 (DMI, triazole) fungicides less effective. Resistant Group 3 isolates detected in southern NSW in 2016. Fungicide resistance confirmed in South Australia to Group 11 (QoI) fungicides in 2021. Rotate mode of action (MOA) of fungicides, don't apply the same MOA more than twice in one season. Use fungicides that contain 2 MOA.
Septoria nodorum blotch *Phaeosphaeria nodorum*	Leaf blotches with minute grey–brown spots; leaf death. Glumes darken to brown to grey. Easily mistaken for septoria tritici blotch or yellow leaf spot.	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. Increasingly detected in NSW crop surveys conducted in 2020 and 2021 which had above average rainfall. Importance presently unclear.
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 physiological expression of an over production of a melanoid associated with the stem rust resistance gene Sr2, which is present in some wheat varieties.	None. Is not a disease.
Stripe (yellow) rust *Puccinia striiformis* f.sp. *tritici*	Scattered yellow powdery pustules appear on leaves in the seedling plant stage and often in stripes on leaves in the adult plant stage.	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. High nitrogen levels within a crop can favour development.	Survives on wheat volunteers and spreads as airborne spores. Three different pathotypes were of economic importance across NSW in 2022. Two which have been prevalent in previous seasons, 198 E16 A+ J+ T+ 17+ (198) and239 E237 A- 17+ 33+ (239). The third is a new pathotype, 238 E191 A+ 17+ 33+ (238) which became widespread during 2022.	Sow varieties with improved levels of resistance (can vary for different pathotypes); 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 to reduce 'green-bridge'.
Leaf rust *Puccinia triticina*	Small, scattered orange–brown powdery pustules on upper side of leaf.	Can develop from early spring; favoured by mild (15–22 °C) moist weather.	Survives on living wheat volunteers and spreads as airborne spores.	Sow varieties with improved levels of resistance (can vary for different pathotypes); foliar fungicides; control volunteer wheat over summer–autumn period.
Stem rust *Puccinia graminis* f.sp.*tritici*	Red–brown, powdery, oblong pustules with tattered edges on leaf (both sides) and stem.	Can develop from mid-spring to end of season, more severe in the north; favoured by warm, 15–30 °C) humid weather.	Survives on living wheat volunteers and spreads as airborne spores.	Sow varieties with improved levels of resistance; foliar fungicides; control volunteer wheat and barley over summer–autumn period.
Wheat powdery mildew *Blumeria graminis* f.sp. *tritici*	White–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.	Sow varieties with improved levels of resistance, seed or in-furrow fungicides at sowing or foliar fungicides in-crop. Note: fungicide resistance/reduced sensitivity to triazoles (Group 3, DMIs) and strobilurin (Group 11, QoI) actives recorded in NSW and Victoria in 2020, 2021 and 2022.

Table 20. Diseases and crop injury guide – wheat (page 2 of 3).

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Virus diseases				
Barley yellow dwarf virus (BYDV) and *Cereal yellow dwarf virus* (CYDV)	Yellowing, infected plants have reduced height and reduced seed set. Purple/red leaf margins.	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 virus (WSMV)	Light green streaks and blotches on leaves, stunted plants, twisted leaves and trapped heads in the boot, reduced seed set.	Has occurred in wheat in southern irrigation areas, and in early-sown grazing wheat on the tablelands and slopes. Earlier infection impact on crop. Increased prevalence in southern NSW in 2021.	Transmitted by the wheat curl mite (WCM). Low level of seed transmission.	Generally, no control required. Spray out grasses in paddock and adjoining paddocks 4 weeks before sowing wheat. No in crop treatment available, insecticides do not control WCM as they are protected within the curled leaf. Do not retain seed from infected crops for planting.
Root and crown diseases				
Take-all *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 heat/moisture stress at anthesis and flowering. .	Soil and stubble-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.
Fusarium crown rot *Fusarium pseudograminearum*	Brown stem bases, crown and sometimes roots go brown; pink hyphae around leaf sheath under high moisture conditions; 'white heads'; pinched grain. White mycelium inside stem after harvest.	Common across NSW farming systems, particularly in stubble retention systems.	Stubble-borne on grass and cereal residues.	Crop rotation, preferably for 18 months to 2 years; grow more resistant or tolerant varieties; grass weed control; balance inputs to available soil water. Inter-row sowing and avoid delayed sowing to minimise losses. Only grow susceptible varieties (e.g. durum) in low risk paddocks based on PreDicta B or stubble testing. Registered seed treatments have 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 throughout grain belt, often found in association with crown rot; scattered through the crop. Exacerbated by deep sowing. Infection favoured by warmer soil temperatures (20–30 °C)	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, as deeper sowing into warmer soils favours infection.
Rhizoctonia root rot *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 2 herbicides and agricultural hardpans.	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 2 herbicides building up, which can cause root pruning. Some seed treatments provide suppression only. Liquid banding of some fungicides is also registered.
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. Rarely detected in recent crop surveys across NSW.	Rain-splashed spores from crop or grass residue during winter.	Crop rotation (two-year break from cereals); fungicide at first node stage (Zadok 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 effects.	Survives 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 2 nematode species, tolerant or resistant varieties, which again can differ for the 2 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.

Table 20. Diseases and crop injury guide – wheat (page 3 of 3).

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Grain conditions				
Fusarium head blight *Fusarium pseudograminearum and Fusarium graminearum*; other *Fusarium* spp.	Dying portions of head; white or pink, pinched grain; orange spore masses on head. Browning of stem in head (rachis) where bleach spikelets attached.	In wet springs with high humidity during flowering; more common in the 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 fusarium head blight (FHB) in very wet seasons.	Crop rotation (maize is the highest inoculum risk); avoid highly susceptible varieties especially durum; fungicide at flowering applied correctly (angled nozzles and 100 L/ha water rate) to provide good coverage of heads. High levels of fusarium crown rot in base of plants increases FHB risk in very wet seasons. In overseas studies, application of strobilurin (Group 11, QoI) fungicides after GS45 is not recommended where FHB risk is high.
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				
	Dark or split nodes, kinked stem. Whole or partial head death. Absence of seeds.	After severe frost at stem elongation. After frost during booting and from heading to flowering.	–	Target the correct sowing window for the varieties being used. Avoid early sowing of short season varieties. Avoid varieties with a short sowing window to spread risk.

Durum

Milled durum wheat is ideal for making semolina, which is used to make pasta, couscous and many other 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 crown rot risk.

Varieties

BitalliΦ. ADR quality in southern NSW. A quick-mid maturing variety, 1–2 days slower than DBA_LillaroiΦ. BitalliΦ exhibits high yield potential and has shown adaptation to tougher environments. It has very good physical grain characteristic with low screenings and high test weights. BitalliΦ is resistant to moderately resistant (R–MR) to root lesion nematodes (*Pratylenchus thornei*) and susceptible to very susceptible (S–VS) to crown rot. Marketed by AGT.

CaparoiΦ. ADR quality in NSW. A mid season maturity durum, with a maturity between EGA_BellaroiΦ and JandaroiΦ. It is a semi-dwarf durum variety with good yield potential in all regions. The grain quality is better than EGA_BellaroiΦ and generally achieves lower grain protein content. CaparoiΦ has improved dough strength compared with EGA_BellaroiΦ, but is inferior to JandaroiΦ for this trait. CaparoiΦ is superior to JandaroiΦ for semolina yellowness. Moderately resistant (MR) to root lesion nematode (*P. thornei*) and very susceptible (VS) to crown rot. Adequate resistance to common root rot. Marketed by Seednet.

DBA_AuroraΦ. ADR quality in NSW. A mid season maturity durum variety, released for the southern grains region. High yield potential, with yield levels similar to, or better than, HypernoΦ in most NSW regions, so nitrogen (N) 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 DBA_LillaroiΦ, JandaroiΦ and CaparoiΦ. Avoid sowing DBA_AuroraΦ 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. Bred by the Southern Program of Durum Breeding Australia (University of Adelaide). Marketed by SA Durum Growers Association.

DBA_BindaroiΦ. ADR quality for northern NSW only. Early–mid maturing durum wheat variety that is adapted to dryland production areas in NSW, with a higher yield potential than CaparoiΦ. DBA BindaroiΦ has erect plant growth and is shorter in stature than CaparoiΦ with better straw strength. Grain, semolina and pasta making quality are superior to CaparoiΦ with improved colour and brightness. Low screening variety, similar to JandaroiΦ. Rated S–VS to crown rot, but has been shown to have better field tolerance to crown rot than other durum varieties. Bred by the Northern Program of Durum Breeding Australia (NSW Department of Primary Industries). Marketed by Seednet.

DBA_LillaroiΦ. ADR quality in NSW. An early–medium maturity variety, 3 days later to head emergence than JandaroiΦ, with a higher grain yield. Excellent durum quality with the largest grain size of the commercial varieties, low screenings, high test milling yield, and improved semolina colour compared with older varieties. Adapted to the rain-fed durum production regions of NSW and is also suited to sowing later in the season. DBA_LillaroiΦ is not recommended for high-input irrigated systems without the appropriate agronomic management. Rated R–MR to root lesion nematode (*P. thornei*) and S–VS to crown rot. Bred by the Northern Program of Durum Breeding Australia (NSW Department of Primary Industries). Marketed by Seednet.

Table 21. Suggested sowing times, Durum wheat varieties.

Variety / Weeks	April				May				June				July		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Northern Slopes															
DBA_Aurora					>	★	★	<							
Caparoi, DBA_Bindaroi, Westcourt						>	★	★	★	★	★	<			
DBA_Lillaroi, DBA_Vittaroi							>	★	★	★	★	★	<	<	<
DBA_Mataroi							>	★	★	★	★	★	<	<	<
Jandaroi							>	★	★	★	★	★	<	<	<
Northern Plains (Moree, Narrabri)															
Caparoi							>	★	★	★	★	<			
DBA_Aurora					>	★	★	<							
DBA_Bindaroi, Westcourt						>	★	★	★	★	★	<			
DBA_Lillaroi, DBA_Vittaroi								>	★	★	★	★	<	<	<
DBA_Mataroi								>	★	★	★	★	<	<	<
Jandaroi								>	★	★	★	★	<	<	<
Liverpool Plains															
Caparoi								>	★	★	★	<			
DBA_Aurora					>	★	★	★	<						
DBA_Bindaroi, Westcourt						>	★	★	★	★	★	★	<		
DBA_Lillaroi, DBA_Vittaroi								>	★	★	★	★	★	<	<
DBA_Mataroi									>	★	★	★	★	<	<
Jandaroi									>	★	★	★	★	<	<
South Western Plains (Griffith, Hillston)															
Caparoi						>	★	★	<						
DBA_Aurora					>	★	★	★	<						
Bitalli, DBA_Bindaroi, Westcourt						>	★	★	★	★	<				
DBA_Lillaroi, DBA_Vittaroi							>	★	★	★	<				

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 could occur.

★ Optimum sowing time.

< Later than ideal, but acceptable, yield might be reduced. DBA_Lillaroi^{Φ}, DBA_Mataroi^{Φ} and Jandaroi^{Φ} given their quicker maturities, are suitable for double cropping following cotton.

DBA_Mataroi^{Φ}. ADR quality for northern NSW only. An early–mid maturing durum variety, with a similar heading date to Jandaroi^{Φ}. DBA_Mataroi^{Φ} is adapted to dryland durum production areas of NSW and Queensland. Currently not recommended for high input irrigated cropping systems. Erect plant type, with medium stature and straw strength similar to Caparoi^{Φ}. Grain, semolina and pasta making quality comparable to Caparoi^{Φ}, low screenings, similar to Caparoi^{Φ} with excellent yellow colour and good milling yield. It is resistant–moderately resistant (R–MR) to root lesion nematode (*P. thornei*), moderately resistant–moderately susceptible (MR–MS) to black point and S–VS to crown rot. Bred by the Northern Program of Durum Breeding Australia (NSW Department of Primary Industries). Marketed by Seednet.

DBA_Vittaroi^{Φ}. ADR quality in NSW. An early–mid maturing durum variety that is suitable for high-input irrigated durum production systems and replaces EGA_Bellaroi^{Φ}. DBA_Vittaroi^{Φ} is shorter in stature than all other released varieties, with superior straw strength. It is approximately 7 days earlier to heading than EGA_Bellaroi^{Φ}. Grain, semolina and pasta making quality are superior to EGA_Bellaroi^{Φ}. Low screenings, similar to Jandaroi^{Φ} and superior to EGA_Bellaroi^{Φ}. Bred by the Northern Program of Durum Breeding Australia (NSW Department of Primary Industries). Marketed by Seednet.

Jandaroi^{Φ}. ADR quality for northern NSW only. 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} and EGA_Bellaroi^{Φ} , 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 MR–MS to root lesion nematode (*P. thornei*), MR to black point and VS to crown rot. Marketed by Seednet.

Westcourt^{Φ}. ADR quality in NSW. A main season variety similar in maturity to Caparoi^{Φ}. Westcourt^{Φ} exhibits high yield potential in the northern region across diverse environments, with particular adaptation to dryland production systems. Westcourt^{Φ} has very good physical grain quality attributes including large seed size and a low percentage of screenings losses, high test weight and excellent semolina colour. Westcourt has maintained an MR rating to stripe rust, is MR to root lesion nematodes (*P. thornei*) and VS to crown rot. Marketed by AGT.

Yield performance experiments from 2018–2022.

The regional mean yields shown in the guide are average varietal performances 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).

New varieties can have less trial data supporting the five-year-across-sites analysis and should be viewed with caution, especially where there are only 2 trial results, or they have only been tested for 2 years in a region.

Table 22. Durum – North east region – compared with Caparoi = 100%.

North east							
	Yearly group mean					Regional mean	Number of trials
Variety	2018	2019	2020	2021	2022		
% Caparoi (t/ha)	**2.28**	**1.03**	**4.10**	**4.98**	**3.73**	**3.63**	
Caparoi	**100**	**100**	**100**	**100**	**100**	100	11
DBA_Aurora	97	112	100	100	117	105	11
DBA_Bindaroi	99	106	100	100	101	100	11
DBA_Lillaroi	93	87	94	93	98	95	11
DBA_Mataroi	102	105	101	103	122	108	11
DBA_Vittaroi	94	98	97	96	108	99	11
Jandaroi	83	72	87	84	95	87	11
Westcourt	106	110	104	107	118	109	11

Table 23. Durum – North west region – compared with Caparoi = 100%.

North west							
	Yearly group mean					Regional mean	Number of trials
Variety	2018	2019	2020	2021	2022		
% Caparoi (t/ha)	**–**	**1.09**	**3.01**	**5.20**	**4.51**	**3.74**	
Caparoi	**–**	**100**	**100**	**100**	**100**	**100**	**12**
DBA_Aurora	–	98	104	113	105	107	12
DBA_Bindaroi	–	102	101	105	97	101	12
DBA_Lillaroi	–	89	93	90	100	94	12
DBA_Mataroi	–	97	106	108	116	110	12
DBA_Vittaroi	–	92	98	100	103	101	12
Jandaroi	–	75	84	78	98	87	12
Westcourt	–	104	108	111	114	111	12

Table 24. Durum – South west region – compared with Caparoi = 100%.

South west ❸							
	Yearly group mean					Regional mean	Number of trials
Variety	2018	2019	2020	2021	2022		
% Caparoi (t/ha)	**4.26**	**3.33**	**5.28**	**6.26**	**3.68**	**4.67**	
Bitalli	–	109	107	104	123	109	15
Caparoi	**100**	**100**	**100**	**100**	**100**	**100**	**17**
DBA_Aurora	102	112	111	99	115	107	17
DBA_Bindaroi ❷	102	104	103	100	100	102	17
DBA_Lillaroi	95	96	98	94	98	96	17
DBA_Mataroi ❷	99	108	106	103	122	108	17
DBA_Vittaroi	98	104	105	96	108	102	16
Jandaroi ❷	89	93	96	85	95	91	17
Westcourt	102	107	105	106	119	108	17

❷ No classification currently for this growing region, feed quality only.
❸ Includes irrigated and dryland variety trials.
Yield results are a combined across sites analysis of NVT yield trials from 2018–2022.

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

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 7). Germination percentage should exceed 90%.

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Calculating sowing rates on page 7

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 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 levels when grown on heavy, self-mulching black earths (pH_{Ca} 8.0–8.5). When grown in very wet, high phosphate soils for several weeks, zinc deficiency symptoms can appear.

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

Diseases

With the change in stripe pathotypes present across NSW since 2020, growers should ensure they are using the latest resistance ratings and, depending on variety, consider using a seed, fertiliser or foliar fungicide management program for stripe rust.

Durum varieties are very susceptible to fusarium crown rot and 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 or sorghum stubble. This disease was not commonly observed under irrigation in southern NSW when grown in rotation with maize until 2022. In very wet seasons basal infections from fusarium crown rot can result in the rain splash of spores (conidia) produced around lower nodes into heads during flowering, creating fusarium head blight infection. Rotations and paddock selection are therefore important to minimise the risk of both fusarium crown rot and fusarium head blight. Avoid wheat on wheat/barley situations due to the high fusarium crown rot risk and low nutrition. All paddocks intended for durum production should be PreDicta B tested and only paddocks with a low risk of fusarium crown rot chosen to grow durum crops.

Ensure good grass weed control as many grass species also host the fusarium crown rot pathogen. Current varieties have useful tolerance to yellow spot.

Contributing authors

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Barley

Crop management

Sowing time

Sowing time determines the time a crop matures; 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 (N) and phosphorus (P), are essential to optimise yield.

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

Sowing depth

Pay close attention to sowing depth, particularly when direct drilled and for varieties with a short coleoptile. The ideal depth is 3–6 cm, but seed should always be sown into moist soil. If considering dry sowing, target a sowing depth of 3–4 cm, particularly on a hard-setting 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. 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.

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How to calculate sowing rates: on page 7.

Acid soils tolerance

No new acid-tolerant barleys have been released in recent years specifically for NSW. A new acid soil tolerant barley, Buff(ϕ), was released in 2018 for Western Australia, and has shown adaption to NSW conditions. Limited yield data is available on Buff(ϕ) under acid soil conditions in 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.

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 N fertiliser can increase screenings and protein levels.

Timely weed control

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

Care with harvest

- Avoid skinning: partial loss of the husk from harvest damage.
- Try to minimise weather damage effects.
- Avoid varietal contamination.
- Only use grain protectants registered for malting barley.

Variety selection

Varietal characteristics

The following is a list of barley varieties, including new releases for 2023. The variety descriptions should be read in conjunction with Table 29. Disease and crop injury guide – barley. on page 55.

There are several new specialist malt barley varieties available on the Australian market, which are grown under contract to specific companies. 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 a variety's yield performance and disease resistance ratings and ensure grain contracts reflect any differences in yield or disease management for other, more locally adapted, barley varieties.

Information has been collated from breeding companies. Refer to Table 25. Suggested sowing times – barley on the next page for suggested sowing times.

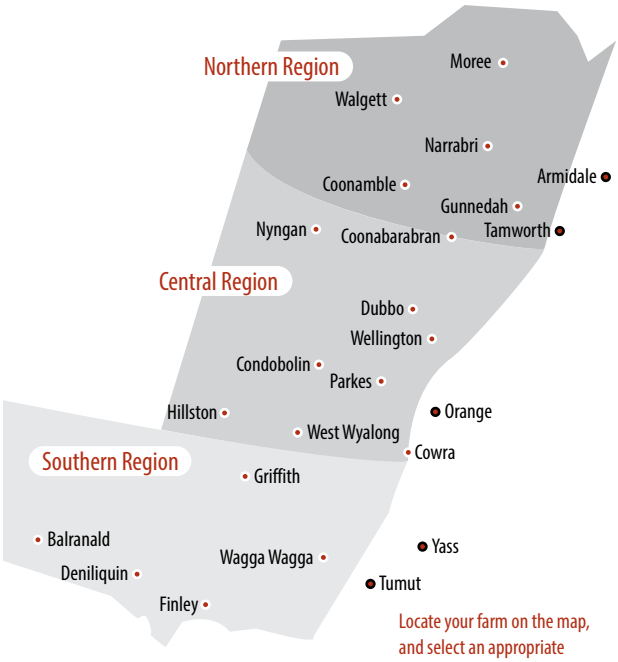

Figure 6. Map of NSW showing barley-growing zones.

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. Actual sowing date selection should allow for soil fertility and frost damage risk in particular paddocks.

Table 25. Suggested sowing times – barley.

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 ❶		>	★	★	★	★	★	★	★	★	<								
GrangeR							>	★	★	★	★	<							
Alestar, Bottler, Commander, Laperouse, Minotaur ❷, Nitro, RGT Planet, Zena CL ❷									>	★	★	★	★	★	<				
Combat ❷,Commodus CL ❷, Compass, Cyclops ❷, Hindmarsh, La Trobe, Leabrook, Maximus CL, Rosalind, Spartacus CL, Titan AX ❷									>	>	★	★	★	★	<				
Beast, Fathom, Shepherd, Yeti ❷										>	★	★	★	★	★	<			
Central region																			
Urambie ❶		>	★	★	★	★	★	★	★	★	★	<							
GrangeR, Nitro								>	★	★	★	★	<	<					
Bottler, Commander, Laperouse, Minotaur ❷, RGT Planet, Zena CL ❷									>	★	★	★	★	<	<				
Combat ❷, Commodus CL ❷, Compass, Cyclops ❷, Leabrook, Rosalind, Titan AX ❷										>	★	★	★	<	<				
Beast, Fathom, La Trobe, Hindmarsh, Maximus CL, Shepherd, Spartacus CL, Yeti ❷										>	★	★	★	★	<	<			
Southern region																			
Urambie ❶		>	★	★	★	★	★	★	★	★	<								
GrangeR							>	>	★	★	★	★	★	★	<	<			
Bottler, Commander, Laperouse, Minotaur ❷, Nitro, RGT Planet, Zena CL ❷										>	★	★	★	★	★	★	<		
Beast, Combat ❷, Commodus CL ❷, Compass, Cyclops ❷, Fathom, Hindmarsh, La Trobe, Leabrook, Maximus CL, Rosalind, Shepherd, Spartacus CL, Titan AX❷, Yeti ❷										>	>	★	★	★	★	★	★	<	

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

❶ Dual-purpose varieties that can be grazed. Urambie can be sown from mid–late March, if grazed.
❷ Limited information available on performance in NSW.

Variety characteristics (continued)

Alestar[Φ]. Malt. A medium–long season barley, 3 days earlier than Commander[Φ] and 5 days earlier than Gairdner[Φ] and Oxford[Φ]. 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/Elders in Australia. EPG Seeds.

Beast[Φ]. A quick maturing, high yielding barley suited to low–medium rainfall environments. Beast[Φ] is 1–2 days quicker to reach awn peep than Spartacus CL[Φ]. A similar plant type to Compass[Φ] with excellent early vigour and a competitive physical grain package make it well adapted to terminal stress conditions and shorter season environments. Released as a feed quality barley, Beast[Φ] is currently under evaluation with Grains Australia for malt accreditation. AGT.

Bottler[Φ]. Malt. A mid season maturity variety (5 days earlier than Gairdner[Φ]), with high yield potential. Suits medium and high rainfall zones, with the potential for irrigation use. Barrett Burston Malting is supporting malt grain production in selected regions. Commercialised by Seednet.

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. Higher yield 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. Commercialised by Seednet.

Commodus CL[Φ]. New feed barley, high yielding quick-maturity imidazolinone (IMI) tolerant variety suited to lighter soils and medium–low rainfall environments. Agronomically similar to Compass[Φ]. Similar lodging tolerance and head loss risk to Compass[Φ], which could require in-season agronomic management. Excellent grain size with high retention levels and low screening. Moderate hectolitre weight. Under evaluation by Grains Australia for malt accreditation. InterGrain.

Compass[Φ]. Malt. Developed by the University of Adelaide as an early–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 than Commander[Φ] and similar to Hindmarsh[Φ]. Compass has shown good physical grain quality, with plump grain, high retention and low screenings. Commercialised by Seednet.

Cyclops[Φ]. A quick-mid maturing barley, slightly slower than Spartacus CL[Φ]. Very high and stable yield potential with a short plant type similar to LaTrobe[Φ], reducing lodging susceptibility compared with taller varieties. Widely adapted to a range of environmental conditions across NSW and has a competitive physical grain package. Released as a feed quality barley, Cyclops[Φ] is currently under evaluation by Grains Australia for malt accreditation. AGT.

Fathom[Φ]. Feed. Developed using wild barley to improve stress tolerance and water use efficiency. Fathom[Φ] has a long coleoptile and shows particularly good early vigour and weed competitiveness. Early maturity is 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. Commercialised by Seednet.

Hindmarsh[Φ]. Food. An erect, semi-dwarf variety that 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 classification of 'food' and can be segregated for human food, and possibly used for Shochu (Japanese distilled spirit), and for malt production in some markets. Commercialised by Seednet.

Laperouse[Φ]. Released through SECOBRA Recherches as a competitive-yielding feed type and is under evaluation for malt accreditation with Grains Australia. Competitive growth habit with medium plant height. Laperouse[Φ] is a spring type barley – when sown in a main season sowing time maturity is typically between Compass[Φ] and RGT Planet[Φ]. Laperouse[Φ] has shown a low incidence of head-loss and good physical grain quality. Commercialised by Seednet.

La TrobeΦ. Malt. 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. InterGrain.

LeabrookΦ. Malt. Mid tall plant type, with mid–early maturity similar to Compass Φ. Generally higher grain yield, higher grain plumpness percentage and low screenings percentage compared with Compass Φ. Released in 2019 and bred by the University of Adelaide. Commercialised by Seednet.

Maximus CLΦ. Malt. A quick-mid maturing IMI-tolerant high yielding barley. Maximus CL Φ is similar to Spartacus CL Φ with an erect plant type, strong lodging tolerance and low–medium head loss risk. Maximus CL Φ has a short coleoptile so adjust sowing depth accordingly. The variety also has a good physical grain package, slightly improved over Spartacus CL Φ. InterGrain.

MinotaurΦ. A mid-slow maturity slightly later than RGT Planet Φ. Suited to medium–high rainfall environments. Minotaur Φ has a good physical grain package with improved test weight, screenings and retention compared with RGT Planet Φ. Released as a feed quality barley, Minotaur Φ is currently under evaluation by Grains Australia for malt accreditation. AGT.

Nitro. A mid season maturity, spring feed barley with mid straw height. Good early vigour and strong tillering variety, which appears to tolerate sodic soils – performing well under these conditions in northern NSW. High yield potential in favourable environments and suited to early–mid May sowing. Nitro can only be grown under licence from GrainSearch. Commercial seed is available through AMPS (Tamworth NSW) or their affiliates.

RGT PlanetΦ. Malt. Mid season flowering, but maturity is flexible with a multi-environmental fit that has shown a high yield potential in NSW. Similar maturity to Commander Φ. Excellent standability. RAGT.

RosalindΦ. 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 is similar to La Trobe Φ. InterGrain.

ShepherdΦ. Feed. Slightly later maturing than Grout Φ, but has a similar growth habit with erect, vigorous early growth. Suited to the medium rainfall areas of northern NSW and Qld. Commercialised by Seednet.

Spartacus CLΦ. Malt. A high-yielding IMI-tolerant barley suited to NSW. Spartacus CL Φ is an early-maturing semi-dwarf barley with a maturity similar to La Trobe Φ. Short coleoptile length. Moderately good straw strength and head retention with good physical grain quality. High level of pre-harvest sprouting tolerance. InterGrain.

SakuraStarΦ. There is limited information on this variety's performance in NSW. A boutique malting barley developed by Sapporo Breweries and the University of Adelaide. Targeted to replace SouthernStarΦ as it has improved pre-harvest sprouting tolerance. Superior grain size compared with SouthernStarΦ and is similar to BulokeΦ. Can only be grown under production contracts with Barrett Burston Maltings and Cargill.

Urambie. 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.

YetiΦ. A high yielding barley variety released for northern NSW. YetiΦ is closely related to CompassΦ and has a robust physical grain package with low screenings and high retention. Shorter in plant height compared with CompassΦ, YetiΦ offers improved lodging resistance. Released as a feed quality barley, YetiΦ is currently under evaluation by Grains Australia for malt accreditation. AGT.

The following are more recently named or released varieties. Some lines might only have limited seed available in NSW for 2023.

CombatΦ. A highly competitive yielding feed barley that has performed well across a range of growing environments in NSW, released in 2022. It is a mid maturing variety, longer than RosalindΦ and similar to Scope CLΦ in maturity. CombatΦ has a semi-prostrate growth habit providing a higher level of early vigour, improving ground cover and weed competition compared with RosalindΦ. InterGrain.

FandagaΦ. A mid-slow maturity, high-yielding barley, suited to medium–high rainfall zones and irrigation production. Approved overseas as a malt variety, yet to be classified in Australia, currently a feed barley only. Marketed by AGF Seeds.

Titan AXΦ. World first CoAXium barley variety that is tolerant to Sipcam Aggressor® (Group 1, quizalofop-P-ethyl) herbicide offering an alternative to Clearfield® technology. A mid season maturing, high-yielding barley derived from CompassΦ suited to medium–low rainfall environments. Titan AXΦ reaches awn peep slightly later than CompassΦ and similar to RGT PlanetΦ. Agronomically similar to CompassΦ with similar height and lodging tolerance that might require in-season agronomic management in some environments. Good grain package with low screenings and good retention, moderate test weight, similar to CompassΦ. Titan AXΦ will enter Grains Australia malt evaluation in 2023. AGT.

Zena CLΦ. An IMI-tolerant barley closely related to RGT PlanetΦ with similar maturity and agronomic management, with the added herbicide tolerance. Suited to the medium–high rainfall environments, the variety has good levels of resistance to powdery mildew and leaf rust. The net form and spot form of net blotch will need to be monitored. Zena CLΦ has been accepted into the Grains Australia malt accreditation program. Seed available for planting in 2023. Bred and marketed by InterGrain.

Northern NSW barley yield performance experiments from 2018–2022

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 2018–2022. Further results are on the NVT website.

Table 26. Northern NSW main season sown: Compared with LaTrobe = 100%.

North east							
Variety	Yearly group mean					Regional mean	Number of trials
	2018	2019	2020	2021	2022		
% LaTrobe (t/ha)	**2.17**	**0.89**	**4.20**	**3.87**	**4.06**	**3.30**	
Alestar ❷	115	52	94	102	122	104	16
Beast	–	94	105	98	108	105	13
Bottler ❷	119	76	101	104	122	108	16
Combat	–	–	–	107	121	111	7
Commander ❷	114	48	93	98	112	100	16
Commodus CL	–	–	97	95	106	100	11
Compass ❷	115	86	99	94	103	100	16
Cyclops	–	–	109	111	106	106	11
Fathom	95	83	105	101	95	100	16
LaTrobe ❷	**100**	**100**	**100**	**100**	**100**	**100**	**16**
Laperouse	110	81	117	107	115	111	16
Leabrook ❷	123	75	104	99	115	107	16
Maximus CL ❷	97	80	122	111	111	112	16
Minotaur	–	–	–	112	112	112	7
Nitro	–	–	106	–	–	111	4
RGT Planet ❷	125	76	108	109	132	115	16
Rosalind	113	77	108	106	120	110	16
Spartacus CL ❷	94	105	107	105	102	104	16
Titan AX	–	–	–	–	108	101	3
Yeti	–	97	121	104	115	114	13
Zena CL	–	–	–	110	131	113	7

North west							
Variety	Yearly group mean					Regional mean	Number of trials
	2018	2019	2020	2021	2022		
% LaTrobe (t/ha)	**2.44**	**1.42**	**4.17**	**5.07**	**5.52**	**4.06**	
Alestar ❷	105	76	95	109	103	102	20
Beast	–	106	104	105	105	106	17
Bottler ❷	109	88	100	114	108	107	20
Combat	–	–	–	116	114	113	10
Commander ❷	110	82	98	102	102	101	20
Commodus CL	–	–	100	99	100	101	14
Compass ❷	113	102	100	97	98	100	20
Cyclops	–	–	105	111	108	107	14
Fathom	105	104	105	97	101	101	20
LaTrobe ❷	**100**	**100**	**100**	**100**	**100**	**100**	**20**
Laperouse	111	103	104	110	105	107	20
Leabrook ❷	119	100	104	108	107	107	20
Maximus CL ❷	103	101	103	109	103	105	20
Minotaur	–	–	111	119	115	114	13
Nitro	–	–	101	–	–	109	4
RGT Planet ❷	114	92	106	125	117	116	20
Rosalind	108	93	102	114	108	108	20
Spartacus CL ❷	95	101	100	103	100	100	20
Titan AX	–	–	–	–	103	102	5
Yeti	–	115	108	111	107	110	17
Zena CL	–	–	–	123	115	112	10

❷ Accredited malt varieties.

For grazing and grain recovery consider Urambie, no longer tested in the NVT program.

For malting production, consider Alestar[Φ], Commander[Φ], Compass[Φ], La Trobe[Φ], Leabrook[Φ], Maximus CL[Φ] and Spartacus CL[Φ].

In more reliable rainfall regions also consider RGT Planet[Φ].

For food grade production, consider Hindmarsh[Φ].

For feed grain production only consider Beast[Φ], Combat[Φ], Fathom[Φ], Nitro, Laperouse[Φ], Rosalind[Φ], Titan AX[Φ], Yeti[Φ] and Zena CL[Φ].

Southern NSW barley yield performance experiments from 2018–2022

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 2018–2022. Further results are on the NVT website.

Table 27. Southern NSW main season sown: Compared with LaTrobe = 100%.

South east							
	Yearly group mean					Regional mean	Number of trials
Variety	2018	2019	2020	2021	2022		
% LaTrobe (t/ha)	**–**	**2.07**	**5.10**	**4.38**	**4.84**	**3.69**	
Alestar ❷	–	78	97	107	105	97	5
Beast	–	109	91	84	107	98	5
Bottler	–	86	100	104	114	101	5
Combat	–	–	–	112	120	111	2
Commander ❷	–	90	90	92	104	94	5
Commodus CL	–	–	80	80	105	91	3
Compass ❷	–	104	80	79	106	92	5
Cyclops	–	–	114	99	112	109	3
Fandaga	–	–	–	109	121	107	2
Fathom	–	102	92	93	106	98	5
LaTrobe ❷	**–**	**100**	**100**	**100**	**100**	**100**	**5**
Laperouse	–	104	106	91	105	102	5
Leabrook ❷	–	105	89	85	112	98	5
Maximus CL ❷	–	106	111	95	100	103	5
Minotaur	–	–	118	105	115	110	3
Nitro	–	87	107	–	–	106	3
RGT Planet ❷	–	87	114	119	121	111	5
Rosalind	–	103	114	106	112	109	5
Spartacus CL ❷	–	102	103	96	98	100	5
Titan AX	–	–	–	–	109	98	1
Yeti	–	106	105	90	106	102	5
Zena CL	–	–	–	106	119	106	2

Note: ❷ Accredited malt varieties.
For grazing and grain recovery consider Urambie. Urambie can be sown from mid–late March if grazed. No longer tested in the NVT program.

For malting production consider Commander^{Φ}, Compass^{Φ}, La Trobe^{Φ}, Leabrook^{Φ}, Maximus CL^{Φ} and Spartacus CL^{Φ}.

In more reliable rainfall regions also consider RGT Planet^{Φ}.
For food grade production consider Hindmarsh^{Φ}.

For feed grain production consider, Combat^{Φ}, Cyclops^{Φ}, Laperouse^{Φ}, Minotaur^{Φ} ,Rosalind^{Φ} and Zena CL^{Φ}. In western areas, also consider Beast^{Φ}, Fathom^{Φ} and Titan AX^{Φ}.

Table 27. Southern NSW main season sown: Compared with LaTrobe = 100% (continued).

South west							
Variety	Yearly group mean					Regional mean	Number of trials
	2018	2019	2020	2021	2022		
% LaTrobe (t/ha)	1.55	2.21	4.85	5.48	5.38	4.55	
Alestar❷	76	72	98	93	107	97	23
Beast	–	108	99	102	104	102	22
Combat	–	–	–	111	114	110	12
Commander❷	83	77	97	96	102	96	23
Commodus CL	–	–	93	97	101	97	18
Compass❷	104	101	94	98	101	98	23
Cyclops	–	–	110	108	111	109	18
Fathom	101	101	98	101	102	101	23
LaTrobe❷	**100**	**100**	**100**	**100**	**100**	**100**	**23**
Laperouse	99	95	105	100	106	103	23
Leabrook❷	103	103	99	102	107	103	23
Maximus CL❷	105	103	105	100	103	103	23
Minotaur	–	–	112	106	116	110	18
RGT Planet❷	82	88	109	107	120	109	23
Rosalind	102	106	109	106	113	109	23
Spartacus CL❷	103	100	101	98	101	100	23
Titan AX	–	–	–	–	105	102	6
Yeti	–	103	105	100	108	104	22
Zena CL	–	–	–	106	117	108	12

Note: ❷ Accredited malt varieties.
For grazing and grain recovery consider Urambie. Urambie can be sown from mid–late March if grazed. No longer tested in the NVT program.

For malting production consider Commander^{Φ}, Compass^{Φ}, La Trobe^{Φ}, Leabrook^{Φ}, Maximus CL^{Φ} and Spartacus CL^{Φ}.

In more reliable rainfall regions also consider RGT Planet^{Φ}.
For food grade production consider Hindmarsh^{Φ}.

For feed grain production consider, Combat^{Φ}, Cyclops^{Φ}, Laperouse^{Φ}, Minotaur^{Φ} ,Rosalind^{Φ} and Zena CL^{Φ}. In western areas, also consider Beast^{Φ}, Fathom^{Φ} and Titan AX^{Φ}.

Table 28. Variety characteristics and reaction to diseases.

Variety	Leaf scald	Net blotch net form	Net blotch spot form	Powdery mildew	Leaf rust	BGYR (stripe) rust	Crown rot	Common root rot ❺	Cereal cyst nematode resistance	RLN *P. thornei* Resistance ❸	RLN *P. thornei* Tolerance ❹	RLN *P. neglectus* Resistance ❸	RLN *P. neglectus* Tolerance ❹	Issued by	Year registered
Alestar ❷	S–VS	MS	S	MR	MR–MS	R	S	MS–S	R ❶	MR	MT–MI	MR	I	Limagrain/EPG Seeds	2017
Beast	S–VS	MS–S	MS	S	MS–S	R	S	S	MR	MR–MS	T	MR–MS	MI	AGT	2020
Bottler ❷	S–VS	MR–MS	MS–S	R–MR	MR	R & R–MR	S–VS	MS	–	R–MR	MI	MS	MT	DLF Seeds	2017
Combat	MS–S	MS–S	MR	MS	S	R	S ❶	–	MR–MS	MS	–	MR	-	InterGrain	2022
Commander ❷	S–VS	S	MS–S	MS–S	S–VS	R	S	MS–S	R	MR–MS	MT	MR–MS	MT–MI	University of Adelaide	2008
Commodus CL	S–VS	MS	MS–S	MS	MS	R–MR	S ❶	S	R	MR–MS	MT–MI	MR–MS	T–MT	InterGrain	2021
Compass ❷	S	MS–S	MS	MS–S	S	R	S	MS	R	MR	T–MT	MR–MS	T–MT	University of Adelaide	2013
Cyclops	S	MS	MS	S	S	R	S ❶	–	S	MR–MS	MT–MI	MR–MS	MI	AGT	2021
Fandaga	S–VS	MR–MS	S	R	MR	R & MR	MS–S ❶	–	R	MR	–	MR	–	AGF Seeds	2022
Fathom	S	S	MR	MR–MS	MS	R–MR	S–VS	MS–S	R	MR	T–MT	MR–MS	T	University of Adelaide	2012
La Trobe ❷	S–VS	MR–MS	S	MS–S	MS	R	S	S	R	MR–MS	MT	MR–MS	MT	InterGrain	2013
Laperouse	S–VS	MS	MR–MS	MS–S	S–VS	R & MR	S	MS–S	S	MR	MT–MI	MR	MI	SECOBRA Recherches/Seednet	2020
Leabrook ❷	S–VS	MS	MS	S	S–VS	R–MR	S	MS	R–MR	R–MR	T–MT	MR–MS	MT	University of Adelaide	2019
Maximus CL ❷	S	MR–MS	MS	MS	MS–S	R	S	S	R	MR	MT–MI	MR–MS	MT	InterGrain	2020
Minotaur	VS	MR–MS	S	S	S–VS	R	MS	–	R	MR	MT	MR–MS	MI	AGT	2021
Nitro	S	MR–MS	S	R	MR–MS	R–MR	S	MS–S	R	MR	MI	MR	MI	DLF Seeds	2020
RGT Planet ❷	MS–S	MS–S	S–VS	R–MR	MR	R & R–MR	MS–S	MS–S	R ❶	MR	MI	MR–MS	MT	RAGT	2017
Rosalind	MS–S	MR	MS–S	MS–S	MR	R	MS–S	S	R	MR	T–MT	MR–MS	MT	InterGrain	2015
Spartacus CL ❷	S–VS	MS–S	S	MS–S	MR–MS	R	S	MS–S	R	MR–MS	MI	MR–MS	MI–I	InterGrain	2016
Titan AX	S–VS	MS	MS–S	MS	S	R	MS–S ❶	–	MR ❶	MR	–	R	–	AGT	2022
Yeti	VS	MS	MR–MS	MS–S	S	MR	S	–	R–MR	MR	T–MT	MR	T–MT	AGT	2021
Zena CL	MS	MS	MS–S	R	S	R–MR	MS–S ❶	–	R	MR	–	MR–MS	–	InterGrain	2022

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.

– insufficient data or no data available.

❶ Provisional rating.

❷ May be accepted as malting. Accredited by Barley Australia.

❸ **RLN Resistance ratings.**
The root-lesion nematode (*Pratylenchus. 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.

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

❺ Common root rot screening was discontinued; ratings are from 2020 with no data available for newer varieties.

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 could develop in favourable conditions, some yield loss can occur.

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

MT–MI (Moderately tolerant to moderately intolerant) indicates disease can be conspicuous in favourable situations with moderate yield losses.

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

MI–I (Moderately intolerant to Intolerant) indicates high levels of disease can occur with substantial 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.

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 can be seen and grain yield should not be reduced.

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

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

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

MS–S (Moderately susceptible to susceptible) indicates significant disease can develop in favourable situations with moderate yield losses. Fungicide applications are likely to be economic.

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

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

VS (Very susceptible) indicates very high levels of disease can occur in favourable seasons with serious yield losses. Will require close monitoring and proactive fungicide control. It is likely to develop some disease even when conditions are less favourable.

Diseases

Sound integrated management is the key to minimising losses from disease. Avoid sowing barley into barley stubble and carefully consider whether to sow barley into wheat stubble. An improved level of resistance to specific leaf diseases is available in some newer 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 leaf scald and powdery mildew from building up early in the season, with some providing useful net blotch control.

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 a variety's disease rating will depend on which pathotype(s) of a pathogen are present in their region. This can vary within and between seasons.

For a number of varieties, there are 2 distinct ratings or a range that relate to differences in susceptibility to different pathotypes. Growers are advised to show caution and monitor their crops carefully and be prepared, where feasible, to apply foliar fungicides to manage leaf disease should the variety begin to show susceptibility and seasonal conditions are favourable for disease development.

Leaf diseases

Rusts – Four rusts: barley leaf rust, barley grass stripe rust, stem rust and wheat stripe rust, can affect barley in NSW, with barley leaf rust the major concern.

- **Barley leaf rust** is present in all growing regions, with increased importance in central and northern NSW. Varieties that are rated very susceptible to leaf rust should be monitored carefully as they can build up leaf rust in local areas and spread it to other susceptible varieties causing leaf damage and the need for fungicide control. Fungicides should be rotated and selected carefully as resistance to Group 3 (triazoles, DMI) has been detected within the pathogen population. 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.
- **Barley stripe rust** is a major disease of barley in some 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. A new pathotype of barley grass stripe rust has been recently detected in mainly southern NSW which has increased virulence on some barley varieties such as RGT Planet(ϕ). However, it is still questionable whether the severity of infection warrants fungicide application. 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 a NSW DPI plant pathologist and send samples to the Australian cereal rust survey, contact details can be found in Industry information on page 80.
- **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.

Net blotch – There are 2 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 2 forms and mixed infections are possible.

1. 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. Lesions will often join into each other. The spot form of net blotch is widespread as most varieties are susceptible.
2. 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 net form can infect grain, which can result in seed-borne infections if this seed is retained for sowing next season. The net form has been less common in the southern region but increasing in importance as more susceptible varieties are being grown. It however can be a major disease in northern NSW if susceptible varieties are grown.

It is advisable to use a seed treatment that will control the seed-borne stage of the net form of net blotch. Growers should be aware that the fungicide flutriafol, commonly applied as a fertiliser treatment, is not 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 90 on page 173 for details. Note that this only controls the seed borne infection and will not provide protection against infection from spores coming off infected barley stubble.

The fungicide seed treatment Systiva® provides 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 vulnerable to resistance development and should not be repeatedly used. Field resistance to Systiva® has been detected in areas of South Australia and Western Australia where barley has been grown at high intensity in crop rotations.

Ramularia leaf spot – Recent crop surveys by NSW DPI with co-investment from GRDC have confirmed that ramularia leaf spot (RLS) is present in NSW. Crops can be infected without disease symptoms appearing. Grain yield loss is possible when symptoms are present, although currently little is known about the effects of this disease in NSW. Overseas research indicates yield loss from RLS can be as severe as losses from net blotches and barley scald under ideal environmental conditions.

Overseas research has also shown that fungicides are best applied prophylactically i.e. before symptoms appear. There are foliar fungicides registered for RLS control in Australia, but do not undertake more than 2 applications of the same product in one season. There are currently confirmed instances of fungicide resistance in Europe and New Zealand.

RLS is commonly misdiagnosed as other barley diseases and environmental stresses such physiological spotting. Correct identification can be obtained by contacting a NSW DPI plant pathologist.

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.

Powdery mildew – Can occasionally be severe on seedlings and tillering barley in northern and central NSW, favoured by high humidity, but reduced with rainfall. High N 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 reduced sensitivity and resistance to some triazole fungicides. Some seed treatments provide effective and economic control of powdery mildew at the seedling stage in areas where the disease frequently develops. See Table 90 on page 173 for details.

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 (PLS) can be easily mistaken for diseases but, not being related to pathogens, applying fungicides is not warranted. Some varieties (e.g. RGT Planet$^{\phi}$ and Spartacus CL$^{\phi}$) are more prone to developing PLS than others, and growers are advised to consult their agronomist/adviser or NSW DPI plant pathologist if uncertain about what is causing the leaf spotting.

Managing diseases with foliar fungicides

Foliar fungicides are often used as one component of an integrated disease management plan 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 economically viable. 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 when the fungicide was applied.

Fungicide resistance has been documented in several barley foliar pathogens in Australia, such as powdery mildew and net blotch – net form (*Pyrenophora teres* f. *teres*), net blotch – spot form (*Pyrenophora teres* f. *maculata*) and barley leaf rust (*Puccinia hordei*). This means that repeated applications of the same fungicide group should be avoided. Rotate fungicide groups, use mixtures of different groups where possible and adhere to label instructions.

Root and crown diseases

Barley is susceptible to the same root diseases (*Pythium*, rhizoctonia, take-all, fusarium crown rot and common root rot) as wheat. With fusarium 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 fusarium crown rot infection and builds up inoculum levels within the rotation. Barley can still suffer significant yield loss from fusarium crown rot if there is moisture stress during crop development. Barley varieties also differ in their susceptibility and yield loss from fusarium crown rot infection. As with wheat, fusarium 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 and variety choice.

Smuts

Growers should be aware that varieties with a Hindmarsh background (La Trobe$^{\Phi}$, Spartacus CL$^{\Phi}$ and Rosalind$^{\Phi}$) are more susceptible to loose smut in barley. Over past seasons, loose smut has built up in the more susceptible varieties where a seed fungicide has not been used or poorly applied. Both malting and feed barley receival standards have a zero tolerance for smuts. Control is readily achieved by using seed dressings at sowing. See Table 90 on page 173 for details.

Treat all barley 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.

Black point

The grain coat can darken at the embryo (shoot) end 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 can 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-lots 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 3 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 170 for more details.

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

GO TO PAGES

Barley delivery standards (http://www.graintrade.org.au/commodity_standards)

Barley Australia website (https://www.barleyaustralia.com.au/)

Malting varieties

Malting barley varieties in Australia are accredited by Grains Australia (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 classification was introduced by Barley Australia in 2010 to meet a growing market for food grade barley. Barley varieties 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

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

Further reading

Barley Australia (https://www.barleyaustralia.com.au/)

Grains Australia (https://grainsaustralia.com.au/)

GTA – Barley Trading Standards (https://www.graintrade.org.au/)

GRDC – *Wheat & barley leaf symptoms: The back pocket guide* (https://grdc.com.au/resources-and-publications/all-publications/publications/2011/03/wheat-barley-leaf-symptoms-the-back-pocket-guide)

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Table 29. Disease and crop injury guide – barley (page 1 of 2).

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Foliar diseases				
Barley scald *Rhynchosporium commune*	Initially 'scalded' patches that can spread to entire crop. Leaf lesions first appear water-soaked and then elongate into bleached blotches with dark brown margins. Can also affect the heads.	More common and severe in the south, favoured by wet weather.	Rain-splashed spores from barley stubble and barley grass residues Secondary infection from infected leaves during the season. Can be seed-borne.	Sow varieties with improved levels of genetic resistance; 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.	Widespread, favoured by wet weather and early sowing.	Airborne spores from infected plants and stubble. Carried on seed.	Sow varieties with improved levels of genetic resistance; 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.	Widespread, favoured by wet weather and early sowing.	Airborne spores from infected plants and stubble.	Sow varieties with improved levels of genetic resistance; 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 and under irrigation. More prevalent in winter and early spring.	Airborne spores from infected trash and infected plants.	Sow varieties with improved levels of genetic resistance; seed and foliar fungicides. Control volunteer barley plants.
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.	Survives on barley volunteers and spreads via airborne spores from living plants.	Sow varieties with improved levels of genetic resistance; clean fallows; foliar fungicides to protect flag-1 to flag-2 leaves. Monitor very susceptible varieties regularly. Group 3 (triazole, DMI) resistance detected in pathogen population.
Ramularia leaf spot *Ramularia collo-cygni*	Reddish-brown rectangular lesions ringed with yellow margin. Lesions restricted by leaf veins and through both sides of leaf. Often confused with net blotches.	Identified in NSW barley crops since 2020, especially southern and central regions. Prevalent during 2022 in southern NSW.	Stubble, seed and wind-borne. Is an endophytic fungus that lives within the plant for part of its lifecycle without causing symptoms, before becoming pathogenic and causing disease.	Clean seed. In-crop fungicide applications.
Barley grass stripe rust *Puccinia striiformis* f.sp. *pseudo-hordei*	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.	Survives on barley volunteers and barley grass, spreads via airborne spores from living plants.	Rarely required. Resistant varieties, foliar fungicides not likely to be required or economically viable.
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.	Survives on barley volunteers and spreads via 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. Can occur after frost events with spots concentrated towards leaf tips. Some genotypes are more susceptible. Spartacus CL and RGT Planet 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 it will provide no control of PLS because it 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.

Table 29. Disease and crop injury guide – barley. (Page 2 of 2)

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Virus diseases				
Barley yellow dwarf virus (BYDV) or *Cereal yellow dwarf virus* (CYDV)	Yellowing, reduced height 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.	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 virus (WSMV)	Light-green leaf streaks and blotches, stunted plants, reduced seed set.	Not yet observed in barley. Has occurred in wheat in southern irrigation areas and early-sown grazing wheat crops on the tablelands and slopes.	Transmitted by the wheat curl mite.	No control required.
Root and crown diseases				
Take all *Gaeumannomyces graminis* var. *tritici*	Blackened roots and crown, stunting, white heads, pinched grain.	More common in south, favoured by wet winter and early spring, followed by heat or moisture stress at anthesis and grain fill. Less severe on barley than on wheat.	Soil and stubble-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 root rot *Rhizoctonia solani*	Patches of spindly, stunted plants with erect leaves; spear point root rot; plant death. Later infection of crown roots seen as a wavy appearance across the crop.	Associated with minimum or reduced tillage; often aggravated by Group 2 (formerly Group B) herbicides and agricultural hardpans.	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 and fertiliser treatments provide suppression only. Liquid banding of some fungicides is also registered.
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 grain filling.	Stubble-borne on grass and cereal residues.	Crop rotation. More resistant varieties. Grass weed control. Balance fertiliser 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. Infection favoured by warmer soil temperatures (20–30 °C).	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. Certain varieties (Hindmash, La Trobe, Spartacus CL and Rosalind) appear more susceptible.	Airborne spores infect developing seeds at flowering.	Seed-applied fungicides. Treat seed every season.
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. Source clean seed.

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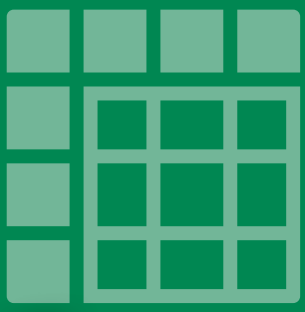

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Oats

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 5 cm sowing depth 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 vegetative period than grain-only crops.

To achieve grain protein of 10% and above in high yielding varieties such as Bilby$^{\Phi}$, Kowari$^{\Phi}$ and Mitika$^{\Phi}$, 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
- 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.

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For the seed rate calculation, go to page 7.

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.

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 Table 91 on page 176 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 genetic control of this disease. Monitor crops in season for these rusts. Rusts can be managed by selecting appropriate varieties, avoiding sowing later maturing varieties, applying late irrigations, and adjusting grazing management (see Managing grazing cereals on page 77) or controlled by applying foliar fungicides at key growth stages.

Insects

Earth mites and **armyworms** commonly affect crops.

- **Earth mites** should be suppressed in the previous spring by applying an insect spray with the fallow weed control program.

- **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.

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.

Producing quality grain

There are strong domestic and export markets with premium payments for oats with a high test weight (kg/hL) – see Table 35. Oat varieties. on page 65.

Producers aiming at milling markets should consider Bannister$^{\Phi}$, Bilby$^{\Phi}$, Durack$^{\Phi}$, Kowari$^{\Phi}$, Mitika$^{\Phi}$, Williams$^{\Phi}$ or Yallara$^{\Phi}$.

For high-quality feed grain oats for livestock, consider low husk lignin varieties Kowari $^{\Phi}$, Mannus$^{\Phi}$, Mitika$^{\Phi}$, Yarran or Yiddah$^{\Phi}$. 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 3 months, protect against insects. Store in the best possible facility to ensure a quality product.

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

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

Bannister$^{\Phi}$, Bilby$^{\Phi}$, Durack$^{\Phi}$, Kowari$^{\Phi}$, Mitika$^{\Phi}$, Williams$^{\Phi}$ or Yallara$^{\Phi}$ are accepted milling varieties. The newer varieties, while 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 might also be accepted.

Variety selection

When selecting a variety consider:

- **region**
- **crop use** – for grazing only, for dual-purpose grazing and grain, for hay, for silage, or for grain-only
- **grazing value** – when is feed most important – in early or late winter
- **hay** – freedom from leaf and stem diseases, resistance to lodging, and maturity to cutting time
- **grain**:
  - to keep on-farm or sell
  - to keep – high yield and low husk lignin content
  - for sale – market requirements – white or cream colour, 'attractive'
  - for feed – high test weight, protein and low husk lignin content
  - for milling – ss 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 might 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 in 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.

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. Check Table 35 for current oat disease ratings and choose varieties with the best resistance for diseases important in your farming system.

Figure 7. Map of NSW showing oat-growing zones.

Milling and potential milling varieties

Bannisterϕ. 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 Mitikaϕ and heads about 3–4 days later than Mitikaϕ. Bannisterϕ has a slightly lower hectolitre weight and slightly higher screenings compared with Mitikaϕ. Seednet.

Bilbyϕ. Released in 2019 from the National Oat Breeding Program. Bilbyϕ is a dwarf, early–mid season milling oat. Plant height is similar to Mitikaϕ and it is 3 days later to head emergence. Grain yield is similar to Bannisterϕ in NSW, but with improved grain quality. Bilbyϕ has low screenings and high groat percentage compared with Williamsϕ and Bannisterϕ. It has a lower hectolitre weight and slightly higher screenings compared with Mitikaϕ and Kowariϕ. Protein is similar to Mitikaϕ and Kowariϕ and grain size is similar to Mitikaϕ, but bigger than Kowariϕ, Bannisterϕ or Williamsϕ. Bilbyϕ has high β-glucan and lower oil than other dwarf varieties with bright grain. High hull lignin oat variety. Barenbrug Australia.

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

Koalaϕ. Released in 2022 from the National Oat Breeding Program (SARDI). Koalaϕ has a high grain yield potential and has performed well in trials throughout the NSW medium–high rainfall zone. Koala is a tall dwarf variety with similar height to Bannisterϕ, and taller than Mitika, Bilbyϕ or Kowariϕ. Koalaϕ has a mid season maturity that can be 7 days later to head compared with Bannisterϕ and Williamsϕ. Early vigour is similar to Bannisterϕ and slightly slower than Bilbyϕ and Yallaraϕ. Limited seed available for 2023 season, contact Seednet if interested. Seed will be widely available to growers in 2024, commercialised by Seednet.

Kowariϕ. Released in 2017 from the National Oat Breeding Program, it is a 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 when compared with Mitikaϕ. It combines high β-glucan with low screenings. Kowariϕ has high grain protein and a slightly higher groat percentage compared with Mitikaϕ. Kowariϕ has a response, similar to Mitikaϕ for stem rust and leaf rust. Like Mitikaϕ, it has low hull lignin. Barenbrug Australia.

Oat grazing and grain yield performance.

Table 30. Higher tablelands dual-purpose compared with Eurabbie = 100% (2004–2009).

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 31. Tablelands/slopes dual-purpose compared with Bimbil = 100% (2004–2009).

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 ❶	106	106	87	87
Eurabbie	114	107	119	118
Mannus	99	97	98	101
Yarran ❶	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 32. Slopes/plains dual-purpose compared with Bimbil = 100% (2004–2009).

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 ❶	106	106	97	86
Eurabbie	107	107	112	120
Mannus	99	97	101	94
Yarran ❶	106	95	120	103
Yiddah	111	111	103	87

❶ Outclassed varieties.

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 33. Sowing times for oats in NSW.

	January		February				March				April				May				June		
Variety Weeks	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Higher tablelands/tablelands: Dual-purpose – grazing and/or grain recovery																					
Bass, Blackbutt, Nile	>	★	★	★	★	★	★	★	★	★	<	<									
Eurabbie			>	>	★	★	★	★	★	★	★	★	★	★	<	<					
Bimbil, Mannus					>	>	★	★	★	★	★	★	★	★	<	<					
Tablelands/slopes: Dual-purpose – grazing and/or grain recovery																					
Blackbutt					>	★	★	★	★	<	<	<	<								
Eurabbie					>	★	★	★	★	★	★	<	<								
Cooba❶						>	★	★	★	★	<	<	<	<	<						
Bimbil, Mannus, Yiddah								>	★	★	★	★	<	<	<						
Coolabah❶, Yarran❶									>	★	★	★	★	<	<						
Slopes/plains: Dual-purpose – grazing and/or grain recovery																					
Cooba❶, Eurabbie						>	★	★	★	★	★	<	<	<	<						
Bimbil, Mannus, Yiddah								>	★	★	★	★	★	★	<	<	<				
Coolabah❶, Yarran❶									>	★	★	★	★	★	<	<	<				
Tablelands/slopes grain only																					
Koala														>	★	★	★	<	<		
Bannister, Possum, Williams,															>	★	★	★	<	<	
Bilby, Koorabup, Kowari, Mitika, Yarran❶															>	>	★	★	★	<	
Slopes/plains grain only																					
Koala														>	★	★	★	<			
Bannister, Possum, Williams, Yallara															>	★	★	★	★	<	
Bilby, Koorabup, Kowari, Mitika, Yarran❶															>	★	★	★	★	★	<
Durack																>	★	★	★	★	★

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

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

Table 34. Grain only varieties compared with Kowari (2018–2022).

North east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% Kowari (t/ha)	2.35	–	4.48	5.17	6.39	4.57	
Bannister	111	–	111	117	116	114	5
Bilby	102	–	106	106	106	106	5
Durack	102	–	92	95	87	92	5
Koala	113	–	104	118	124	114	5
Koorabup	114	–	94	108	91	98	5
Kowari	**100**	**–**	**100**	**100**	**100**	**100**	**5**
Mitika	100	–	96	99	97	98	5
Williams	110	–	113	122	111	114	5
Yallara	115	–	97	107	90	99	5

South east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% Kowari (t/ha)	2.74	1.50	4.79	4.98	4.89	3.89	
Bannister	105	86	112	113	116	110	18
Bilby	103	101	106	107	107	106	18
Durack	97	93	86	83	84	86	18
Koala	97	64	115	113	120	110	18
Koorabup	96	69	86	79	87	84	18
Kowari	**100**	**100**	**100**	**100**	**100**	**100**	**18**
Mitika	96	95	98	94	97	96	18
Williams	100	86	112	106	116	108	18
Yallara	103	78	84	82	85	84	18

South west							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% Kowari (t/ha)	–	1.59	3.78	4.60	5.55	3.88	
Bannister	–	103	105	108	113	108	8
Bilby	–	104	105	103	106	105	8
Durack	–	95	86	91	87	89	8
Koala	–	92	101	111	115	108	8
Koorabup	–	90	77	91	87	86	8
Kowari	**–**	**100**	**100**	**100**	**100**	**100**	**8**
Mitika	–	96	95	98	97	97	8
Williams	–	105	99	104	111	105	8
Yallara	–	95	81	90	86	87	8

The table presents NVT 'Production value' multi environment trial (MET) data on a yearly regional group mean and regional mean basis from 2018–2022.

Preferred milling varieties are Bilby$^{(\flat)}$, Kowari$^{(\flat)}$, Mitika$^{(\flat)}$ and Yallara$^{(\flat)}$. Preferred varieties for feeding grain to livestock are Mitika$^{(\flat)}$ and Kowari$^{(\flat)}$.

MitikaΦ. 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 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. Barenbrug Australia.

WilliamsΦ. Released in 2013 by the National Oat Breeding Program, Williams Φ has a high grain yield potential and has performed well in trials throughout the NSW medium–high rainfall zone. Williams Φ is an early–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 than Yallara Φ. 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. Barenbrug Australia.

YallaraΦ. A medium–tall, early–mid season variety similar to Euro for flowering and maturity. Yallara Φ was released in 2009. It is a Euro lookalike milling line with slightly better grain quality. Yallara Φ has excellent grain quality. It has a high hectolitre weight, low screenings and a high groat per cent. Yallara Φ has bright, plump grain suitable for the milling industry and specialised feed end uses such as the horse racing industry as well as human consumption. Yallara Φ was evaluated for hay production and although the hay yield might be lower than popular hay varieties, it has excellent hay quality. Seednet.

Feed grain, hay and grazing varieties

AladdinΦ. 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 Barenbrug Australia in 2012, and available through Barenbrug Australia.

ArcherΦ. A mid maturing hay oat with single-gene imidazolinone (IMI) tolerance. Medium plant height with good early vigour and hay colour retention. Hay yield data is currently limited in NSW. Improved tolerance to soil-residual IMI herbicides, ideal for use where there are IMI residue concerns. Registered with IBS Sentry® herbicide for hay, seed production and grain (domestic stockfeed markets) only. Archer Φ grain cannot be delivered into bulk grain handling systems. Released in 2022, bred by Grains Innovation Australia (GIA) and commercialised by InterGrain.

AustinΦ. 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. Resistant to current races of leaf (crown) rust. Released in 2018, commercialised by DLF Seeds.

BassΦ. 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.

BondΦ. 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 Taipan Φ. 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 eastern Qld growing environments. DLF Seeds.

BossΦ. A semi-erect medium–late maturing forage oat with high dry matter yields in both initial growth and regrowth. Marketed by EPG Seeds.

BrigalowΦ. A semi-erect, high tillering, medium–late maturity forage oat variety. Flowers slightly later than Drover Φ. Selected Seeds.

Table 35. Oat varieties.

Variety	Grazing		Straw strength after grazing	Grain maturity	Test weight (kg/hL)	Husk lignin content ❺	Diseases						Acid soils sensitivity to aluminium
	Early dry matter production	Grazing recovery					Stem rust ❶	Leaf (crown) rust ❶	BYDV ❻	Red leather leaf	Bacterial blight	Septoria blotch	
Dual-purpose varieties													
Bass	medium	excellent	good	late	medium	low	–	–	T	–	–	–	Tol
Bimbil	medium	excellent	good	early–mid	high	low	–	–	MS	–	–	–	–
Blackbutt	slow	excellent	good	late	low–med	medium ❷	–	–	MT	–	–	–	Tol
Cooba ❸	medium	excellent	fair	early–mid	high	low	–	–	MT	–	–	–	Int
Coolabah ❸	quick	moderate	fair	early	medium	high	–	–	MT	–	–	–	Sen
Eurabbie	quick	excellent	very good	late	low–med	low	–	–	VS	–	–	–	Tol
Mannus	medium	excellent	good	mid	high	low	–	–	MS	–	–	–	–
Nile	quick	excellent	good	very late	medium	low	–	–	T	–	–	–	Tol
Yarran ❸	medium	moderate	good	early	high	low	–	–	VS	–	–	–	Int
Yiddah	slow	excellent	good	early	high	low	–	–	MT	–	–	–	–
Grain only varieties ❹													
Bannister	quick	poor	–	early–mid	med–high	high	S	S–VS	MS	MS–S	S	MS–S	–
Bilby	quick	poor	–	early–mid	med	high	S	S	S	MS	S–VS	S	–
Durack	quick	poor	–	very early	high	high	S	S	S	S–VS	S	S	–
Koala	quick	Moderate-poor	–	mid–late	–	high	MS–S	S	MS–S	S	S	MS–S	–
Koorabup	quick	poor	–	early	–	high	S	S	MS–S	S–VS	S–VS	MR–MS	–
Kowari	quick	poor	–	early	med–high	low	S	S–VS	S	S	S	S	–
Mitika	quick	poor	very good	early	high	low	S	S–VS	S–VS	S–VS	S	S–VS	–
Williams	quick	poor	–	mid	med-high	high	S	MS–S	MS–S	MS	MS–S	MS–S	–
Yallara	quick	poor	good	early–mid	high	high	MS–S	S	MS–S	S–VS	S	MS–S	–

– 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.
Sen Sensitive
Int Intermediate
MT Moderately tolerant
Tol Tolerant.

❶ Field resistance to the rusts on crops differ depending on season, maturity and strains present.
❷ Lignin content of Blackbutt can be variable.
❸ Outclassed, Yarran (BYDV), Cooba and Coolabah (grain yield).
❹ Ratings for the grain only varieties are from the NVT pathology program.
❺ Refer to Table 36.
❻ BYDV ratings for dual purpose oat varieties based on old NSW ratings from local BYDV strains, new strains may be present in NSW and may affect variety performance.

Bronco(Φ). A mid late flowering forage oat with a semi-erect growth habit and good resistance to leaf rust. Suitable for grazing and hay production. Marketed by S&W Seeds Company.

Brusher(Φ). A tall, early- to mid-season hay variety with improved hay digestibility. Resistant and moderately intolerant to cereal cyst nematode. Intolerant to 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 in 2010. DLF Seeds.

Coolabah. Suitable for lenient grazing and good recovery for grain in most areas. Quick early growth. Early maturing. Straw is 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.

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.

ExpressΦ. An erect forage type suitable for grazing, hay or silage, with quick early growth. Late maturing variety. Marketed by Barenbrug Australia.

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

ForesterΦ. A very late hay variety adapted to high rainfall and irrigated cropping regions. It is 3 days later than Riel and 3 weeks later than WintarooΦ. ForesterΦ 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. ForesterΦ has excellent hay quality. Released by SARDI in 2012. ForesterΦ seed is available from AGF Seeds, Smeaton, Victoria.

GalileoΦ. 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; moderately resistant to crown rust. Released by Barenbrug Australia in 2006.

GenieΦ. 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 Barenbrug Australia in 2008 and available through Barenbrug Australia.

Graza 53. A medium maturity forage oat line, with resistance to leaf rust in northern NSW. Semi-erect growth habit. Seed available through EPG Seeds.

Graza 85Φ. A grazing forage oat released by Elders. Medium–medium-quick maturity, with good early vigour, quicker to first grazing than Graza 80Φ. 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 EPG Seeds.

IgniteΦ. Released in 2022. A semi-erect, late maturing forage oat with excellent early growth. Ideal for early plantings with good tillering ability. High total season dry matter production. Will remain vegetative into late spring. Showing resistance to all current pathotypes of leaf (crown) rust. Commercialised by DLF Seeds.

KingbaleΦ. A new mid maturing hay oat variety with single gene tolerance to IMI chemistry. Improved tolerance to soil-residual IMI herbicides. Registered with IBS Sentry® herbicide for hay, seed production and grain (domestic stockfeed markets) only. KingbaleΦ grain cannot be delivered into bulk grain handling systems. A variety for use where there are IMI residue concerns from previous crops. Hay yield data is currently limited in NSW, similar agronomic profile to WintarooΦ. Bred by GIA and commercialised by InterGrain.

KoorabupΦ. Released in 2019 from the National Oat Breeding Program, it is a hay oat variety with improved grain yield over other hay varieties. KoorabupΦ is a medium-tall hay variety with early–mid to mid season maturity developed for the WA market. It is similar in height, 2–4 days later in maturity and has similar grain yield and stem diameter compared with YallaraΦ. Hay yield is slightly higher than CarrolupΦ, but lower than YallaraΦ and BrusherΦ. It has improved disease and grain quality compared with other current hay varieties. It has excellent hay colour, and hay quality is similar to WintarooΦ across all traits except water soluble carbohydrates, which averages slightly lower in Victoria and WA. Grain quality is similar to YallaraΦ, but with a lower groat per cent. It has low oil and bright grain. Commercialised by AEXCO.

KultarrΦ. A quick-mid maturing hay oat variety with tall plant height. Slightly later to flower than BrusherΦ, similar to MulgaraΦ. Preliminary hay quality data indicated suitable quality profile. Released in 2022, bred by SARDI, commercialised by InterGrain.

LavishΦ. A semi-erect, high tillering, late maturity forage oat variety. Maturity similar to TaipanΦ. Marketed by Upper Murray Seeds.

MammothΦ. A long season forage oat variety. Marketed by Barenbrug Australia.

MannusΦ. 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.

MoolaΦ. 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.

MulgaraΦ. A tall, mid season hay oat slightly earlier in heading time than, and similar in height to, Wintaroo Φ with cereal cyst nematode and stem nematode resistance and tolerance. Mulgara Φ is an improvement compared with Wintaroo Φ for resistance to stem rust and bacterial blight, lodging and shattering resistance and has early vigour. Hay yield is an improvement compared with Brusher Φ, but slightly lower than Wintaroo Φ. Hay quality is better than Wintaroo Φ. Mulgara Φ also maintains good hay colour and resists brown leaf at hay cutting. Grain yield and quality is similar to Wintaroo Φ, but slightly better grain quality. 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.

OliverΦ. A dual-purpose grazing and hay oat variety. Mid maturity forage oat variety, that has good early vigour. Low growing point compared with many forage oats, with narrow leaves and a high tillering capability. Marketed by EPG Seeds.

Outback. A forage oat that has quick, early growth and dry matter production. Erect habit and mid–late maturity. Released in 2005, marketed by S&W Seeds Company.

Overlander. A forage oat that has quick, early growth and dry matter production. Erect habit and mid–late maturing forage oat with improved tiller production. Marketed by S&W Seeds Company.

Raptor. Earlier maturing forage oat that has a semi erect growth habit. Suited to all livestock types, with quick early growth. Currently has a good level of resistance to all leaf rust pathotypes. Marketed by Pacific Seeds.

Sabre. Late maturity forage oat variety, with intermediate growth habit. Currently resistant to all leaf rust pathotypes. Due to Sabre's late maturity, it will remain vegetative into late spring for an extended grazing period. Marketed by Pacific 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 RAGT.

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

SF Regency. A new mid season forage oat variety, with more prostrate growth habit then traditional forage oats. Only available in propriety seed blends SF Taurus and SF Aries. Marketed by RAGT.

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

TaipanΦ. 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.

TammarΦ. 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.

TungooΦ. 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 than Massive® in maturity. Semi-erect growth habit. Marketed by Upper Murray Seeds.

WallabyΦ. A mid slow-maturing hay oat variety with similar yields to Mulgara Φ and Brusher Φ. Good digestibility, high water-soluble carbohydrate levels and low neutral detergent fibres. Moderately tall plant height and likely suited to medium–high rainfall zones. Hay yield data is currently limited in NSW. Released in 2022, bred by SARDI and commercialised by InterGrain.

WarlockΦ. A medium–late maturity grazing oat variety. Erect early growth habit, tall plant height, high tillering and medium thick leaves and stems. Similar appearance to Genie Φ but slightly taller, higher tillering and later in maturity. Known to be susceptible to at least one known leaf rust pathotype. If leaf rust is present, use an appropriate foliar fungicide to reduce impact. Selected for Queensland and northern NSW. Released by DAF Qld and Barenbrug Australia in 2018, and available through Barenbrug Australia.

WintarooΦ. 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.

WizardΦ. 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 Barenbrug Australia in 2017, and available through Barenbrug Australia.

Yarran. A medium height, early–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 out yields 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.

YiddahΦ. 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.

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 Φ 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 36 below 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 in young animals.

Table 36. 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, Bilby, Carrolup, Coolabah, Dawson, Drover, Dunnart, Durack, Echidna, Forester, Genie, Graza 50, Kangaroo, Koala, Koorabup, Mortlock, Nugene, Possum, Taipan, Williams, Yallara

Table 37. Hay oat varieties.

Variety	Grazing		Straw strength after grazing	Maturity	Diseases					Acid soils – sensitivity to aluminium
	Early dry matter production	Grazing recovery			Stem rust ❶	Leaf (crown) rust ❶	BYDV ❹	Red leather leaf	Bacterial blight	
Bass	medium	excellent	good	late	–	–	T	–	–	Tol
Bimbil	medium	excellent	good	early–mid	–	–	MS	–	–	–
Blackbutt	slow	excellent	good	late	–	–	MT	–	–	Tol
Cooba ❷	medium	excellent	fair	early–mid	–	–	MT	–	–	Int
Coolabah ❷	quick	moderate	fair	early	–	–	MT	–	–	Sen
Nile	quick	excellent	good	very late	–	–	T	–	–	Tol
Yarran ❷	medium	moderate	fair	early	–	–	VS	–	–	Int
Yiddah	medium	excellent	good	early	–	–	MT	–	–	–
Specialist hay varieties										
Archer	–	–	–	Mid	–	–	–	–	–	–
Brusher	medium	–	good	early–mid	S–VS	S q	S–VS ❸	MS	S	–
Kingbale	–	–	–	mid–slow	–	–	MS ❸	S	MS & S	–
Koorabup	medium	–	–	early	S	S	MS–S	S–VS	S–VS	–
Kultarr	–	–	–	early-mid	–	–				–
Mulgara	medium	–	–	early–mid	MR–MS	MR–MS	MS ❸	S–VS	MS–S ❸	–
Tungoo	medium	–	–	mid–late	MS	MS–S	MS–S	MR–MS	S	–
Wallaby	–	–	–	mid–slow	–	–	–	–	–	–
Wintaroo	medium	–	fair–good	mid–slow	MS–S	MS–S	MS	S	S ❸	–

Select more than one variety, with at least one from the early maturing group and another from mid or late maturing group.

– Insufficient data

Resistances

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.

Sensitivity

Sen Sensitive
Int Intermediate
MT Moderately tolerant
Tol Tolerant.

❶ Field resistance to the rusts on crops differ depending on season, maturity and strains present.
❷ Outclassed, Yarran (BYDV), Cooba and Coolabah (grain yield).
❸ Provisional disease rating.
❹ BYDV ratings for dual purpose oat varieties based on old NSW ratings from local BYDV strains, new strains may be present in NSW and can affect variety performance.

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 80 for details).

Table 38. 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 (BYDV) *Barley yellow dwarf virus*	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.
Septoria blotch *Phaeosphaeria avenaria* f.sp. *avenaria*	Small dark coloured spots on leaf, oval to elongated in shape. Chlorotic margin surrounds lesions as they mature. Often lesions coalesce. Leaf death.	More severe in in oat-on-oat rotation. Becoming more common in southern NSW.	Oat stubble inoculum and rain splash in crop.	Sow varieties with improved levels of resistance. Crop rotation. Avoid sowing oats back into infected stubbles. In crop fungicides when economically viable (under high disease pressure)
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.	Uniformly graze infected crops in autumn, with crash grazing more effective than set stocking rates. Sow varieties with improved levels of resistance. Application of 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 might 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*	Reddish-brown, powdery, oblong pustules with tattered edges on leaf (both sides) and stem; progressive plant death.	More important inland, from spring to summer in warm, wet weather.	Airborne spores from living plants.	Early maturing varieties to avoid rust. Apply 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.

Contributing authors

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Key grain characteristics

Table 39. 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.

Figure 8. Canola being offloaded into open bunkers at Temora NSW.

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 receives a lower price per tonne at the farm gate compared with milling wheat. An exception to this can be where there is strong local demand for feed grain when a better cash return from lower 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 triticale's good shattering tolerance 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 at 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.

Table 39. 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.

GO TO PAGES

How to calculate sowing rates: on page 7.

Read in conjunction with Table 43 on page 76.

Grazing

The ideal stage to start grazing dual-purpose varieties is when plants are well anchored and the canopy has closed. For fattening stock, continuous grazing is better than rotational grazing. 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.

Disease

Triticale is susceptible to loose smut and should be treated with a fungicidal 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, Kokoda$^{\Phi}$ and Tuckerbox.
Grazing and grain recovery – outclassed: Wonambi (stripe rust).

Grain only: Astute$^{\Phi}$ or Bison$^{\Phi}$ – for main season sowings (mid May–June).

Grain only – outclassed: Fusion$^{\Phi}$ (stripe rust).

Varietal characteristics

Dual-purpose grazing varieties

Cartwheel$^{\Phi}$. A long-season dual-purpose triticale that is suitable for an early March to early April sowing. 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$^{\Phi}$. Grain yield after grazing is equivalent to Tobruk$^{\Phi}$. Resistant to cereal cyst nematode, flag smut and bunt. Resistant to moderately resistant to septoria tritici blotch and moderately resistant to yellow leaf spot. Released by the University of Sydney. Seed is available from Waratah Seeds distributors.

Crackerjack 2. A mid–late season replacement for the original Crackerjack. Earlier sowing option than 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 Barenbrug Australia.

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

Kokoda$^{\Phi}$. A dual-purpose semi-awnless triticale that can be sown from mid March to the end of April, though could be sown earlier if grazed judiciously. Very good first dry matter production with excellent forage recovery and dry matter production in winter. It can be grazed until the end of July. High grain yield after grazing, being better than Endeavour$^{\Phi}$ and Cartwheel$^{\Phi}$ in NSW dual-purpose cereal evaluation trials. Limited trials have shown improved metabolisable energy in the grain for pigs and chickens, and higher starch and lower fibre compared with Endeavour$^{\Phi}$. Resistant to flag smut and bunt. Resistant–moderately resistant to septoria tritici blotch and moderately resistant to yellow leaf spot. Released by the University of Sydney. Seed available through Waratah Seeds distributors.

Tuckerbox. A reduced-awn, medium season, tall, dual-purpose variety suitable for grain, hay or silage production. Tuckerbox is most suited to production areas with 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.

Wonambi. A late spring-type triticale suitable for grazing, forage conservation and grain production. Tip-awned, dense grained triticale. Bred at Sherlock, South Australia, by Kath Cooper. Marketed by Naracoorte seeds. Non PBR.

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 vary 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 40. Suggested sowing times for triticale.

Variety	February		March				April				May				June				July	
Weeks	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Endeavour	>	★	★	★	★	★	★	★	<	<										
Cartwheel, Kokoda		>	★	★	★	★	★	★	<	<										
Crackerjack 2						>	★	★	★	★	★	<	<							
Wonambi ❶							>	★	★	★	★	★	<							
Tuckerbox									>	★	★	★	★	★	★	<				
Astute, Bison, Fusion											>	★	★	★	★	★	<			
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.

❶ **Note**: Limited information available on the response to sowing time for this variety .
> Earlier than ideal, but acceptable.
★ Optimum sowing time.
< Later than ideal, but acceptable.

Table 41. Dual-purpose triticale performance compared with Endeavour (2011–2017).

Variety	1st grazing DM	2nd grazing DM	Grain recovery
% of Endeavour (t/ha)	**2.30**	**2.83**	**4.10**
Cartwheel	91	102	107
Endeavour	**100**	**100**	**100**
Kokoda	103	107	109
Wonambi	97	87	91
Tobruk	92	102	108

Table 42. Dual-purpose triticale performance compared with Endeavour (2011–2017).

North east						
	Yearly group mean				Regional mean (2008–2015)	Number of trials
Variety	2012	2013	2014	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
Fusion ❹	**100**	**100**	**100**	**100**	**100**	**11**
KM10 ❹	–	–	92	94	87	4

South east						
	Yearly group mean				Regional mean (2008–2015)	Number of trials
Variety	2012	2013	2014	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
Fusion ❹	**100**	**100**	**100**	**100**	**100**	**22**
KM10 ❹	–	–	88	91	89	7

South west irrigated						
	Yearly group mean				Regional mean (2008–2015)	Number of trials
Variety	2012	2013	2014	2015		
% Fusion (t/ha)	**6.46**	**–**	**8.07**	**6.49**	**6.08**	
Astute	–	–	104	111	112	2
Bison	–	–	100	110	103	2
Fusion ❹	**100**	**–**	**100**	**100**	**100**	**5**
KM10 ❹	–	–	90	100	91	2

❹ Outclassed – Fusion (stripe rust) and KM10 (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, 2014 and 2015.

No new data is available for triticale variety performance in NSW, with NVT testing stopping in 2015.

Grain only varieties

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

BisonΦ. An early to mid maturity variety, suited to low–medium yield potential environments, performing well across NSW. Reduced-awned variety; possible replacement for Rufus. Seed is available through AGT Affiliates. AGT.

FusionΦ. Mid maturity triticale, a unique line bred from a cross between triticale parents and a bread wheat parent called Stylet. Fusion Φ maintains exceptionally high yields under tough conditions such as drought or tight finishes. It is best suited to medium yield potential environments and has performed well across all regions of NSW. Fusion Φ is available through AGT Affiliates. AGT.

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

The following are more recently released varieties with no yield performance data available for NSW.

Joey. Mid maturity, tall, reduced-awn triticale, suitable for forage conservation and grain for feed and milling. Rated susceptible for stem rust and is not recommended for northern NSW where stem rust is an increased risk. Selected at Sherlock, South Australia, by Kath Cooper, non-PBR.

Razoo. Mid maturity, medium height, reduced-awn triticale, suitable for forage conservation, and grain for feed and milling. Selected at Sherlock, South Australia, by Kath Cooper, non-PBR.

Woomera. Later maturing, medium-tall spring triticale with reduced-awn head type. Suited to forage and grain production, preferring higher rainfall and longer season environments. Seed available for the 2023 season. Selected at Sherlock, South Australia, by Kath Cooper, non-PBR.

Table 43. Variety characteristics and reaction to diseases ❶.

Variety	Grazing production	Straw strength	Maturity	Resistances				Acid soils – sensitivity to aluminium
				Stem rust	Leaf rust	Stripe rust ❷	Cereal cyst nematode	
Dual-purpose								
Cartwheel	quick–early	very good	mid–late	R	R	R–MR	R ❸	–
Crackerjack 2	quick–early	moderate	mid–late	–	–	–	–	–
Endeavour	quick–early	very good	late	–	–	–	–	V. tol
Kokoda	quick–early	very good	mid–late	R	R–MR	R–MR ❸	MR	–
Tuckerbox	quick–early	–	mid	–	–	–	–	V. tol
Wonambi ❹	quick–early	good	mid–late	R	R	S	MS	–
Woomera	quick–early	good	mid–late	MS	R–MR	MS–S	MS	–
Grain only								
Astute	NR	very good	early–mid	MR	R–MR	MS–S	R	V. tol
Bison	NR	good	early–mid	–	–	–	R	V. tol
Fusion ❹	NR	medium-good	mid	R	R	S	R	V. tol
Joey	NR	–	mid	S	R–MR	MS–S	MS	–
KM10 ❹	NR	good	very early	R	MR & S	S	S	–
Razoo	NR	–	mid	MS	R–MR	MS–S	MS	–

❶ Disease ratings come from the NVT pathology project, funded by GRDC. Very limited disease testing of triticale varieties is undertaken in the NVT pathology project.
❷ Stripe rust ratings shown is a combined rating for all pathotypes.
❸ Provisional rating
❹ Outclassed
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.

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
–	Unknown or no data

Marketing

Triticale is predominantly used as a stockfeed and 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, 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.

Contributing authors

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Managing grazing cereals

Key considerations

Grazing cereals have the capacity to:

- produce large amounts of stock feed
- develop a whole farm feed plan (including both grazing crops and pasture) to avoid forage wastage or impacting cereal crop growth, development or grain yield.

Some long season varieties sown early rely on grazing to delay growth stages to avoid frost risks at stem elongation, booting and flowering.

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.

Dual-purpose grazing cereal varieties have been evaluated across NSW for their dry matter production and grain yield recovery. 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 44. Average dry matter yield performance for cereals in NSW.

Crop type	Dry matter 1❶ (kg/ha)	Dry matter 2❶ (kg/ha)
Oats	2593	2324
Barley	2183	2570
Wheat	1922	2222
Triticale	2303	2525

❶ 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 to 2010.

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 a crop that is grown in a particular area. Applying seed insecticide dressings can reduce effects from diseases such as BYDV on the crop by reducing the levels of early aphid feeding activity, which spreads the virus. 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 Manning$^{\phi}$ 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.

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See Table 91 on page 176 for a list of currently available seed dressings for aphid control.

GRAZING WITHHOLDING PERIODS

For the current withholding periods for the main seed fungicide and insecticide dressings, see Table 90 on page 173.

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. 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 delay 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 8.

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.

Figure 8. Cross-section showing wheat head in young plant.

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 46 below).

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 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 45 below 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.

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 45. Dry matter 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.

Table 46. 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/day crop growth.
DM Dry matter.
DDM Digestible dry matter.

Contributing authors

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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 is 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, SA 5001
t: 1300 928 170 or 08 8303 9549
e: PIRSA.seeds@sa.gov.au

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

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

Industry organisations

Australian Fodder Industry Association Inc.
(www.afia.org.au)
PO Box 527, Ascot Vale, Victoria, 3032
t: 0411 529 634
e: info@afia.org.au

Australian Oilseeds Federation
(www.australianoilseeds.com)
PO Box H236, Royal Exchange NSW 1225
t: 02 8007 7553
e: admin@australianoilseeds.com.au

Grains Australia
(www.grainsaustralia.com.au)
Level 13, Suite 1A, 465 Victoria Avenue,
Chatswood, NSW 2067
t: 02 9994 8000
e: admin@grainsaustralia.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
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
e: admin@graintrade.org.au

NSW Durum Growers Association
Chairman: Ross Durham
Nombi, Mullaley NSW 2379
m: 0427 437 841
e: ross@nombi.com.au

SA Durum Growers Association
(www.durumgrowerssa.org.au)
Secretary: Deb Baum m: 0481 322 821
e: sadgasecretary@gmail.com

Pulse Australia Ltd
(www.pulseaus.com.au)
PO Box H236, Royal Exchange NSW 1225
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

Variety Central
(www.varietycentral.com.au)
Contact: Denis McGrath
m: 0408 688 478
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:

University of Sydney
Australian Cereal Rust Survey
Reply Paid 88076
Narellan NSW 2567

For more information, go to the University of Sydney's Australian Cereal Rust Survey page (https://www.sydney.edu.au/science/our-research/research-areas/life-and-environmental-sciences/cereal-rust-research/rust-reports.html).

Canola

Key considerations for 2023

- Target high fertility paddocks to increase crop yield potential and minimise the need for high N inputs.
- Ensure fallow weeds are controlled and soil cover is maintained to maximise sowing opportunities.
- Disease inoculum levels will be high in 2023; plan crop protection inputs ahead of potentially conducive seasonal conditions for disease.
- Test farmer-retained seed for germination and vigour 4–6 weeks before sowing.

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 competes strongly with weeds, which complements herbicide control and reduces reliance on herbicides.

Canola is best suited to paddocks with a high nitrogen (N) level as it has a greater N demand than other commonly grown crops. Growing a pulse crop the year before sowing canola can be useful for fixing and conserving N and controlling weeds.

Pulses, especially field pea, leave more water than cereals deeper in the soil profile for the following crop. Faba bean is another option to field pea. A pulse crop will have a low stubble load at sowing, which will help crop establishment, but could increase the risk of diseases such as sclerotinia stem rot (*Sclerotinia*). In northern and western 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 fertile paddocks free of hard pans, crusting, waterlogging potential, or subsoil constraints. Avoid acidic soils, especially those high in aluminium and manganese. Severely acidic layers (pH_{Ca} <4.5) are common at depths of 5–10 cm and 10–15 cm in the main cropping soils of central and southern NSW. Check for acidic layers by sampling soils at 5 cm intervals to 20 cm deep, 2 years before sowing canola.

Where acidity is detected below the surface soil, the most rapid method to increase pH is to incorporate fine-grade lime to 10–15 cm deep, at least 12 months before sowing canola.

Maintain an adequate break between canola crops to minimise the risk of yield losses from blackleg and *Sclerotinia*. 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 2 herbicides should be thoroughly decontaminated before being used on canola.

Sowing

Seedbed preparation

Canola is best sown using no-till systems, which minimises the loss of seedbed moisture. Stubble retention and strict fallow weed control will greatly increase the chance of germinating canola on time.

When sowing into cereal stubble, ensure that straw and header residue is pushed away from the sowing row. Stubble that is 'hair-pinned' in the furrow or covering the row can reduce canola emergence, early plant growth and reduce yield. Burning stubble residue from the previous crop can be a useful strategy to improve canola emergence where stubble loads are very high and suitable machinery is not available. Burning should be done as close as possible to sowing to minimise soil moisture loss from the surface.

Sowing depth

Where conditions allow, aim to sow 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 high-vigour 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.

Dry sowing

Canola can be successfully dry sown in reliable rainfall zones, allowing emergence following the first rain after sowing. Seed should be placed at around 1.5–2 cm deep and pressure on closing devices (e.g. press wheels) should be minimised. When sowing dry, select a variety with flexible phenology (i.e. one with a stable flowering date across a wide range of germination dates) as the germination date will be uncertain unless sowing in front of an assured rain.

Seed quality and establishment

Research has shown that retaining and replanting seed from hybrid crops (F2 seed) can reduce yield by 7–17% compared with the F1 hybrid crop. 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 ≥1.8 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 on time 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, too fast, sowing into marginal moisture, 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 their larger seed size.

Farmer-retained seed for sowing

Seed retention blocks need to be managed differently from commercial crops to ensure high-vigour seed is produced with superior establishment characteristics. Retaining large sized seed alone will not guarantee successful establishment if the seed crop has been poorly managed.

The key principles of seed crop production include:

- favourable conditions during seed fill
- low seed chlorophyll levels
- adequate seed phosphorus concentration
- allowing the crop to reach harvest maturity (not physiological maturity)
- retaining large sized seed.

Five key steps to grow high-vigour seed-lots are:

1. Match phenology and sowing time. Ensure the seed crop flowers within the critical flowering period for the environment (see Table 46), as the aim is to reduce heat and frost stress and provide favourable conditions for seed fill.
2. Target high plant density (>40 plants m^2). Ensure a high proportion of seed yield is derived from the main stem and not lower branches. Seeds produced from the main stem have a longer seed fill duration (slower and preferential accumulation of assimilates and nutrients) and less seed chlorophyll compared with lower branches.
3. Apply an adequate amount of phosphorus (P) fertiliser. Phosphorus-deficient seed crops can produce up to 50% abnormal seedlings; ensure the seed-crop is not P deficient (see Phosphorus section) while maintaining high plant density.
4. Allow the crop to reach harvest maturity. Seeds develop germination capacity before seed vigour, and the gap between germination percentage and vigour is reduced when the seed-crop is allowed to reach harvest maturity. Therefore, direct heading is the preferred option, but if not possible, windrow late (80% seed colour change) in the cool of the evening. Do not apply glyphosate as a harvest aid or for late weed control.

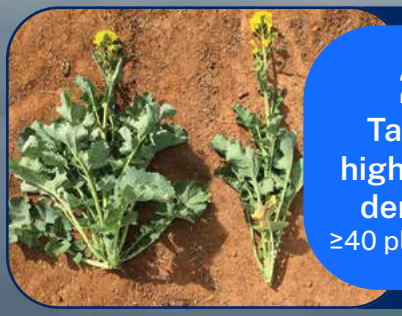
Five tips to grow high-vigour canola seed

NSW GOVERNMENT

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

1 Match phenology and sowing time

- Ensure seed crop flowers within the critical flowering period for your region.
- Aim is to provide favourable and prolonged conditions for seed fill, with reduced abiotic (frost/heat) and biotic (blackleg/sclerotinia) stress.
- Apply normal disease management strategies (foliar fungicide).



2 Target high plant density

≥40 plants/m^2

- Ensure high proportion of seed yield is derived from the main-stem (not lower branches).
- Reduce sowing speed, ensure adequate fertiliser separation from seed, reduce stubble loads if necessary and ensure uniform seed placement.

3 Apply adequate phosphorus fertiliser

- Ensure seed-crop is not phosphorus deficient whilst also maintaining high plant density.
- If phosphorus fertiliser cannot be separated from the seed, increase seeding rate by 10–20% to allow for establishment losses.

Photo: Chris Roberts

4 Allow seed-crop to naturally mature

- Direct heading is the preferred option (crop allowed to naturally ripen).
- If direct heading is not possible, windrow late (80% seed colour change) in the cool of the evening.
- DO NOT apply glyphosate as a harvest aid or late weed control .

5 Grade and retain large sized seed

- Target 1.8 mm seed size or above (bigger the better).
- Larger seed = larger cotyledons = higher seedling biomass accumulation.
- At a minimum ensure seed smaller than 1.6 mm is removed, and also sclerotia.

These outcomes are derived from project DAN1906-007RTX
Improving production of grower retained open pollinated canola seed using agronomic management to increase establishment in the MRZ and LRZ of the GRDC Northern Region, a co-investment between NSW DPI and GRDC.

5. Grade and retain large sized seed. Target ≥1.8 mm seed size or above (the bigger the better). At a minimum ensure <1.6 mm seed size is graded out. Larger seed size is required when sowing depth increases, for example 1 cm depth ≥1.6 mm; 3 cm depth ≥1.8 mm; 5 cm depth ≥2 mm. Larger seed size will always provide quicker ground cover, no matter the seeding depth.

Varietal phenology

Research has shown that there are major differences in canola variety phenology, especially when sown early. Sowing fast varieties early can lead to flowering starting in early winter, exposing the crop to increased frost and disease risk, and often lower yield potential. Where early sowing is a viable option, choose a slow developing variety that still flowers at the optimum time for the environment (see *Ten tips to early-sown canola* and *Twenty tips for profitable canola – central & southern NSW*).

Slower developing varieties generally have a wider optimum sowing window, as large variations in sowing date only result in small changes in flowering date. On the other hand, fast varieties have a shorter sowing window as small variations in sowing date can lead to large changes in flowering date, especially when sowing date is moved earlier. The optimum sowing times for key canola growing environments are summarised in Table 47 below. For locations not included in the table, it is best to take the middle point of 2 nearby locations. Adjustments can be made based on local knowledge, for example sowing early in the sowing window is feasible in low frost-risk paddocks, while sowing later in the window is recommended in high disease risk environments.

Consider the chances of sowing early when selecting a variety. In western and northern regions there is generally less opportunity to sow canola in the first 2 weeks of April, so fast and mid season varieties are more suitable. For eastern regions, especially in the key canola growing regions of the eastern Riverina, South West Slopes and central western slopes, early sowing opportunities are more likely. Sowing slower developing varieties early should be considered to increase water use efficiency and profitability.

Phenology ratings (especially in response to early sowing) for most varieties are now available so growers and agronomists can match the sowing date recommendations in Table 47 with the varietal phenology ratings in Table 48 on page 95.

Research is ongoing with the goal of predicting flowering times based on a variety's genetics. Canola variety characteristics and disease reactions are also highlighted on page 95. It is more important to consider a variety's phenology than its maturity.

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Ten tips to early-sown canola (https://grdc.com.au/resources-and-publications/all-publications/publications/2018/ten-tips-to-early-sown-canola)

Twenty tips for profitable canola – central & southern NSW (https://grdc.com.au/resources-and-publications/all-publications/publications/2019/20-tips-for-profitable-canola-northern-nsw)

Table 47. Canola suggested sowing times for variety types with slow, mid and fast phenology (speed to flowering).

Region/locations	Phenology	March				April				May			
		1	2	3	4	1	2	3	4	1	2	3	4
North-east/Liverpool Plains Gunnedah, Bellata, North Star	Slow												
	Mid												
	Fast												
North-west Coonamble, Burren Junction, Garah	Slow												
	Mid												
	Fast												
Central-east Wellington, Parkes, Canowindra	Slow												
	Mid												
	Fast												
Central-west (north) Gilgandra, Trangie, Nyngan	Slow												
	Mid												
	Fast												
Central-west (south) Condobolin, West Wyalong, Rankins Springs	Slow												
	Mid												
	Fast												
South West Slopes Young, Cootamundra, Culcairn	Slow												
	Mid												
	Fast												
Riverina Coolamon, Lockhart, Corowa	Slow												
	Mid												
	Fast												

Optimal sowing time.
Earlier than optimal; potential yield reduction.
Later than optimal; potential yield reduction.

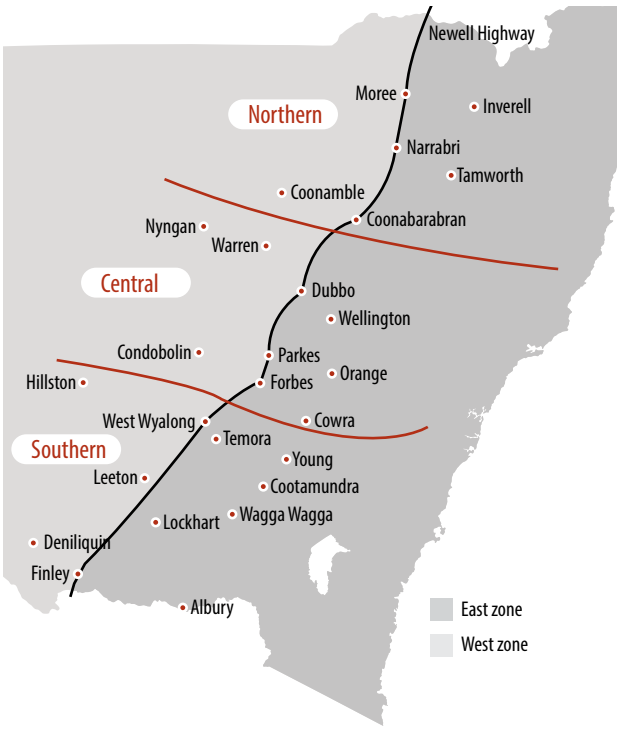

Figure 9. Map of NSW showing canola-growing zones.

Nutrition

Nitrogen

High yielding canola crops have a high N requirement, which can be provided by:

- 2–4 years of legume-dominant pasture
- pulse crops that supply some of the N requirement
- applying adequate N throughout the rotation
- applying N 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 usually 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 a high yield potential and rain falls soon after. 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 72 kg N/ha per tonne of grain (assuming 50% efficiency), so a 2.5 t/ha crop requires 180 kg N/ha. This can be supplied by existing soil mineral N at sowing, applied N fertiliser and soil N mineralisation during the growing season.

High N application rates 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. It should therefore be separated at sowing.

Eastern zones of central and southern NSW: No more than 10 kg N/ha 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

Canola has a high sulfur (S) requirement – more than double that of wheat. Apply 25 kg S/ha as 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. Even where there is high S down deep, roots might not be able to access it in dry or waterlogged years. Apply S fertiliser test strips at sowing to confirm that S is not lacking. Sulfur deficiency can be quickly corrected in-crop by applying sulfate of ammonia.

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

Phosphorus

Ensure that adequate phosphorus (P) is applied at sowing. Unless the crop is sown into a soil with high P, apply at least 8 kg P/ha for every tonne of canola expected to be harvested, e.g. apply 20 kg P/ha if the target yield is 2.5 t/ha. Low or deficient P levels can limit the crop's potential response to N. 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 P/ha 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, 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 many pests that can affect canola crops, particularly during the emergence, early seedling and flowering/podding growth stages. Pests are best managed using an integrated pest management (IPM) approach. All canola pests have a range of natural predators that can help keep the pest populations below economic damage levels. Before sowing, check the paddock history for previous pests, stubble load and 'green bridge' weeds from the summer fallow period. To help identify potential problem pests refer to the publication *Insect pests of establishing canola in NSW* on the GRDC website.

Regularly monitoring crops after sowing will ensure problems are identified and, if necessary, treated early. Decisions to use chemical controls should consider the effects on the beneficial populations, especially early in the season when using broad-spectrum insecticides could destroy many of the natural predators that will keep later season pests in check. More recent information on insecticides and miticides effects on beneficial organisms is available on the GRDC website.

Be aware of nearby beehives when insecticides are being applied, to ensure that damage is not caused to hives. Many beneficial insects including European and native bees are attracted to canola flowers, so care needs to be taken when spraying to preserve these. Early morning or evening spraying will help when these insects are less active. Ensure you adhere to the harvest withholding period (WHP) of the insecticide.

Earth mite –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 and baluastium 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 4 species of mites to ensure that the correct insecticide and rate is applied to the relevant species. The trend towards earlier sowing for some canola varieties can avoid the cool, wet conditions that trigger mite hatching and gives seedling canola a competitive growth advantage.

- **Treatments – bare earth:** 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 3 registered bare earth sprays that will give several weeks of residual protection:
  1. bifenthrin is registered for RLEM, BOM and bryobia mites, but the application rate varies according to the targeted mite species.
  2. alpha-cypermethrin will control RLEM
  3. methidathion is registered for both RLEM and BOM.

  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.

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Insect pests of establishing canola in NSW (https://grdc.com.au/resources-and-publications/all-publications/publications/2019/insect-pests-of-establishing-canola-in-nsw)

GRDC website (https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2022/02/the-impact-of-insecticides-and-miticides-on-beneficial-arthropods-in-australian-grains)

- **Treatments – seed treatments**
  - Imidacloprid (see Table 93. Canola and pulse seed dressings – 2023. on page 181) 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 suppressing 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.
  - Cosmos® (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 earth mite damage.

Lucerne flea –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 mainly a problem in heavier clay/loam soils 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 effects on seedling vigour and crop performance. Ensure sufficient monitoring to detect localised patches or hot spots. Lucerne flea will move in from the edge of paddocks and a border spray is often all that is needed for control. Seek advice on management and spray strategies.

Slugs –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 (DBM) –has been observed in canola crops for many years in NSW. Moisture-stressed crops will attract DBM, so monitoring early along tree lines can give an indication that populations are about to increase. 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. Winter canola crops that are sown in late summer–early autumn, and those maturing in early summer, are more likely to require DBM control. The pest has developed resistance to a range of insecticides, so future management will involve regular monitoring and carefully selecting control methods.

Aphids –flights can occur in autumn and winter and can infest young canola crops, especially following a wet summer that provides a green bridge of alternative host plants on which aphids can survive and breed. Seed treated with imidacloprid, Poncho® Plus and Cruiser® Opti will protect seedling canola for up to 5 weeks. This is especially important in seasons and at sites with early aphid infestations.

- Transform™ (sulfoxaflor), MainMan® (flonicamid) and Versys® (aphidopyropen) are selective insecticides to control early-season infestations of the green peach aphid. The green peach aphid is the major vector of *Turnip yellows virus* (TuYV) – formerly known as *Beet western yellows virus* – which caused some crop damage in southern and central NSW in 2014. Green peach aphid has developed resistance to the synthetic pyrethroid, carbamate and organophosphate groups of insecticides. The GRDC GrowNotes publication *Reducing aphid and virus risk* has more information.
- 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. Aphids have a wide range of natural predators that will keep moderate populations in check in most seasons. Lady beetles, hover flies, lacewings and parasitic wasps are the main natural predators providing a level of aphid control. Using the 'soft' insecticide pirimicarb (e.g. Pirimor®) will help maintain populations of natural predators.

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Reducing aphid and virus risk (https://grdc.com.au/resources-and-publications/all-publications/factsheets/2015/02/reducing-aphid-and-virus-risk)

***Helicoverpa* spp. caterpillars** – 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 caterpillars

- **Cabbage centre grub** (*Hellula* spp.) is a sporadic pest in early sown canola. They are a warm season pest of forage brassica in spring, summer and autumn and can transfer to early sown canola. In most cases they will not persist in cool, wet conditions and most early sown canola is intended for grazing, which is often an effective control measure. If chemicals are used be aware of the grazing withholding period (WHP).
- **Brown pasture looper** (*Ciampa arietaria*) is another occasional caterpillar pest that occurs later in winter and into spring, coming off weedy pasture paddocks. Economic damage is not likely in vigorously growing canola, but any late sown or poorly growing canola could be targeted. Spot spraying or border sprays might be needed.

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. Retained stubble, 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 other soil-dwelling insect pests such as **Portuguese millipede**, **cutworm**, **wireworm**, **bronzed field beetle**, **cockchafer** and **false wireworm** 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 – the most important disease of canola, with a range of management strategies available. 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. Use the BlacklegCM app before sowing to identify high risk paddocks and explore management strategies to reduce potential yield loss.

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 pydiflumetofen, fluopyram or 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. The foliar fungicides Prosaro®, Aviator Xpro®, Veritas® Opti, Miravis® Star, Maxentis® EC, Mirador® 625/Proviso® tank-mix and Proviso®/Veritas® Opti tank-mix are registered for managing blackleg at the seedling to early vegetative stage. Rotating fungicide actives will reduce the risk of developing resistance in the pathogen population. Croplife Australia has on-line resources available for rotating fungicides in canola.

Upper canopy infection (UCI) symptoms include infection of stems, branches and pods, and has become more common in NSW in recent years, despite variable seasonal conditions from year to year. Symptoms include either single or a number of branches dying off prematurely without a crown canker developing at the stem base. Flower, flowering spike and pod infection are also UCI symptoms. Yield loss is due to reduced flower set, reduced seeds per pod, reduced seed size and pod shatter before harvest. These blackleg symptoms are related to early plant development and flowering time, where crops are elongating and flowering during mid winter and exposed to airborne spore showers of the blackleg fungus. Canola crops that flower later tend to develop fewer UCI symptoms. The foliar fungicides Aviator Xpro®, Veritas® Opti, Miravis® Star, Maxentis® EC and Mirador 625/Proviso tank-mix are registered for managing UCI.

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BlacklegCM app (https://www.agric.wa.gov.au/apps/blacklegcm-blackleg-management-app)

Croplife Australia (https://www.croplife.org.au/)

Croplife Australia on-line resources (https://www.croplife.org.au/resources/programs/resistance-management/canola-blackleg)

Crops should be scouted regularly and monitored for UCI during the growing season. Leaf lesions developing up the crop canopy during stem elongation and early flowering are a warning sign and have the potential to develop into an UCI. Yield loss from UCI can be significant when conditions for infection are favourable. Under these conditions, foliar fungicide applications have been shown to give significant improvements in yield and economic returns. Foliar fungicide applications to manage sclerotinia stem rot are effective at reducing UCI levels, especially when applied at 20–30% bloom (15–20 open flowers on the main stem).

- **Blackleg resistance groups**: All current canola varieties are assessed for resistance genes and classified into resistance groups. If the same variety has been grown for 2 or more seasons, consider changing to a variety with a different resistance group. 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 R in high blackleg-risk areas and at least MR in lower blackleg-risk areas will normally give sufficient disease protection.

  Table 48. Canola variety characteristics and disease reactions on page 95 lists the blackleg resistance rating for each variety. Please note they are the ratings released in spring 2022. Blackleg resistance ratings can change from year to year and are updated in autumn and spring.

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Consult the *Blackleg management guide* on the GRDC website (https://grdc.com.au/resources-and-publications/all-publications/factsheets/2022/blackleg-management-guide)

Sclerotinia stem rot (SSR) – 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 very effective at building up levels of soil-borne sclerotia and increasing disease pressure. Canola grown in a double break rotation (canola following a pulse crop, especially lupin and chickpea) is more prone to developing SSR.

Burning canola stubble will not effectively control *Sclerotinia* as sclerotia survive mainly on or in the soil. The most effective means of reducing disease levels are:

- increasing the length of time between broadleaf crops in the same paddock (especially canola)
- separation from last year's canola stubble
- avoiding early crop flowering
- applying foliar fungicides, which are best applied at 20–30% bloom (15–20 open flowers on the main stem), targeting protection of the main stem and early flowers.

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Sclerotinia stem rot in canola (https://grdc.com.au/resources-and-publications/all-publications/factsheets/2014/03/grdc-fs-sclerotinia)

SclerotiniaCM app (https://www.agric.wa.gov.au/apps/sclerotiniacm-sclerotinia-management-app)

Above average spring rainfall across most of NSW in 2022 resulted in SSR developing across many districts, even where the disease might not normally develop to damaging levels. This will have implications for broadleaf crops in the next few seasons, as sclerotia populations in paddocks will have increased, presenting a disease risk. Lupin and chickpea in particular are highly susceptible to SSR.

The environmental conditions for SSR to develop are very specific and will not occur every year, so even when the fungus is present the disease can fail to develop in dry conditions. Consult your farm adviser and refer to the fact sheet *Sclerotinia stem rot in canola* on the GRDC website. Use the SclerotiniaCM app to assess disease risk. There are no commercial canola varieties in Australia with resistance to SSR. The foliar fungicides Prosaro®, Aviator Xpro®, Veritas® Opti, Miravis® Star, Maxentis® EC, Mirador® 625/Proviso® tank-mix and Proviso®/Veritas® Opti tank mix, along with products containing iprodione and some procymidone products are registered for managing SSR.

Canola pod infection – The above average spring rainfall across most of NSW in 2022 resulted in high levels of canola pod infection late in the season. The pod infection was caused by several pathogens including Alternaria spp., Sclerotinia and the blackleg fungus. In a 'normal' season these foliar pathogens stop spreading up the crop canopy as conditions dry out in late spring, however in 2022 the continuation of rainfall allowed these fungi to continue to develop and spread within the crop canopy as pods developed and ripened. The outcome was pods developed symptoms of infection that also resulted in seed discolouration (white seed), smaller seed and seed abortion in some cases. At this stage there are very few control options as foliar fungicides cannot be applied at this late crop stage due to the risk of residue carry-over.

Virus diseases

Three virus species have been recorded in canola in Australia:

1. *Turnip yellows virus* (TuYV, formerly known as *Beet western yellows virus*)
2. *Turnip mosaic virus* (TuMV)
3. *Cauliflower mosaic virus* (CaMV).

Of these, TuYV is the more common with the potential to cause yield losses in canola. Commercial canola varieties appear resistant to TuMV. However, TuMV has severely affected some lines of condiment mustard (*Brassica juncea*) in trials in northern NSW in the past. The importance of CaMV in canola and *B. juncea* is not known.

All 3 viruses are spread by aphids from weeds, which act as hosts. TuYV can come from a range of weed, pasture and crop species. Turnip weed, wild radish and other *Brassica* weeds are important TuMV hosts.

Viruses, particularly TuYV, can cause substantial yield losses, 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.

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Agnote DPI 495: *Virus diseases in canola and mustard* (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/general-disorders-of-crops/virus-canola-mustard)

GRDC GrowNotes: *Reducing aphid and virus risk* (https://grdc.com.au/resources-and-publications/all-publications/factsheets/2015/02/reducing-aphid-and-virus-risk).

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 as high as possible 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 60–80% 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.

A decision-support tool released in 2020 will assist with determining the correct windrow timing that maximises yield and profit. See the GRDC website for *Windrow on time, reap the rewards*.

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, the ripening crop needs careful and regular monitoring 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. 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. Using glyphosate for crop desiccation might be required to stop the crop from growing, especially when late rain falls on droughted, frosted crops. 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 highest yield and oil content. Direct harvesting could also be required when a paddock is too wet to windrow.

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Canola – Windrow on Time, Reap the Rewards (https://grdc.com.au/resources-and-publications/all-publications/publications/2020/canola-windrow-on-time,-reap-the-rewards)

NVT website (https://www.nvtonline.com.au/).

New varieties

New releases – there are 16 for NSW

- ATR Swordfish$^{\Phi}$, HyTTec Velocity TT$^{\Phi}$, Nuseed Eagle TF and Nuseed Hunter TF from Nuseed
- Bandit TT$^{\Phi}$, Renegade TT$^{\Phi}$ and Outlaw$^{\Phi}$ from AGT
- DG Torrens TT$^{\Phi}$ and DG Hotham TF from Nutrien Ag Solutions
- Hyola® Regiment XC and Hyola® Solstice CL from Pacific Seeds
- InVigor® T 4511$^{\Phi}$ from BASF
- Pioneer® PY520TC from Pioneer Seeds
- RGT Baseline™ TT and RGT CLAVIER™ CL from Seed Force (RAGT)
- VICTORY® V55-04TF from AWB.

Outclassed, but still available:

SF Ignite TT$^{\Phi}$, ATR-Stingray$^{\Phi}$, ATR-Wahoo$^{\Phi}$.

Withdrawn

InVigor® R 3520, InVigor® R 5520P, BASF® 3000TR, Nuseed® GT-53.

Varietal characteristics

The amount of information on the following varieties varies as some of them are new and have minimal independent data. Some statements about the newer varieties are based on seed company information. Blackleg resistance ratings and resistance groups published for each variety are for spring 2022 and based on blackleg nursery data from 2019–2021. Resistance ratings and resistance groups for 2023 will be available on the GRDC website by late March 2023.

Yield. Comparative performance data for early and mid maturing NVT trial groups for 2018–2022 is presented from Table 49 to Table 55.

Oil content. Oil data is also presented from Table 49 to Table 55. Comparative performance in NVT Trials – early maturing and mid maturing – is the average oil content across sites for each chemistry group and region in 2022. Some varieties have oil data from only one site; view with caution as seasonal factors might have affected the oil content at that site. Check the NVT website for individual site quality data.

Varieties. Canola varieties are either hybrid or open-pollinated (OP). Within these breeding groups there are 7 herbicide tolerance groups:

1. Conventional
2. Triazine tolerant
3. Imidazolinone tolerant
4. Roundup Ready®
5. TruFlex® with Roundup Ready® Technology
5. TruFlex® with Roundup Ready® Technology + imidazolinone tolerant
6. Imidazolinone plus triazine tolerant
7. LibertyLink® plus triazine tolerant

The following are 16 new releases for 2023. Information on characteristics and disease reactions of most current commercial varieties can be found in Table 48 on page 95 Canola variety characteristics and disease reactions.

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GRDC website (https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2022/02/the-impact-of-insecticides-and-miticides-on-beneficial-arthropods-in-australian-grains)

Conventional varieties

Outlaw$^{\phi}$. Early maturing open-pollinated conventional canola suited to medium–low rainfall zones. Tall plant height, similar to AV Garnet. No GRDC blackleg resistance rating or resistance group. Not tested in NVT. Eligible for AGT Seed Sharing™. Marketed by AGT. EPR $10.00/t (ex. GST).

Triazine tolerant (TT) varieties

ATR Swordfish$^{\phi}$. (coded NT504). Early maturing OP TT. Medium plant height. Similar yield and oil content to ATR-Stingray$^{\phi}$ but with improved early vigour and biomass. Suited to low–medium rainfall zones. No GRDC blackleg resistance rating or resistance group. Tested in NVT trials 2020 and 2021. Marketed by Nuseed. EPR $5.00/t (ex. GST).

Bandit TT$^{\phi}$. (coded AGTC0006). Early maturing OP TT. Adapted to medium–low rainfall environments. Medium plant height. Blackleg resistance rating MS and resistance group A. Tested in NVT trials in 2021 and 2022. Eligible for AGT Seed Sharing™. Marketed by AGT. EPR $10.00/t (ex. GST).

DG Torrens TT$^{\phi}$. (coded DG 1924TT). Early–mid maturing OP TT. Short–medium plant height. Suited to low–medium rainfall zones. Blackleg resistance rating R–MR and resistance group H. Tested in NVT trials 2020–2022. Bred and marketed by Nutrien Ag Solutions. EPR $5.00/t (ex. GST).

HyTTec® Velocity$^{\phi}$. (coded NCH19T588). Early maturing hybrid, 2–4 days earlier than HyTTec® Trident. Fast phenology offers an earlier alternative to HyTTec® Trident. Suited to low-medium rainfall zones. Medium height with improved standability over HyTTec® Trident. Blackleg resistance rating MR–MS and resistance group AB. Tested in NVT trials 2020–2022. Marketed by Nuseed Pty Ltd. EPR $5/t (ex. GST).

InVigor® T 4511$^{\phi}$. (coded CHYB4372TT). Early–mid maturing TT hybrid. Medium plant height. Suited to early and mid season growing regions. Better blackleg resistance than InVigor® T 4510$^{\phi}$. Blackleg resistance rating R and resistance group currently unknown. Tested in NVT trials 2021 and 2022. Marketed by BASF.

Renegade TT$^{\phi}$. (coded AGTC0034). Early–mid maturing OP TT. Short to medium plant height. Blackleg resistance rating MR–MS and resistance group A. Tested in NVT trials 2021 and 2022. Eligible for AGT Seed Sharing™. Marketed by AGT. EPR $10.00/t (ex. GST).

RGT Baseline™ TT. (coded SFR65-028TT). Early–mid maturing hybrid, similar flowering to SF Turbine TT. Medium plant height. Suited to low–medium rainfall areas. Blackleg resistance rating MS and resistance group B. Tested in NVT trials 2019–2021. Marketed by Seed Force, an RAGT company. EPR $10.00/t (ex. GST).

CLEARFIELD® (imidazolinone tolerant) varieties

Hyola® Solstice CL. (coded PS-21CL208). Mid maturing hybrid. Suited to medium–high rainfall zones. Blackleg resistance rating R–MR and resistance group ADFH. Tested in NVT trials 2021 and 2022. Bred and marketed by Pacific Seeds.

RGT CLAVIER™ CL. Late maturing winter dual-purpose hybrid with very high biomass and tall plant height. Adapted to high to very high rainfall zones. Blackleg resistance rating R and resistance group currently not known. Not tested in NVT. Marketed by Seed Force, an RAGT company. EPR $12.00/t (ex. GST).

Imidazolinone tolerance plus triazine tolerance varieties

Pioneer® PY520TC. (coded AA0419E). Mid maturing Clearfield® + triazine tolerant hybrid variety. Suited to medium–high rainfall zones. Mid–fast phenology. Medium height. Blackleg resistance rating MR, resistance group BC. Tested in NVT trials 2021 and 2022. Marketed by Pioneer Seeds.

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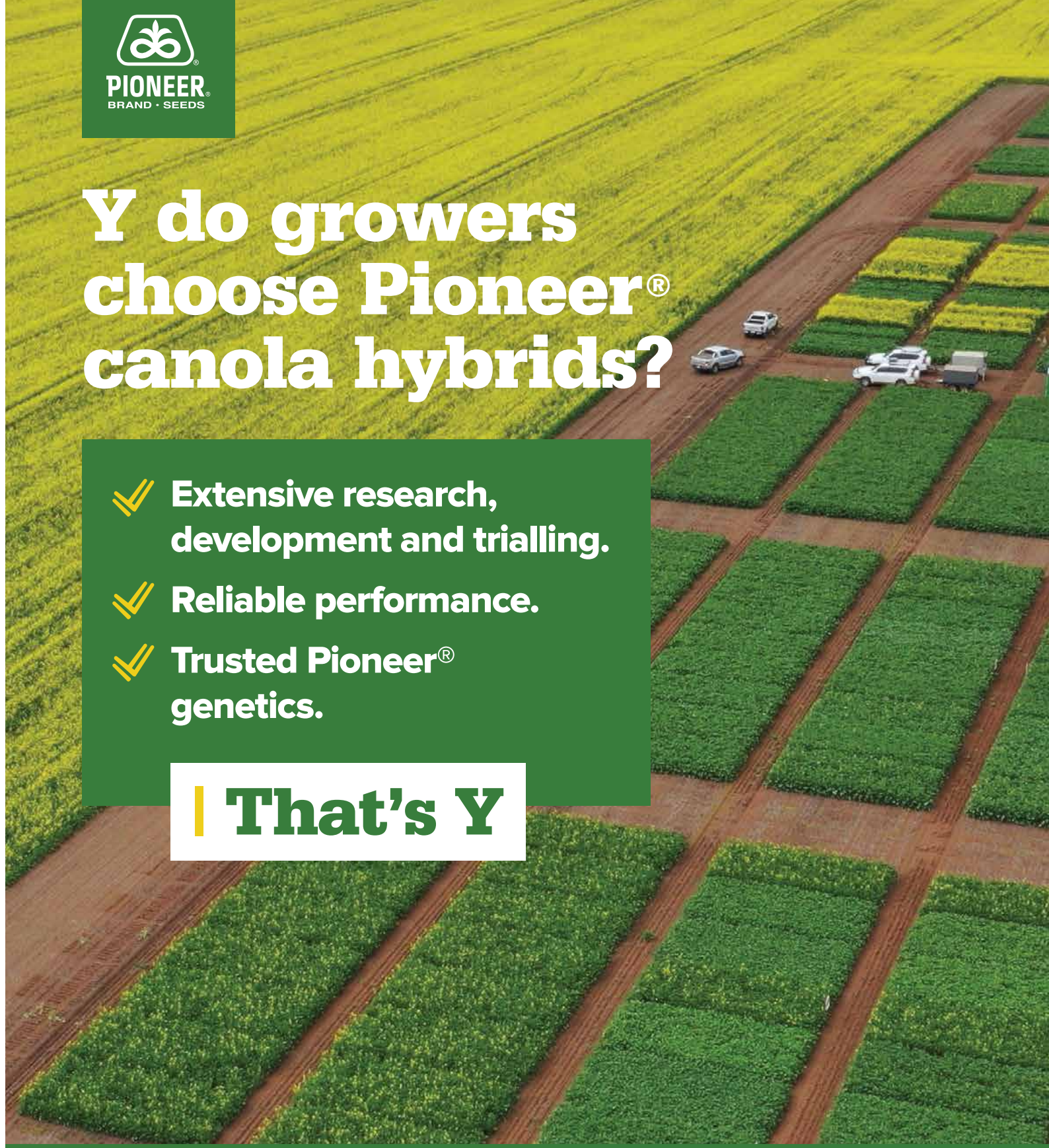

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WHAT YOU SEED IS WHAT YOU GET

TruFlex® with Roundup Ready® Technology varieties

DG Hotham TF. (coded DG2103XX). Mid maturing Truflex® hybrid. Medium–tall plant height. Suited to medium–high rainfall zones. Blackleg resistance rating R and resistance grouping ABH. Tested in NVT trials 2021 and 2022. Bred and marketed by Nutrien Ag Solutions.

Nuseed® Eagle TF. (coded NCH20Q732). Mid-maturing Truflex® hybrid, 1–2 days later than Nuseed® Condor TF with mid phenology. Nuseed® Eagle TF is a potential replacement for Nuseed® Condor TF with slightly improved yields in higher rainfall zones. Blackleg resistance rating R and resistance group ABD. Tested in NVT trials 2021 and 2022. Marketed by Nuseed Pty Ltd.

Nuseed® Hunter TF. (coded NCH20Q733). Early–mid maturing Truflex® hybrid, with mid–fast phenology. Nuseed® Hunter TF is a later alternative to Nuseed® Emu TF and is suited to low–medium rainfall zones. Medium plant height. Blackleg resistance rating R–MR and blackleg resistance group AB. Tested in NVT trials 2021 and 2022. Marketed by Nuseed Pty Ltd.

VICTORY® V55-04TF. (coded 19TH6009). Mid maturing TruFlex® specialty (high oleic, low linoleic oil) hybrid. Medium plant height. Suited to higher rainfall areas. Blackleg resistance rating R–MR and blackleg resistance group currently unknown. Released in Victoria in 2022. Bred by Cargill. Tested in NVT in 2021 only. Marketed by AWB under contract.

TruFlex® with Roundup Ready® Technology plus IMI tolerance

Hyola® Regiment XC. (coded PS-21XC316). Mid maturing Truflex® + Clearfield® (imidazolinone)-tolerant hybrid. Suited to medium to high rainfall zones. Blackleg resistance rating R and resistance group ADFH. Tested in NVT trials in 2021 and 2022. Bred and marketed by Pacific Seeds.

Table 48. Varietal characteristics and disease reactions (page 1 of 2).

Herbicide group	Variety	Type	Phenology ❶ sown < 15 April	Maturity	Plant height	Blackleg rating spring 2022 ❹	Blackleg group spring 2022 ❹	NVT testing years (NSW)	Company	End Point Royalty ($/t)
Conventional	Nuseed Diamond	Hybrid	Fast	Early	Medium	R	ABF	2012–2020	Nuseed	–
	Nuseed Quartz	Hybrid	Mid	Mid to mid–early	Medium	R–MR	ABD	2016–2020	Nuseed	–
	Outlaw	OP	–		Medium–tall	–	–	No	AGT	$10.00
Triazine tolerant (TT)	ATR-Bluefin	OP	–	Early	Medium	R–MR	AB	2020–2022	Nuseed	$5.00
	ATR-Bonito	OP	Mid–fast	Early to early–mid	Short–medium	MS	A	2012–2022	Nuseed	$5.00
	ATR-Stingray	OP	Fast	Early	Short	MR–MS	C	2010–2022	Nuseed	$5.00
	ATR-Swordfish	OP	–	Early–mid	Medium	–	–	2020–2021	Nuseed	$5.00
	ATR-Wahoo	OP	Mid–slow	Mid–late	Medium	MR–MS	A	2012–2020	Nuseed	$5.00
	Bandit TT	OP	–	Early	Medium	MS	A	2021–2022	AGT	$10.00
	DG Bidgee TT	OP	Mid–fast ❸	Early–mid	Medium	R	H	2019; 2021–22	Nutrien Ag	$5.00
	DG Murray TT	OP	Mid–slow ❸	Mid to mid–late	Medium	R	H	2020–2022	Nutrien Ag	$5.00
	DG Torrens TT	OP	–	Early–mid	Short–medium	R–MR	H	2020–2022	Nutrien Ag	$5.00
	Hyola Blazer TT	Hybrid	Mid ❸	Mid	Medium	R	ADF	2019–2022	Pacific	–
	HyTTec Trident	Hybrid	Mid–fast	Early	Medium–tall	R	AD	2017–2022	Nuseed	$5.00
	HyTTec Trophy	Hybrid	Mid–fast	Early to early–mid	Medium–tall	R	AD	2017–2022	Nuseed	$5.00
	HyTTec Trifecta	Hybrid	Mid	Mid	Medium–tall	R	ABD	2018–2022	Nuseed	$5.00
	HyTTec Velocity	Hybrid	Fast ❸	Early	Medium	MR–MS	AB	2020–2022	Nuseed	$5.00
	InVigor T 4510	Hybrid	Mid–fast	Early–mid	Medium–tall	MR	BF	2016–2022	BASF	–
	InVigor T 4511	Hybrid	–	Early–mid	Medium	R	Unknown	2021–2022	BASF	–
	InVigor T 6010	Hybrid	Mid ❷	Mid	Medium–tall	MR–MS	BC	2019–2022	BASF	–
	Monola H421TT	Hybrid; specialty	Fast ❸	Early	Medium	R–MR	BC	2019–2022	Nuseed	–
	Monola 422TT	OP; specialty	–	Early–mid	Medium	MR	BC	2020–2022	Nuseed	–
	Renegade TT	OP	–	Early–mid	Short–medium	MR–MS	A	2021–2022	AGT	$10.00
	RGT Baseline™ TT	Hybrid	–	Early–mid	Medium	MR–MS	B	2021–2022	Seed Force	$10.00
	RGT Capacity TT	Hybrid	Mid–fast ❸	Early–mid	Medium	MR–MS	B	2019–2022	Seed Force	$10.00
	SF Dynatron TT	Hybrid	–	Mid	Medium–tall	MR–MS	BC	2019–2022	Seed Force	$10.00
	SF Spark TT	Hybrid	Fast	Early	Medium	R	ABDS	2018–2022	Seed Force	$10.00
Imidazolinone tolerant (Clearfield®)	Hyola 970CL	Hybrid	Winter type	Very late	Tall	R	H	No	Pacific	–
	Hyola Equinox CL	Hybrid	Mid–fast ❸	Mid to mid–early	Medium	R	ADF	2020–2022	Pacific	–
	Hyola Feast CL	Hybrid	Winter type	Late	Tall	R	H	No	Pacific	–
	Hyola Solstice CL	Hybrid	–	Mid	Medium–tall	R–MR	ADFH	2021–2022	Pacific	–
	Phoenix CL	Hybrid	Winter type	Late	Tall	R	B	No	AGF Seeds	–
	Pioneer 43Y92 (CL)	Hybrid	Mid	Early	Medium	R–MR	B	2016–2022	Pioneer	–
	Pioneer 44Y94 (CL)	Hybrid	Mid ❷	Early–mid	Medium–tall	R–MR	BC	2019–2022	Pioneer	–
	Pioneer 45Y93 (CL)	Hybrid	Mid	Mid	Medium	R	BC	2017–2022	Pioneer	–
	Pioneer 45Y95 (CL)	Hybrid	Mid–slow ❸	Mid	Medium	R–MR	C	2018–2019; 2021–2022	Pioneer	–
	RGT Nizza CL	Hybrid	Winter type	Late	Medium–tall	R	B	No	Seed Force	$12.00
	RGT CLAVIER™ CL	Hybrid	Winter type	Late	Medium–tall	R	Yet to be determined	No	Seed Force	$12.00
	Victory V7002CL	Hybrid; speciality	–	Early–mid	Medium–tall	–	ABF	2017–2021	AWB	–
	Victory V75-03CL	Hybrid; speciality	Mid–slow	Mid	Medium	R–MR	AB	2017–2021	AWB	–
Roundup Ready® (RR)	Pioneer 44Y27 (RR)	Hybrid	Mid–fast	Early to early–mid	Medium	R–MR	B	2016–2022	Pioneer	–
	Pioneer 44Y30 (RR)	Hybrid	Mid ❸	Early–mid	Medium	MR	AB	2021–2022	Pioneer	–
	Pioneer 45Y28 (RR)	Hybrid	Mid	Mid	Medium–tall	R–MR	BC	2017–2022	Pioneer	–
	Victory V5003RR	Hybrid	Mid	Mid	Medium	R–MR	AB	2013–2021	AWB	–

N.B. The relative maturity of varieties can vary depending on location and sowing time. The maturity rankings are provided by seed companies. They are a guide only and relate to physiological maturity or windrow/harvest maturity.

❶ Phenology – speed to flowering when sown before 15 April.

❷ based on 2020–2021 phenology data at Wagga Wagga ONLY.

❸ seed company estimate.

❹ Blackleg ratings are the published ratings for spring 2022. Ratings will be updated in autumn 2023 and will be available on the GRDC website.

Table 48. Varietal characteristics and disease reactions (page 2 of 2).

Herbicide group	Variety	Type	Phenology ❶ sown < 15 April	Maturity	Plant height	Blackleg rating spring 2022 ❹	Blackleg group spring 2022 ❹	NVT testing years (NSW)	Company	End Point Royalty ($/t)
TruFlex® with Roundup Ready® Technology	Hyola 410XX	Hybrid	Mid–fast	Mid–early	Medium	MR	ABD	2019–2022	Pacific	–
	DG Bindo TF	Hybrid	Mid–slow ❸	Mid	Medium	MR–MS	AB	2021–2022	Nutrien Ag	–
	DG Hotham TF	Hybrid	–	Mid	Medium–tall	R	ABH	2021–2022	Nutrien Ag	–
	DG Lofty TF	Hybrid	Mid–fast ❸	Early–mid	Medium	R	ABH	2021–2022	Nutrien Ag	–
	InVigor R 4022P	Hybrid	Mid–fast	Early–mid	Medium	MR	ABC	2019–2022	BASF	–
	InVigor R 4520P	Hybrid	Mid–fast ❷	Early–mid	Medium	MR–MS	B	2019–2022	BASF	–
	Nuseed Condor TF	Hybrid	Mid–fast ❷	Mid	Tall	R	ABD	2017–2022	Nuseed	$5.00
	Nuseed Eagle TF	Hybrid	Mid ❸	Mid	Medium–tall	R	ABD	2021–2022	Nuseed	$5.00
	Nuseed Emu TF	Hybrid	Fast ❸	Early–mid	Medium	MR	AB	2019–2022	Nuseed	$5.00
	Nuseed Hunter TF	Hybrid	Mid–fast ❸	Early–mid	Medium	R–MR	AB	2021–2022	Nuseed	$5.00
	Nuseed Raptor TF	Hybrid	Mid–fast	Early–mid	Medium	R	AD	2017–2022	Nuseed	$5.00
	VICTORY V55-04TF	Hybrid; speciality	Mid ❸	Mid	Medium	R–MR	Unknown	2021	Cargill	–
TruFlex® + IMI	Hyola Battalion XC	Hybrid	Fast ❸	Early	Medium	R	ADF	2020–2022	Pacific	–
	Hyola Garrison XC	Hybrid	Mid ❸	Mid	Medium	R	ADF	2019–2022	Pacific	–
	Hyola Regiment XC	Hybrid	–	Mid	Medium–tall	R	ADFH	2021–2022	Pacific	–
Liberty Link + TT	InVigor LT 4530P	Hybrid	Mid–fast ❷	Early–mid	Medium	R–MR	BF	2020–2022	BASF	–
TT + IMI	Hyola Enforcer CT	Hybrid	Mid ❷	Mid	Medium	R	ADF	2019–2022	Pacific	–
	Pioneer PY520TC	Hybrid	Mid–fast ❸	Mid	Medium	MR	BC	2021–2022	Pioneer	–

N.B. The relative maturity of varieties can vary depending on location and sowing time. The maturity rankings are provided by seed companies. They are a guide only and relate to physiological maturity or windrow/harvest maturity.

❶ Phenology – speed to flowering when sown before 15 April.

❷ based on 2020–2021 phenology data at Wagga Wagga ONLY.

❸ seed company estimate.

❹ Blackleg ratings are the published ratings for spring 2022. Ratings will be updated in autumn 2023 and will be available on the GRDC website.

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.

Comparative performance in NVT trials – early maturing.

The more trials, the greater the reliability.

– insufficient or no data.

❶ Oil content, adjusted to 6.0% moisture content, is expressed as a region-wide average for each herbicide chemistry and maturity group in 2022 only.

Table 49. Comparative performance of early maturing canola – north west NSW.

North west									
Early maturing triazine tolerant (TT) – mean yield expressed as % of HyTTec Trident									
	Yearly group mean							Oil % ❶	
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials	2022	Trials
HyTTec Trident t/ha	–	**1.76**	**2.15**	**3.15**	**2.79**	**2.46**			
ATR Bonito	–	61	95	–	73	79	3	46.6	1
Bandit TT	–	–	–	90	80	86	2	45.2	1
DG Bidgee TT	–	–	–	–	86	89	1	46.0	1
Hyola Blazer TT	–	–	117	–	110	103	2	46.8	1
Hyola Enforcer CT	–	79	101	–	83	89	3	46.5	1
HyTTec Trident	–	**100**	**100**	**100**	**100**	**100**	**4**	**45.7**	**1**
HyTTec Trophy	–	–	105	98	100	98	3	45.2	1
InVigor LT 4530P	–	–	110	95	102	98	3	44.9	1
InVigor T 4510	–	87	105	96	100	98	4	45.4	1
InVigor T 4511	–	–	–	94	90	93	2	45.5	1
Monola 420TT	–	–	80	79	56	71	3	45.6	1
Monola 422TT	–	–	90	84	71	78	3	44.7	1
Monola H421TT	–	–	76	83	61	73	3	44.7	1
Renegade TT	–	–	–	95	97	93	2	45.0	1
SF Spark TT	–	79	95	91	84	88	4	46.9	1
Early maturing CLEARFIELD trials – mean yield expressed as % of Pioneer 43Y92 (CL)									
Pioneer 43Y92 (CL) t/ha	–	**1.33**	**2.27**	**3.47**	**2.35**	**2.36**			
Hyola Equinox CL	–	–	–	–	86	96	1	47.8	1
Pioneer 43Y92 (CL)	–	**100**	**100**	**100**	**100**	**100**	**4**	**46.0**	**1**
Pioneer 44Y94 CL	–	–	–	–	132	116	2	46.5	1
Early maturing Roundup Ready trials – mean yield expressed as % Pioneer 44Y27 (RR)									
Pioneer 44Y27 (RR) t/ha	–	–	**2.35**	**3.08**	**2.96**	**2.80**			
DG Lofty TF	–	–	–	87	76	86	2	45.6	1
Hyola 410XX	–	–	90	91	73	84	3	46.8	1
Hyola Battalion XC	–	–	90	91	76	85	3	45.4	1
Hyola Garrison XC	–	–	95	–	78	88	2	46.6	1
InVigor R 4022P	–	–	104	95	96	98	3	46.0	1
InVigor R 4520P	–	–	116	99	112	108	3	45.2	1
Nuseed Emu TF	–	–	80	93	77	84	3	44.2	1
Nuseed Raptor TF	–	–	106	95	93	97	3	46.5	1
Pioneer 44Y27 (RR)	–	–	**100**	**100**	**100**	**100**	**3**	**44.9**	**1**
Pioneer 44Y30 (RR)	–	–	–	98	94	98	2	45.8	1

Table 50. Comparative performance of early maturing canola – north east NSW.

North east									
Early maturing triazine tolerant (TT) – mean yield expressed as % of HyTTec Trident									
	Yearly group mean							Oil % ❶	
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials	2022	Trials
HyTTec Trident t/ha	**1.33**	–	**1.23**	–	**1.67**	**1.41**			
ATR Bonito	–	–	65	–	86	85	3	49.9	1
Bandit TT	–	–	–	–	89	87	1	47.7	1
Hyola Blazer TT	–	–	113	–	106	118	2	49.1	1
Hyola Enforcer CT	–	–	83	–	95	100	2	48.3	1
HyTTec Trident	–	–	**100**	–	**100**	**100**	**2**	**49.0**	**1**
HyTTec Trophy	–	–	100	–	101	104	3	49.1	1
InVigor T 4510	–	–	92	–	94	100	3	45.8	1
InVigor T 4511	–	–	–	–	93	99	1	49.6	1
Renegade TT	–	–	–	–	101	98	1	47.6	1
RGT Capacity TT	–	–	–	–	106	97	1	48.7	1
SF Dynatron TT	–	–	–	–	98	111	1	49.7	1
SF Spark TT	–	–	78	–	91	88	2	47.6	1
Early maturing CLEARFIELD trials – mean yield expressed as % of Pioneer 43Y92 (CL)									
Pioneer 43Y92 (CL) t/ha	**1.38**		**1.14**		**1.81**	**1.38**			
Hyola Equinox (CL)	–	–	–	–	112	90	1	49.3	1
Pioneer 43Y92 (CL)	**100**	–	**100**	–	**100**	**100**	**2**	**46.0**	**1**
Pioneer 44Y94 (CL)	–	–	–	–	107	119	1	47.2	1

Table 51. Comparative performance of early maturing canola – south west NSW.

South west									
Early maturing triazine tolerant (TT) – mean yield expressed as % of HyTTec Trident									
	Yearly group mean							Oil % ❶	
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials	2022	Trials
HyTTec Trident t/ha	**0.52**	**1.31**	**2.94**	**3.46**	**2.67**	**2.50**			
ATR Bluefin	–	–	80	79	85	80	5	46.3	2
ATR Bonito	79	74	92	84	91	87	8	47.7	2
ATR Stingray	68	70	82	78	78	78	8	45.9	2
Bandit TT	–	–	91	89	92	90	4	45.3	2
DG BIDGEE TT	–	–	–	91	100	98	2	45.9	2
Hyola Blazer TT	88	80	115	–	113	106	4	47.7	2
Hyola Enforcer CT	103	88	104	–	95	96	4	46.9	2
HyTTec Trident	**100**	**100**	**100**	**100**	**100**	**100**	**8**	**46.3**	**2**
HyTTec Trophy	92	–	104	98	104	101	7	46.3	2
HyTTec Velocity	–	–	93	–	97	95	3	45.7	2
InVigor LT 4530P	–	–	98	96	106	99	6	46.1	2
InVigor T 4510	93	92	97	97	103	98	8	46.8	2
InVigor T 4511	–	–	–	93	97	96	4	46.7	2
Monola 420TT	85	84	76	79	78	78	8	47.5	2
Monola 422TT	–	–	80	84	88	83	6	45.8	2
Monola H421TT	–	80	76	83	79	79	7	46.3	2
Renegade TT	–	–	–	94	106	97	3	46.7	2
RGT Capacity TT	–	–	106	94	99	97	6	46.6	2
SF Dynatron TT	–	91	105	99	108	103	5	47.9	2
SF Spark TT	–	86	92	91	94	91	7	48.0	2
Early maturing CLEARFIELD trials – mean yield expressed as % of Pioneer 43Y92 (CL)									
Pioneer 43Y92 (CL) t/ha	**0.63**	**1.02**	**3.20**	**3.43**	**2.78**	**2.56**			
Hyola Equinox CL	–	–	–	–	91	98	2	47.7	2
Pioneer 43Y92 (CL)	**100**	**100**	**100**	**100**	**100**	**100**	**8**	**45.9**	**2**
Pioneer 44Y94 (CL)	–	–	–	110	116	108	4	46.5	2
Early maturing Roundup Ready trials – mean yield expressed as % Pioneer 44Y27 (RR)									
Pioneer 44Y27 (RR) t/ha	**–**	**1.24**	**3.16**	**3.50**	**2.78**	**2.57**			
DG Lofty TF	–	–	–	87	87	91	4	46.8	2
Hyola 410XX	–	91	102	89	86	93	7	48.1	2
Hyola Battalion XC	–	–	94	90	85	91	6	46.3	2
Hyola Garrison XC	–	99	104	–	89	95	5	47.7	2
InVigor R 4022P	–	102	95	96	99	97	7	46.6	2
InVigor R 4520P	–	97	102	101	110	104	7	46.6	2
Nuseed Emu TF	–	–	82	92	83	88	6	44.7	2
Nuseed Hunter TF	–	–	–	102	102	103	3	46.7	2
Nuseed Raptor TF	–	–	103	95	97	100	6	46.3	2
Pioneer 44Y27 (RR)	**–**	**100**	**100**	**100**	**100**	**100**	**7**	**46.1**	**2**
Pioneer 44Y30 (RR)	–	–	–	97	98	102	4	46.9	2

Comparative performance in NVT trials – mid maturing.

The more trials, the greater the reliability.

– insufficient or no data.

❶ Oil content, adjusted to 6.0% moisture content, is expressed as a region-wide average for each herbicide chemistry and maturity group in 2022 only.

Table 52. Comparative performance of mid maturing canola - North west NSW

North west									
Mid maturing triazine tolerant (TT) trials – mean yield expressed as % of HyTTec Trophy									
	Yearly group mean							Oil % ❶	
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials	2022	Trials
HyTTec Trophy (t/ha)	–	–	**2.82**	**3.13**	**3.05**	**3.00**			
ATR Bluefin	–	–	80	81	86	83	3	46.7	1
ATR Bonito	–	–	88	85	91	88	3	49.4	1
ATR Stingray	–	–	83	83	87	84	3	48.8	1
DG Bidgee TT	–	–	–	94	95	96	2	48.1	1
DG Murray TT	–	–	–	–	90	90	1	49.5	1
DG Torrens TT	–	–	–	–	94	94	1	48.6	1
Hyola Blazer TT	–	–	107	101	101	103	3	48.6	1
Hyola Enforcer CT	–	–	90	98	97	95	3	48.3	1
HyTTec Trident	–	–	91	102	98	97	3	47.9	1
HyTTec Trifecta	–	–	103	103	102	103	3	48.9	1
HyTTec Trophy	–	–	**100**	**100**	**100**	**100**	**3**	**47.3**	**1**
HyTTec Velocity	–	–	–	–	100	97	1	48.9	1
InVigor LT 4530P	–	–	96	–	101	97	2	47.5	1
InVigor T 4510	–	–	98	97	100	98	3	48.8	1
InVigor T 4511	–	–	–	98	99	98	2	48.9	1
Monola 420TT	–	–	78	84	87	83	3	48.7	1
Monola 422TT	–	–	81	85	86	84	3	47.6	1
Monola H421TT	–	–	75	88	89	84	3	48.1	1
Renegade TT	–	–	–	87	98	95	2	47.9	1
RGT Capacity TT	–	–	–	96	100	99	2	49.1	1
SF Dynatron TT	–	–	–	97	101	101	2	50.1	1
SF Spark TT	–	–	91	92	94	93	3	50.1	1
Mid maturing CLEARFIELD trials – mean yield expressed as % of Pioneer 44Y94 (CL)									
Pioneer 44Y94 (CL) (t/ha)			**2.96**	**3.04**	**3.24**	**3.08**			
Hyola Equinox CL	–	–	79	100	97	92	3	50.1	1
Hyola Solstice CL	–	–	–	105	100	97	2	49.9	1
Pioneer 43Y92 (CL)	–	–	89	95	96	94	3	47.9	1
Pioneer 44Y94 (CL)	–	–	**100**	**100**	**100**	**100**	**3**	**47.7**	**1**
Pioneer 45Y93 (CL)	–	–	–	–	98	99	1	47.1	1
Pioneer 45Y95 (CL)	–	–	–	–	101	102	1	46.6	1
PY520TC	–	–	–	–	94	93	1	46.6	1

Table 53. Comparative performance of mid maturing canola - north east NSW

North east									
Mid maturing triazine tolerant (TT) trials – mean yield expressed as % of HyTTec Trophy									
	Yearly group mean							Oil % ❶	
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials	2022	Trials
HyTTec Trophy t/ha	**0.98**	**1.46**	**2.61**	**3.49**	**2.65**	**2.35**			
ATR Bonito	77	82	92	–	78	82	6	48.0	2
DG Bidgee TT	–	–	–	87	96	97	3	45.2	2
DG Murray TT	–	–	–	–	80	85	2	46.4	2
Hyola Blazer TT	–	–	108	103	108	106	5	46.1	2
Hyola Enforcer CT	–	99	97	85	86	91	6	46.7	2
HyTTec Trifecta	105	–	–	101	106	105	4	46.2	2
HyTTec Trophy	**100**	**100**	**100**	**100**	**100**	**100**	**7**	**45.7**	**2**
InVigor T 4510	98	102	99	95	96	97	7	45.0	2
InVigor T 4511	–	–	–	96	96	97	3	46.0	2
Monola 420TT	74	75	75	74	65	72	5	47.8	2
PY520TC	–	–	–	100	105	103	3	45.0	2
Renegade TT	–	–	–	87	96	95	3	45.9	2
RGT Baseline TT	–	–	–	93	105	103	3	47.3	2
RGT Capacity TT	95	101	–	92	100	100	4	47.1	2
SF Dynatron TT	–	–	–	99	104	103	3	46.6	2
SF Spark TT	–	89	93	86	86	88	6	46.5	2
Mid maturing CLEARFIELD trials – mean yield expressed as % of Pioneer 44Y94 (CL)									
Pioneer 44Y94 (CL) t/ha	–	–	**2.96**	–	**3.27**	**2.66**			
Hyola Equinox CL	–	–	93	–	78	86	5	47.6	2
Hyola Solstice CL	–	–	–	–	85	93	3	47.9	2
Pioneer 43Y92 (CL)	–	–	–	–	87	90	4	45.7	2
Pioneer 44Y94 (CL)	–	–	**100**	–	**100**	**100**	**4**	**45.7**	**2**
Pioneer 45Y93 (CL)	–	–	107	–	100	100	6	45.7	2
Pioneer 45Y95 (CL)	–	–	–	–	102	103	4	45.7	2

Table 54. Comparative performance of mid maturing canola – south west NSW.

South west									
Mid maturing triazine tolerant (TT) trials – mean yield expressed as % of HyTTec Trophy									
	Yearly group mean							Oil % ❶	
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials	2022	Trials
HyTTec Trophy t/ha	**0.97**	**0.86**	**3.17**	**2.92**	**3.11**	**2.21**			
ATR Bluefin	–	–	80	82	67	72	6	45.1	2
ATR Bonito	60	–	86	85	78	79	8	46.2	2
ATR Stingray	58	–	83	83	72	75	8	44.5	2
ATR Swordfish	–	–	85	83	79	78	4	45.1	2
DG Bidgee TT	–	–	99	94	105	94	4	44.8	2
DG Murray TT	–	55	–	–	86	85	4	45.5	2
DG Torrens TT	–	63	94	91	93	88	6	45.7	2
Hyola Blazer TT	–	94	105	101	113	104	7	45.6	2
HyTTec Trident	117	113	96	102	87	98	10	45.2	2
HyTTec Trifecta	103	–	104	103	107	104	8	45.4	2
HyTTec Trophy	**100**	**100**	**100**	**100**	**100**	**100**	**10**	**44.4**	**2**
HyTTec Velocity	–	–	–	–	83	93	2	43.6	2
InVigor LT 4530P	–	–	92	94	84	89	6	44.0	2
InVigor T 4510	92	98	96	97	92	95	10	44.5	2
InVigor T 4511	–	–	–	98	94	96	4	45.6	2
Monola 422TT	–	–	83	85	71	77	6	44.3	2
Monola H421TT	–	83	80	89	56	76	7	44.2	2
Pioneer PY520TC	–	–	–	–	112	101	2	44.1	2
Renegade TT	–	–	–	88	94	87	3	44.2	2
RGT Baseline TT	–	–	–	95	115	99	3	46.9	2
RGT Capacity TT	–	86	98	96	99	95	8	44.9	2
SF Dynatron TT	–	91	101	97	106	99	8	46.9	2
SF Spark TT	82	79	92	92	86	88	10	46.5	2
Mid maturing CLEARFIELD trials – mean yield expressed as % of Pioneer 44Y94 (CL)									
Pioneer 44Y94 (CL) t/ha	**0.76**	**0.87**	**3.46**	**3.22**	**3.86**	**2.43**			
Hyola Solstice CL	–	–	–	103	77	94	4	46.9	2
Pioneer 43Y92 (CL)	–	–	92	95	83	90	10	45.0	2
Pioneer 44Y94 (CL) t/ha	**–**	**–**	**100**	**100**	**100**	**100**	**6**	**45.6**	**2**
Pioneer 45Y95 (CL)	–	–	–	102	103	102	4	44.7	2
Pioneer PY520TC	–	–	–	–	88	91	2	44.8	2
Mid maturing Roundup Ready trials – mean yield expressed as % InVigor R 4520P									
InVigor R 4520P t/ha	**–**	**1.08**	**3.30**	**3.11**	**3.41**	**2.35**			
DG Bindo TF	–	–	–	93	93	91	4	46.1	2
DG Hotham TF	–	–	–	–	100	91	2	45.8	2
DG Lofty TF	–	–	–	91	82	86	4	45.3	2
Hyola 410XX	–	81	89	95	76	87	8	46.9	2
Hyola Battalion XC	–	–	91	97	76	88	6	45.4	2
Hyola Garrison XC	–	84	91	97	77	90	8	46.8	2
Hyola Regiment XC	–	–	–	103	91	99	4	47.1	2
InVigor R 4022P	–	95	93	96	87	92	8	45.4	2
InVigor R 4520P	**–**	**100**	**100**	**100**	**100**	**100**	**8**	**44.9**	**2**
Nuseed Eagle TF	–	–	–	–	103	101	2	46.5	2
Nuseed Emu TF	–	–	87	97	69	88	6	43.5	2
Nuseed Hunter TF	–	–	–	102	95	101	3	45.8	2
Nuseed Raptor TF	–	91	97	100	93	98	8	46.3	2
Pioneer 44Y27 (RR)	–	96	94	98	89	95	10	44.5	2
Pioneer 44Y30 (RR)	–	–	–	99	98	99	4	45.0	2

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Table 55. Comparative performance of mid maturing canola – south east NSW.

South east									
Mid maturing triazine tolerant (TT) trials – mean yield expressed as % of HyTTec Trophy									
	Yearly group mean							Oil % ❶	
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials	2022	Trials
HyTTec Trophy t/ha	**1.33**	**1.26**	**3.33**	**3.58**	**2.73**	**2.48**			
ATR Bonito	71	72	80	–	72	76	22	47.3	5
ATR Swordfish	–	–	–	–	71	72	5	43.8	5
DG Bidgee TT	–	–	–	90	90	89	11	46.2	5
DG Murray TT	–	–	87	83	78	81	14	45.6	5
DG Torrens TT	–	–	91	85	81	85	11	46.1	5
Hyola Blazer TT	–	97	105	102	105	102	18	45.6	5
HyTTec Trifecta	104	105	106	104	104	105	24	47.5	5
HyTTec Trophy	**100**	**100**	**100**	**100**	**100**	**100**	**28**	**46.4**	**5**
InVigor LT 4530P	–	–	93	89	83	91	15	42.8	5
InVigor T 4510	97	102	96	95	93	96	28	44.4	5
InVigor T 4511	–	–	–	96	95	97	11	45.9	5
InVigor T 6010	–	91	100	92	90	93	22	46.3	5
Monola 420TT	72	70	72	74	68	72	20	47.7	5
Monola 422TT	–	–	75	76	72	73	14	43.3	5
Pioneer PY520TC	–	–	–	98	101	98	8	45.3	5
Renegade TT	–	–	–	82	82	84	9	46.3	5
RGT Baseline TT	–	–	–	94	96	93	10	48.1	5
RGT Capacity TT	–	96	98	93	92	94	22	46.0	5
SF Dynatron TT	–	97	101	97	98	98	20	46.3	5
Mid maturing CLEARFIELD trials – mean yield expressed as % of Pioneer 44Y94 (CL)									
Pioneer 44Y94 (CL) t/ha	**–**	**1.33**	**3.80**	**3.81**	**2.99**	**2.79**			
Hyola Solstice CL	–	–	–	–	87	100	4	46.9	3
Pioneer 44Y94 (CL)	**–**	**100**	**100**	**100**	**100**	**100**	**21**	**45.9**	**3**
Pioneer 45Y93 (CL)	–	88	100	96	97	96	21	46.3	3
Pioneer 45Y95 (CL)	–	102	104	–	101	102	17	45.8	3
Pioneer PY520TC	–	–	–	–	88	90	4	45.0	3
Mid maturing Roundup Ready trials – mean yield expressed as % InVigor R 4520P									
InVigor R 4520P t/ha	**–**	**1.52**	**3.68**	**3.66**	**2.42**	**2.79**			
DG Bindo TF	–	–	–	–	90	85	4	43.1	3
DG Hotham TF	–	–	–	–	93	83	4	44.0	4
Hyola Regiment XC	–	–	–	102	99	98	9	47.1	4
InVigor R 4022P	–	93	91	93	90	92	17	46.4	4
InVigor R 4520P	**–**	**100**	**100**	**100**	**100**	**100**	**17**	**47.0**	**4**
Nuseed Condor TF	–	93	98	103	104	99	17	48.0	4
Nuseed Eagle TF	–	–	–	101	104	98	8	48.7	4
Nuseed Hunter TF	–	–	–	–	102	100	4	47.4	4
Nuseed Raptor TF	–	84	91	99	101	94	15	47.2	4
Pioneer 44Y30 (RR)	–	–	95	98	101	97	12	43.3	4
Pioneer 45Y28 (RR)	–	83	96	99	103	96	15	45.3	4

Further information

NSW DPI Agriculture website for:

Insect and mite control in field crops (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

Agnote DPI 495, *Virus diseases in canola and mustard* (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/general-disorders-of-crops/virus-canola-mustard)

Primefact 115, *Clubroot of canola and mustard* (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/general-disorders-of-crops/clubroot-canola-mustard)

Primefact 783, *Juncea canola in the low rainfall zone of south-western NSW* (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/canola-and-safflower/juncea-canola)

Primefact 786, *Brassica juncea in north-western NSW* (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/canola-and-safflower/brassica-juncea-in-north-west-nsw)

GRDC website for:

Canola best practice management guide for southeastern Australia (https://grdc.com.au/resources-and-publications/all-publications/publications/2009/08/canola-best-practice-management-guide-for-southeastern-australia)

Ten tips to early-sown canola (https://grdc.com.au/resources-and-publications/all-publications/publications/2018/ten-tips-to-early-sown-canola)

Twenty tips for profitable canola – Northern NSW (https://grdc.com.au/resources-and-publications/all-publications/publications/2019/20-tips-for-profitable-canola-northern-nsw)

Twenty tips for profitable canola – central & southern NSW (https://grdc.com.au/resources-and-publications/all-publications/publications/2019/20-tips-for-profitable-canola-central-and-southern-nsw)

Reducing aphid and virus risk (https://grdc.com.au/resources-and-publications/all-publications/factsheets/2015/02/reducing-aphid-and-virus-risk)

Fact sheets:

Blackleg management guide (https://grdc.com.au/resources-and-publications/all-publications/factsheets/2022/blackleg-management-guide)

Sclerotinia stem rot in canola (https://grdc.com.au/resources-and-publications/all-publications/factsheets/2014/03/grdc-fs-sclerotinia)

Australian Oilseeds Federation website for:

AOF standards manual (http://www.australianoilseeds.com/Technical_Info/standards_manual)

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Chickpea

Key considerations for 2023

- Paddock selection should focus on rotation history, disease risk and agronomic suitability for chickpea.
- Select an appropriate variety to suit sowing time, maturity windows and disease risk in your region.
- Sow within the recommended window for your region to maximise yield potential.
- Timely disease and insect control, based on systematic and regular monitoring of the crop, are critical management factors to produce high yields in chickpea crops.
- Ensure the crop is harvested as soon as seed moisture content is 14% to maximise both yield and grain quality potential for human consumption marketing opportunities.

Crop management

Many winter grain-growing areas in NSW are suited to chickpea production. The crop contributes to farming system 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. Both types are usually sold whole, so seed size and visual appearance are critically important.

Desi chickpea has relatively small, light-brown angular seeds that are commonly dehulled and split for use as split seed (dahl) or further ground to a flour (besan). Desi varieties are most widely grown under dryland production in Queensland and northern New South Wales.

Kabuli chickpea is more rounded, coloured creamy–white, and generally a much larger seed than desi chickpea. Kabuli varieties flower at a similar time to the desi type, but have a longer grain-filling period, requiring more water and sunlight to ensure an adequate seed size. Kabuli variety yields can be lower (15–30%), and more variable than desi varieties, which are often offset by premiums for larger seeds (8–10 mm). Kabuli seeds are predominantly consumed as whole seed after cooking or canning. Hommus is another significant market for kabuli chickpea. Small kabuli seeds are mostly used for hommus or besan.

Chickpea is well adapted to warm spring environments and tolerates higher temperatures during and after flowering than other winter pulse crops such as faba bean, lupin and field pea. The crop is not suited to areas where there could be a risk of late frosts in spring.

Soil types

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 soils where pH stratification (acid soil layers) can affect root growth, nodulation, crop vigour and yield potential. Severely acidic layers (pH_{Ca} <4.5) are common at depths of 5–10 cm and 10–15 cm in the main cropping soils of central and southern NSW. Check for acidic layers by sampling soils at 5 cm intervals down to 20 cm 2 years before sowing acid-sensitive pulses.

Where acidity is detected below the surface soil, the most rapid method to increase pH is to incorporate fine-grade lime to 10 cm deep at least 12 months before sowing chickpea.

Chickpea does not tolerate waterlogging and should not be grown in poorly drained paddocks or those prone to flooding.

Sowing

Seed quality

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. Desi seeds with noticeable tiger stripe/blotch markings on the seed coat should not be used for sowing, as there could be a risk of getting a higher percentage of affected seeds in next season's grain. Irrespective of the harvest year and source, all sowing seed must be thoroughly treated with a thiram-based fungicide to control seed-borne *Ascochyta* and *Botrytis* diseases and a range of other opportunistic soil organisms. Chickpea seed quality deteriorates after 12 months and should not be kept any longer than 18 months as sowing seed.

Obtaining good quality seed after the wet harvests of 2021 and 2022 could be an issue. Seed should be tested for germination and if it meets the Pulse Australia minimum standard of 70%, the seed should be treated and test planted into paddocks intended for chickpea in 2023. Count the number of seeds to emerge as this is the best indicator of seed and seedling vigour in the paddock. Paddock emergence tests are best done in March–April.

Sowing high quality, treated seed is the best way to achieve healthy seedlings, which will have a rapidly growing root system to obtain more nutrients and moisture, be more competitive with weeds and less susceptible to disease. Find further information on seed treatment and crop establishment on the Pulse Australia website.

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Pulse Australia website
(http://www.pulseaus.com.au/)

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 3 years between chickpea crops in the same paddock. These practices aim to reduce the amount of disease inoculum available to initiate new season infection. Do not sow chickpea in paddocks with a history of lucerne, medics, phytophthora root rot, *Sclerotinia*, or waterlogging. When planning double break crops for weed management with canola and chickpea, care needs to be taken to avoid *Sclerotinia* becoming a problem. Flooding can also carry disease inoculum long distances.

Stubble

In the northern grain zone, no-till crops sown into cereal stubble consistently yield 10% higher than those sown into conventionally prepared or reduced-tillage seedbeds. During the establishment and early vegetative stage, standing cereal stubble will also help to deter aphids from landing in the crop and transmitting virus disease.

Sowing depth

Sow chickpea seed 5–7 cm deep into moisture. If moisture is not present at this depth at the desired sowing time, chickpea can be sown deeper into stored moisture by sowing the seed 10–17 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 sow deep. Levelling the seedbed after sowing to remove deep furrows 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 for desi and 30–35 plants/m^2 for kabuli. 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.

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:

- sowing into heavy stubble in zero-till situations
- applying pesticide in-crop with a 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, particularly *Botrytis* in spring
- 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. There can be yield penalties in above-average seasons. Wider row spacing (>50 cm) in southern NSW can result in lower grain yields.

Table 56. Sowing rate (kg/ha) guide based on 100% germination, 80% establishment and estimated seed weight for each variety.

Variety	100 seed weight (g)	Target plant density/m^2			
		Northern and Central NSW		Southern NSW	
		20	30	35	45
Desi types					
CBA Captain	23	58	86	101	129
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 Seamer	23	58	86	101	129
PBA Slasher	18	45	68	79	101
PBA Striker	21	53	79	92	118
Kabuli types					
Genesis 090	30	75	113	131	169
Genesis Kalkee	45	113	169	197	253
PBA Magnus	48	120	180	210	270
PBA Monarch	42	105	158	184	236
PBA Royal	38	95	143	166	214

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 time

Aim to sow in the early–mid period of the recommended sowing window to maximise yield potential. However, early sowing can expose the crop to more rainfall events, which can increase the risk of ascochyta blight, *Sclerotinia* and phytophthora root rot diseases. Early sowing can also result in greater crop biomass, which can increase the risk of botrytis grey mould later in the season and increase the risk of lodging. Very early sowing can also lead to poor early pod set and potential moisture shortage during the grain-fill period, which can reduce seed size and hence yield and marketing potential, particularly for kabuli types.

Later sown crops (outside the optimal sowing window) generally have lower yield potential. They can attract greater pest pressure from *Helicoverpa* spp. due to 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* infections and lessen the risk of botrytis grey mould, frosted grains and tiger stripe/blotch seed markings.

Table 57. Suggested chickpea 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 than recommended, yield reduction likely.
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. Check for effective nodulation 6–10 weeks after sowing to ensure inoculation has been successful.

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. An alternative method that gives better rhizobia survival is to use inoculum slurry sprayed directly into the furrow at sowing, thus avoiding contact with the fungicide.

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, leading to blocked hoses, patchy establishment and future weed and herbicide timing problems.

Several new inoculant products are available for chickpea, such as freeze-dried and dry granular products. Read and follow the instructions to avoid inoculation problems.

Nutrition

Select paddocks with a low level of residual nitrogen (N) to promote effective nodulation and N fixation.

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.

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, a number of factors should be considered including:

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

A variety brochure is available from the GRDC website, Pulse Australia or the relevant seed supply company for each variety. Refer to Table 58 for variety characteristics; Table 59 for disease ratings; and from Table 60 to Table 61 for variety yield results.

There are no new chickpea variety releases for 2023. CBA Captain(ф) was released in 2020 as a high yielding, medium sized desi type suited to all chickpea growing regions across Australia. PBA Magnus(ф) was also released in 2020 as a very large-seeded and high yielding kabuli type, suited to medium rainfall chickpea-growing regions in south-eastern Australia.

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GRDC website
(https://grdc.com.au/)

Pulse Australia
(http://www.pulseaus.com.au/)

Ascochyta blight changes

A change in aggressiveness 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 growing regions. The revised *Ascochyta* ratings published in this guide are for northern Australia (NSW) only and are based on NVT chickpea national disease ratings trials with a limited number of pathogen isolates.

Resistance abbreviations: R – resistant; MR – moderately resistant; MS – moderately susceptible; S – susceptible; VS – very susceptible.

Table 58. Chickpea variety characteristics.

Variety	Year of release	100 seed weight (g)	Plant height	Lodging resistance	Maturity
Desi types					
CBA Captain	2020	23	MT	M	E–M
Kyabra	2006	26	T	VG	M
Neelam	2012	17	MT	VG	M
PBA Boundary	2011	19	T	M	M
PBA Drummond	2018	22	T	VG	E–M
PBA HatTrick	2009	20	T	M	M
PBA Maiden	2013	24	MS	M	M
PBA Seamer	2016	23	M	VG	M
PBA Slasher	2009	18	MS	M	M
PBA Striker	2012	21	MS	M	E
Kabuli types					
Almaz	2006	41	MT	G	L
Genesis™ 090	2005	30	M	G	M–L
Genesis™ Kalkee	2011	45	T	VG	L
PBA Magnus	2020	48	MT	F	E–M
PBA Monarch	2013	42	M	F	E
PBA Royal	2019	38	M	F	E–M

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

Table 59. Chickpea disease ratings for common varieties.

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								
CBA Captain	MS	S	S	n.d.	MS	MT	MR	MT
Kyabra	VS	VS	S	S	S	MT	MR–MS	MT
Neelam	S	n.d.	S	n.d.	MS	MI	MR–MS	MI
PBA Boundary	S	VS	S	S	MR–MS	MT	R–MR	MI
PBA Drummond	VS	VS	S	MS	MR–MS	MT	MR	T–MT
PBA HatTrick	S	S	S	S	MR–MS	MT–MI	MR–MS	MT
PBA Maiden	S	n.d.	S	S	MR–MS	I	MR–MS	MI
PBA Seamer	MS	S	S	S	MR–MS	MT–MI	MR–MS	MI
PBA Slasher	S	n.d.	S	S	MR–MS	MT	MR–MS	MI
PBA Striker	S	n.d.	S	S	MR–MS	T–MT	MR–MS	MI
Kabuli types								
Almaz	MS	n.d.	S	S	S	I–VI	MR–MS	MI–I
Genesis™ 090	MS	n.d.	S	S	MS–S	I	MR–MS	I–VI
Genesis™ Kalkee	S	n.d.	S	S	MS	MI	MR–MS	VI
PBA Magnus	MS	n.d.	S	S	MS–S	I	MR	MI–I
PBA Monarch	MS	n.d.	S	S	MS	MI–I	MR–MS	I
PBA Royal	MS	n.d.	S	S	MS	MI	MR	VI

Source: NVT chickpea national disease ratings.

n.d. No data
R Resistant
MR Moderately resistant
MS Moderately susceptible
S Susceptible
VS Very susceptible
T Tolerant
MT Moderately tolerant
MI Moderately intolerant
I Intolerant
VI Very intolerant.

❶ Ascochyta blight ratings are from 2022 data for northern Australia (NSW) only, not southern Australia (Vic & SA).
❷ Phytophthora root rot ratings are from 2022 data.
❸ Botrytis grey mould ratings are from 2020 data. Note the risk of botrytis grey mould (BGM) damage can be affected by the spray programs for ascochyta blight (AB); fungicides used to control Ascochyta can also reduce Botrytis.
❹ Virus ratings are based on information supplied by breeders and could change with different virus species predominating in different regions and seasons.
❺ Root lesion nematode ratings are from 2022 data. 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 60. Comparative performance of desi chickpea in northern and southern NSW compared with CBA Captain(b) = 100%.

North east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% CBA Captain (t/ha)	1.05	n.d.	2.29	2.79	n.d.	2.05	
CBA Captain	**100**	**n.d.**	**100**	**100**	**n.d.**	**100**	**3**
Kyabra	88	n.d.	97	83	n.d.	89	3
PBA Boundary	97	n.d.	92	90	n.d.	92	3
PBA Drummond	106	n.d.	112	104	n.d.	107	3
PBA HatTrick	91	n.d.	95	92	n.d.	93	3
PBA Seamer	88	n.d.	104	102	n.d.	101	3

North west							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% CBA Captain (t/ha)	1.01	n.d.	2.57	3.27	n.d.	2.47	
CBA Captain	**100**	**n.d.**	**100**	**100**	**n.d.**	**100**	**12**
Kyabra	108	n.d.	95	89	n.d.	93	12
PBA Boundary	109	n.d.	95	96	n.d.	97	12
PBA Drummond	103	n.d.	107	106	n.d.	106	12
PBA HatTrick	101	n.d.	95	92	n.d.	94	12
PBA Seamer	88	n.d.	98	92	n.d.	94	12

South west							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% CBA Captain (t/ha)	n.d.	n.d.	2.24	2.34	2.55	2.38	
CBA Captain	**n.d.**	**n.d.**	**100**	**100**	**100**	**100**	**3**
Neelam	n.d.	n.d.	97	97	87	93	2
PBA Boundary	n.d.	n.d.	83	77	67	75	3
PBA Maiden	n.d.	n.d.	93	98	71	87	3
PBA Seamer	n.d.	n.d.	88	76	82	82	3
PBA Slasher	n.d.	n.d.	97	106	72	91	3
PBA Striker	n.d.	n.d.	97	108	72	92	3

Table 61. Comparative performance of kabuli chickpea in northern NSW compared with Almaz(b) = 100%.

North west							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% Almaz (t/ha)	0.92	n.d.	2.62	3.35	n.d.	2.45	
Almaz	**100**	**n.d.**	**100**	**100**	**n.d.**	**100**	**7**
Genesis 090	112	n.d.	98	105	n.d.	103	7
Genesis Kalkee	106	n.d.	97	100	n.d.	100	7
PBA Magnus	95	n.d.	96	95	n.d.	95	7
PBA Monarch	92	n.d.	95	80	n.d.	86	7
PBA Royal	108	n.d.	97	101	n.d.	101	7

Desi types

CBA Captain[Φ]. New variety released in 2020. MS to *Ascochyta* (northern cropping region); S to *Phytophthora*. Erect plant type with good height to lowest pod, moderate lodging resistance and excellent harvestability, with broad adaptation to all chickpea-growing regions across Australia. It is early–mid flowering (earlier than PBA HatTrick[Φ]) with early–mid season maturity (earlier than PBA HatTrick[Φ]). Medium-sized desi seed (larger than PBA HatTrick[Φ], similar to PBA Seamer[Φ]) with a yellow–brown seed coat suited to human consumption. Developed by Pulse Breeding Australia (PBA) Chickpea program and released by Chickpea Breeding Australia (CBA), seed available from CBA seed partners PB Agrifood, PB Seeds and Woods Seeds. EPR is $4.95/tonne incl. GST.

Kyabra[Φ]. 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; VS to *Phytophthora*. Larger seed size and superior grain quality for the whole seed market compared with other current varieties. Marketed by Barenbrug Australia. A seed royalty applies. No EPR.

Neelam[Φ]. S to *Ascochyta*, VS to *Phytophthora* (inferred from non-NVT data) so not recommended for northern NSW. Very small seed size relative to other desi varieties. Marketed by Barenbrug Australia. EPR is $4.40/tonne incl. GST.

PBA Boundary[Φ]. S to *Ascochyta*; VS to *Phytophthora* and only suitable for paddocks with a low *Phytophthora* risk. High yielding across chickpea-growing regions of northern NSW and southern QLD. Mid season maturity, equivalent to PBA HatTrick[Φ]. Medium-sized desi seed suited to human consumption. Developed by PBA. Marketed by Seednet. EPR is $4.40/tonne incl. GST.

PBA Drummond[Φ]. VS to *Ascochyta*; VS to *Phytophthora*. Potentially suited to north-western areas where Kyabra[Φ] has been grown and in paddocks with a low *Phytophthora* risk. Not recommended for southern NSW. Tall, erect plant type with early–mid season maturity, similar to PBA Seamer[Φ]. Medium sized seed suited to human consumption. Developed by PBA. Marketed by Seednet. EPR is $4.40/tonne incl. GST.

PBA HatTrick[Φ]. S to *Ascochyta*; S to *Phytophthora*. Recommended for, and suited to, areas north of Parkes but now outclassed for yield and disease ratings. 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 incl. GST.

PBA Maiden[Φ]. S to *Ascochyta*; VS to *Phytophthora* (inferred from non-NVT data) so not recommended for northern NSW. Semi-spreading plant type with mid season maturity, similar to PBA Slasher[Φ]. Large sized desi seed 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 incl. GST.

PBA Seamer[Φ]. MS to *Ascochyta*; S to *Phytophthora*. 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 incl. GST.

PBA Slasher[Φ]. S to *Ascochyta*; VS to *Phytophthora* (inferred from non-NVT data) so 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. Medium-sized desi seed with a tan–brown seed coat suitable for whole and split seed. Marketed by Seednet. EPR is $4.40/tonne incl. GST.

PBA Striker[Φ]. S to *Ascochyta*; VS to *Phytophthora* (inferred from non-NVT data) so 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 seed with tan–brown seed coat suitable for whole and split seed. Marketed by Seednet. EPR is $4.40/tonne incl. GST.

Kabuli types

AlmazΦ. MS to *Ascochyta*; VS to *Phytophthora* (inferred from non-NVT data). Medium seed size, 8–9 mm. Introduced from the International Center for Agricultural Research in the Dry Areas (ICARDA) and selected by the Department of Agriculture and Food, Western Australia (DAFWA). Marketed by Seednet in eastern Australia. EPR is $7.15/tonne incl. GST.

Genesis™ 090. MS to *Ascochyta*; VS to *Phytophthora* (inferred from non-NVT data), 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 Agriculture Victoria. Marketed by PB Seeds. EPR is $5.50/tonne incl. GST.

Genesis™ Kalkee. S to *Ascochyta*; VS to *Phytophthora* (inferred from non-NVT data). Larger seed size than Almaz^{Φ}, predominantly 9 mm. Yield is similar to 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 Vic DPI and NSW DPI. Marketed by PB Seeds. EPR is $5.50/tonne incl. GST.

PBA MagnusΦ. New variety released in 2020. MS to *Ascochyta*; VS to *Phytophthora* (inferred from non-NVT data). Early–mid flowering and maturity (earlier than Genesis™ Kalkee). Large seed size, predominantly 9 mm (larger than Genesis™ Kalkee). Highest yielding large-sized kabuli chickpea, suited to medium rainfall environments of south-eastern Australia. Semi-spreading plant type which can be prone to lodging. Developed by PBA Chickpea program, seed available from commercial partner PB Seeds. EPR is $7.15/tonne incl. GST.

PBA MonarchΦ. MS to *Ascochyta*; VS to *Phytophthora* (inferred from non-NVT data). Early flowering and early maturing. Medium seed size, 8–9 mm, similar to Almaz^{Φ}. High yielding, medium sized kabuli chickpea. Semi-spreading plant type, which can be prone to lodging. Developed by PBA. Marketed by Seednet. EPR is $7.15/tonne incl. GST.

PBA RoyalΦ. MS to *Ascochyta*; VS to *Phytophthora* (inferred from non-NVT data). Early to mid flowering; early to mid maturing. Medium seed size, 8 mm, larger than Genesis 090 but smaller than Almaz^{Φ} and PBA Monarch^{Φ}. High yielding, medium sized kabuli chickpea in mid to high yield potential environments. Semi-spreading plant type, which can be prone to lodging. Developed by PBA. Marketed by Seednet. EPR is $7.15/tonne incl. GST.

Weed control

Chickpea does not compete well with weeds, and there are limited options for controlling certain broadleaf weeds using in-crop herbicides. However, there is now a wide range of herbicides that can be used either pre-sowing, incorporated by sowing (IBS), or post-sow-pre-emergence, which have made broadleaf weed control much more effective. Some of the newer chemistries include isoxaflutole (e.g. Balance®, Palmero®), terbuthylazine (e.g. Terbyne®), fomesafen (e.g. Reflex®) and flumioxazin (e.g. Terrain®), as well as combination chemistries (e.g. Palmero® TX). Despite these newer options, it is still preferable to sow chickpea in paddocks with relatively low broadleaf weed seed-banks. Chickpea can be sensitive to herbicide wash from some of these products in sowing furrows and care needs to be taken, particularly when deep sowing, 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 arise when residual herbicides are applied to preceding cereal crops in the rotation. Examples include:

- **Sulfonylurea herbicides** (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 where rainfall has been limited. Residues could persist longer in soils that have received surface-applied lime to raise soil pH.
- **Triazine herbicides** (e.g. atrazine, simazine). Seek advice as to potential chickpea crop damage when using triazine herbicides in summer cereals (sorghum and maize) and also TT canola, as application rates on different soil types influence the extent of residual herbicide breakdown. Follow label recommendations and avoid spray overlaps.
- **Clopyralid** (e.g. Lontrel®), 2,4-D amine and some other hormone herbicides. Under dry conditions, these herbicides break down 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®, Palmero® and Palmero® TX) can, under some conditions, damage chickpea varieties. 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 the trench above the seed is closed at sowing to reduce risk of herbicide washing into the seed furrow.

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 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 for further information on current weed control and plantback recommendations.

Insect control

The major insect pest of chickpea is *Helicoverpa* spp. (heliothis caterpillars). They can reduce yield and grain quality. Careful crop monitoring is required from flowering until seed maturity.

The Queensland Department of Agriculture and Fisheries research recommends changes to control decisions for *Helicoverpa*. The change is from a fixed threshold of 1–2 larvae/m^2, to a threshold 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 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®.

When deciding which product to use there are many factors to consider such as:

- *Helicoverpa* species and risk of resistance
- compatibility with fungicides
- cost
- harvest withholding period (WHP).

Read pesticide labels carefully before use. Pesticide label rates, timing and WHPs should be followed carefully as exceeding maximum residue limits could jeopardise markets, since pulse products are usually consumed as they are harvested, with no further processing.

Diseases

Disease monitoring and management is an essential aspect of chickpea production. Growers are urged to seek advice on which diseases occur in their area. The most effective control measures include crop rotation; paddock selection, variety choice, seed selection; and seed treatment, so it is best to start planning one season ahead of sowing.

The major chickpea diseases in NSW are ascochyta blight, phytophthora root rot, botrytis grey mould, botrytis seedling disease, viruses, and ill-thrift caused by root lesion nematodes. *Sclerotinia* can also cause problems in dense canopy crops and in paddocks with a history of canola or lupin production. Physiological disorders with disease-like symptoms are also significant, in particular injury from low temperature, frost, herbicides, waterlogging, sodicity and salinity.

This section describes strategies that will reduce the risk of major chickpea diseases for the coming season. Some of these strategies are based on local and international field experiments, others are based on observations of reduced disease in previous year's crops.

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Helicoverpa management in chickpea (http://www.daf.qld.gov.au/__data/assets/pdf_file/0005/76739/HelicoverpaManagement-InChickpea.pdf)

For more information on all chickpea diseases see *Managing diseases in chickpeas in 2022* on the NSW DPI website.

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Managing diseases in chickpeas in 2022 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/1398188/Managing-diseases-in-chickpeas-in-2022.pdf)

Ascochyta blight, AB (fungus *Ascochyta rabiei*) – is the most serious disease of chickpea in Australia and can cause 100% yield loss in susceptible varieties and years that favour the disease. Managing this disease is integral to producing chickpea in NSW.

The pathogen that causes ascochyta blight survives and spreads in infected chickpea seed, stubble and on volunteers. Under ideal conditions, it can reproduce as fast as 5–7 days on very susceptible varieties such as Kyabra$^{\Phi}$. The disease can develop over a wide range of temperatures (5–30 °C) and needs 3–10 hours of leaf wetness to infect, so small showers can be just as effective in spreading disease as larger rainfall events. The disease develops quickest when temperatures are 15–25 °C and humidity is high. The longer the leaf is wet and subject to higher humidity, the more widespread and severe the infection. However, it is not a soil-borne pathogen and does not survive long when buried or in contact with the soil.

The chickpea industry has successfully adopted management strategies to control ascochyta blight. They are updated as new information becomes available and new varieties are released. Strategies include paddock selection and rotation, growing the least susceptible varieties, planting low risk seed, treating seed with a thiram-based fungicide, applying an early protectant fungicide application, routine crop monitoring, and an ability to apply additional fungicide sprays as required during the growing season if conditions favour further disease development.

Ascochyta inoculum will be present from 4 potential sources:

1. ***Ascochyta*-infected chickpea residue** being discharged from 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 effects from ascochyta blight in chickpea crops:

- **Paddock selection**: The fungus that causes ascochyta blight survives on old chickpea trash, it does not survive in soil. In northern NSW, the high frequency of chickpea in cropping rotations makes separation of last year's stubble from this season's crop often difficult and significantly increases disease pressure. The same also applies to chickpea frequency in the rotation; once every 4 years is ideal.
- **Grow varieties with improved AB resistance:** Varieties such as CBA Captain$^{\Phi}$ and PBA Seamer$^{\Phi}$ will have less disease and require fewer fungicide applications in northern NSW.
- **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** with a registered fungicide to reduce both internally borne *Ascochyta* and external contamination. See Table 62 on page 118 for seed treatment information. *Ascochyta* transmission and spread can still occur from chickpea seed treated with a seed applied fungicide.
- **Plant on wider row spacing (66 cm+)** to 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.

Widespread rainfall in winter and spring 2022 favoured ascochyta blight development across NSW, with wet conditions not only favouring disease spread and development, but prevented timely foliar fungicides application. Even if infected with *Ascochyta*, most varieties recover well during dry conditions, or when the disease is controlled with fungicide.

Late rains in 2022 have contributed to *Ascochyta* pod and seed infection, consequently seed treatment with a fungicide will be imperative when sowing chickpea crops in 2023. For 2023 it is recommended that selecting varieties with better *Ascochyta* resistance and using a preventative fungicide at the initial seedling stage of infection is critical. Subsequently, throughout the season, fungicide should be applied before rain only if the disease is detected or if your crop is in a high risk *Ascochyta* situation.

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GRDC website (https://grdc.com.au/)

High risk situations include planting into paddocks where active inoculum is known to be present, and planting seed of unknown pathogen status that has not been properly treated with fungicide seed dressings. In these situations, apply an *Ascochyta* fungicide before the first post-emergence rain as recommended above, then monitor the crop from 10–14 days after rain.

If *Ascochyta* is detected, apply a registered fungicide before the next rain. This is especially important during the crop's reproductive stage, as *Ascochyta* on pods causes abortion, seed infection and seed defects. If a spray is missed, fungicides with limited curative activity are now available.

Recent research has shown the *Ascochyta* fungicides Aviator® Xpro™ and Veritas® Opti are rainfast (up to 100 mm rain in 150 minutes), however, they have a limited timeframe for use and tight intervals for application after an infection occurs. Application might also be difficult in saturated or boggy paddocks and aerial application could be necessary, which is not as effective. Further information on salvage fungicide options is available on the GRDC website.

The NSW DPI website has more information on *Managing ascochyta blight in chickpeas 2021*.

- **Applying foliar fungicides** – Managing *Ascochyta* begins once the crop has emerged, with regular crop inspections key to applying foliar fungicides at the right time. Foliar fungicides provide cost-effective *Ascochyta* management in all varieties including those rated VS such as Kyabra[◊]. The key to a profitable outcome is timing – labels for all registered fungicide products state they are most effective when applied before rain. Field experiments conducted in 2020 and 2021 at Trangie, Tamworth and Wagga Wagga, in which three varieties were inoculated with *Ascochyta* at different growth stages, showed least *Ascochyta* occurred when the disease was managed early and when the most resistant variety was grown.
  Consider the logistics of multiple fungicide applications when selecting paddocks to be sown to chickpea. This also includes the possibility of using aircraft to apply fungicides if conditions are too wet for a ground rig. Applying fungicides by ground rig is preferred. Select a nozzle such as a DG TwinJet or Turbo TwinJet that will produce droplets no smaller than medium (ASABE standard) 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.

  There are multiple foliar fungicides registered to manage *Ascochyta* in NSW. Older products (such as those containing chlorothalonil and mancozeb) can be used throughout the growing season and have no restrictions on the number of applications. Newer foliar fungicides, such as Aviator® Xpro® (prothioconazole + bixafen), Veritas® Opti (tebuconazole + azoxystrobin), and Miravis® Star (fludioxonil + pydiflumetofen) are very effective, but have restrictions on the number of applications within a growing season. Be aware of the conditions that apply when using different foliar fungicide products.

  The critical timings for foliar fungicide applications are:

  Critical period 1: 4–6 weeks post emergence, apply a foliar fungicide to contain or eliminate any seed-borne infections.

  Critical period 2: Just before canopy closure, apply a foliar fungicide for adequate coverage of the lower canopy before the crop canopy closes. It is important to ensure coverage of the lower canopy and potential infection sites.

  Critical period 3: At podding continue to monitor the crop to protect pods from infection.

  Continue to monitor the crop regularly throughout the growing season and time foliar fungicide applications with periods of fungicide protection and rain.

  Fungicide use should focus on preventing new infections and disease spread prior to rainfall, NOT curing old infections. Monitoring your chickpea crop for *Ascochyta* regularly is the most effective way to manage the disease. The appearance or spread of the disease will be most easily seen 7–10 days after a rainfall event.

Botrytis grey mould, BGM (fungus *Botrytis cinerea*) –is an airborne foliar disease that develops rapidly when temperatures warm up towards spring (approx. 15 °C). It is more prevalent in the warmer regions of the north at canopy closure where

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Managing ascochyta blight in chickpeas 2021 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0015/1220271/managing-ascochyta-blight-in-chickpeas-in-2021.pdf)

significant crop losses can occur in high biomass crops during wet or humid conditions such as in 2016, 2020, 2021 and 2022. 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, including old senescent leaves, flowers and flower parts, which act as foci of infection. The fungus readily produces airborne spores and some isolates form sclerotia. This means that BGM inoculum is always present and, if conditions are favourable, it will occur irrespective of what has happened earlier in the chickpea season.

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

- **Paddock selection**: Avoid sowing chickpea next to paddocks where BGM was an issue the previous season. Chickpea, as for ascochyta blight, 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 its airborne 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 high humidity and therefore BGM development.
- **Plant on wider rows (66 cm +)**: Wide rows improve airflow through the crop leading to more rapid drying after rain, heavy dew, or after irrigation if applicable. Canopy closure can also be delayed, which will improve fungicide penetration.
- **Foliar fungicide**: In areas outside central QLD, spraying for BGM is not needed in most years. However, in seasons and situations that favour the disease, a preventative fungicide spray just before canopy closure, with another application 2 weeks later, will help 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. Select a foliar fungicide that has activity against BGM. None of the fungicides currently registered or under permit for chickpea BGM will eradicate established infections. Consequently, timely and thorough application is critical.
- If a crop is observed to have *Botrytis* present as infection on pods, it is important to treat any retained seed for the following season with a fungicide that will prevent botrytis seedling disease.

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Managing botrytis in chickpeas in 2021 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/1299969/Managing-Botrytis-in-chickpeas-in-2021.pdf)

If conditions such as warm humid weather and dense canopies favour BGM in 2023, the disease is likely to appear. Note that seed treatments are ineffective against the airborne BGM fungus.

The NSW DPI website has more information on *Managing botrytis in chickpeas in 2021*.

Botrytis seedling disease, BSD (fungus *Botrytis cinerea*) – although caused by the same fungus as BGM, is a very different disease. Unlike BGM, BSD is seed-borne and will occur over a range of temperatures. Planting *Botrytis*-infected seed that has not been fungicide treated, or has been treated ineffectively, allows the fungus to grow out of the seed, attack the root and basal stem tissues and cause seedling disease and plant death. The fungus can also spread to, and kill, neighbouring healthy plants, thereby multiplying the BSD threat to crops. See Table 62 on page 118 for seed treatment information.

BSD could pose some threat to 2023 crops sown with seed from the 2022 or 2021 crops. Seed testing at Tamworth has previously detected *Botrytis* infection as high as 34% in seed. Even if only 1% of seed is infected and the seed is not treated, this equates to 3000 infected seedlings per hectare (assuming a target population of 300,000 plants/ha). Seed treatment using a registered fungicide seed dressing will provide complete BSD control.

Phytophthora root rot, PRR (oomycete *Phytophthora medicaginis*) – is a soil- and water-borne disease with inoculum that can establish in some paddocks. Damage is greatest in seasons with above average rainfall, but only a single saturating rainfall event is needed for infection. Avoid high-risk paddocks such as those with a history of *Phytophthora* in chickpea, waterlogging, or pasture legumes. Alternative *Phytophthora* hosts such as pasture legumes, particularly medics and lucerne, must be managed to provide a clean break between chickpea crops.

Surveys in the 2020 and 2021 seasons identified two other *Phytophthora* species (*P. clandestina* and *P. megasperma*) on chickpea roots in the northern region. Current evidence suggests these pathogens are not causing severe root disease on chickpea, but further evaluations are required to confirm this. PRR only develops in northern NSW (Dubbo and north) and has not been detected in southern NSW despite extensive crop surveys over the last 4 seasons.

The PREDICTA® B soil test can be used to assess PRR risk. Detecting any level of *Phytophthora* in a paddock makes it at 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 CBA Captain$^{(\phi)}$, PBA Seamer$^{(\phi)}$ or PBA HatTrick$^{(\phi)}$ and consider treating seed with metalaxyl. Metalaxyl can be applied in the same operation as other fungicide seed treatments. Metalaxyl only provides protection for about 8 weeks; crops can still become infected and die later in the season. See Table 62 on page 118 for seed treatment information. Do not plant PBA Boundary$^{(\phi)}$ or PBA Drummond$^{(\phi)}$ in any paddock that has had a history of pasture legumes or chickpea with PRR.

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Phytophthora root rot yield loss tool (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/chickpeas/phytophthora-root-rot-yield-loss-tool)

Phytophthora root rot management in chickpeas (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/1452082/Phytophthora-root-rot-management-in-chickpeas-2023.pdf)

Phytophthora inoculum will be present from three potential sources:

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 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 chickpea; 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 happen every year. Flooded areas of 2022 paddocks might have also received water-borne *Phytophthora* inoculum.
- **Metalaxyl-based seed dressings are registered** for PRR, 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 have been grown in the past 5–6 years.

Phytophthora root rot disease is considered to be a high risk in 2023, because inoculum loads are likely to have increased for these pathogens where multiplication in other leguminous weeds was favoured by wetter than average seasons.

The NSW DPI website has more information on the *Phytophthora root rot management in chickpeas* and the *Phytophthora root rot yield loss tool.*

Sclerotinia white mould (fungi *Sclerotinia sclerotiorum*, *S. trifoliorum*, *S. minor*) – *Sclerotinia* fungi (*S. sclerotiorum, S. trifoliorum* and *S. minor*) infect chickpea plants in two ways:

1. **Basal infection: 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. **Canopy infection**: **Sclerotia germinate indirectly**, producing apothecia at ground level, which then release airborne ascospores (carpogenic germination) that infect plant parts higher in the canopy.

   The type of infection pathway (basal or canopy) will be dictated by the season, and in particular, soil moisture levels. Paddocks with a high background level of sclerotia tend to develop basal infections. In the past, *Sclerotinia* canopy infection has led to issues with the delivery of chickpea seed and rejection at receival points. Canopy infection leads to the formation of sclerotes on and inside chickpea stems that can be captured during harvest. This can then cause problems at receival points because the cylindrical sclerotia formed inside the stems can resemble ryegrass ergots, and cause loads to be rejected or docked.

In southern NSW, outbreaks of sclerotinia white mould in chickpea are closely linked to paddocks with a history of canola or lupin production and thus are likely to have populations of sclerotia. Chickpea crops that are sown early and reach canopy closure in winter tend to be predisposed to developing the disease. Infection via mycelium directly in the soil or through ascospores appear to be equally prevalent.

Sclerotinia inoculum will be present from 5 potential sources, sclerotia:

1. **spread** by floods and surface water
2. **admixed** with chickpea seed from the previous season and introduced into chickpea paddocks at sowing
3. **in broadleaf crop residue** (e.g. canola or lupin) in paddocks intended for chickpea this year; large sclerotia can survive for up to 10 years
4. **in weed hosts** in paddocks intended for chickpea this year
5. **residing in soils** resulting from infections in the last 5 years (e.g. sclerotia from infected crops have the potential to survive and cause infections for at least the next 5 seasons).

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

- grade seed to remove sclerotia
- avoid paddocks with a history of *Sclerotinia* outbreaks
- avoid paddocks with a recent history of canola or lupin
- avoid paddocks with a history of broadleaf weeds.

Sclerotinia disease is considered to be a high risk in 2023, because inoculum loads are likely to have increased for these pathogens where wetter than average seasons favoured multiplication.

Root lesion nematode, RLN (*Pratylenchus thornei*, *Pratylenchus neglectus*) – causes poor plant growth in situations that otherwise appear favourable. They attack cereals and pulses and are 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 sowing chickpea in paddocks that had susceptible or intolerant cereal varieties in the previous season, and by following the recommendations in *Root lesion nematodes* on the Queensland DAF website.

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Root lesion nematodes (https://www.daf.qld.gov.au/___data/assets/pdf_file/0010/58870/Root-Lesion-Nematode-Brochure.pdf)

Virus diseases

Flying aphids spread viruses, which can cause major chickpea losses in some years. The Liverpool Plains, Gilgandra and Narrabri districts have a history of virus disease. In 2020, viruses caused widespread damage and losses in faba bean crops. Where chickpea crops adjoined or were close to an infected faba bean crop, the viruses also caused problems in the chickpea crops. Fortunately, most of this damage was confined to a narrow strip (10–20 m) beside to the faba bean crop. Scattered instances of virus in chickpea were found in 2021 on the edge of crops, however, no major yield impacts were reported.

Prevention is the only option to limit losses because there is no in-crop management to control or cure virus disease. However, prevention measures are often not adequate due to limited effectiveness and practicality, and there are no immune chickpea 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
- using narrow row spacing
- using a higher sowing rate.

Monitoring and spraying aphids is generally not effective. Virus control is different for chickpea than for other pulses because spread is almost entirely by non-colonising aphids that visit crops only briefly. Management options are detailed in two brochures *Managing viruses in pulse crops in 2021* and *Aphid management in pulse crops 2022* on the NSW DPI website.

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Managing viruses in pulse crops in 2021 (https://www.dpi.nsw.gov.au/___data/assets/pdf_file/0005/1299965/Managing-viruses-in-pulse-crops-in-2021.pdf)

Aphid management in pulse crops 2022 (https://www.dpi.nsw.gov.au/___data/assets/pdf_file/0006/1422168/Aphid-management-in-pulse-crops-2022.pdf)

Fungicide seed dressings

Chickpea seed should always be treated to control seed-borne *Ascochyta* and *Botrytis* and some soil-borne diseases. Research has shown that 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 62. 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 compacted soil can aggravate the situation. Group 2 (previously 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 in the rotation also increases the risk of Group 6 (previously Group C) herbicide damage.

Consult herbicide labels for further information on plantback periods and rainfall requirements.

Harvesting

Chickpea plants often contain pods with various stages of maturity (i.e. first-set pods can be mature while young, green pods are still forming). Chickpea seeds are physiologically mature when yellowing from the seed beak begins to extend through the remainder of the seed.

Chickpea crops can be desiccated using glyphosate (470/570/600 g/L) ± metsulfuron-methyl (600 g/kg) ± saflufenacil (700 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 desiccation product used (e.g. 7 days for glyphosate products; 2 days for diquat products). Crops desiccated with glyphosate should not be kept for sowing seed as desiccation can reduce seed viability.

Desiccation allows earlier harvest, maximising both yield and grain quality. However, a crop ripening evenly under very hot conditions and/or with no weed problems might not require desiccation (see *Chickpea harvest and seed storage*, available from Pulse Australia).

The receival standard for chickpea is 14% seed moisture content. Harvest should start as soon as the seed has dried down sufficiently to thresh. Harvesting chickpea at 14–15% moisture then drying or aerating will normally result in a higher yield, better quality seed, fewer harvest difficulties and reduced risk of 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 darkened, discoloured or sprouted seeds).

There can be significant harvest losses if harvest operators are inexperienced.

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Chickpea harvest and seed storage
(http://www.pulseaus.com.au/storage/app/media/crops/2007_Chickpea-Harvest-Storage.pdf)

Pulse Australia website
(http://www.pulseaus.com.au/)

Make sure contractors are experienced in chickpea harvesting, that header settings are optimised for each crop and that harvesting machinery travels 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 often as every 30 minutes if required.

Late rains can cause a second flush of growth and podding. When this occurs, timing the 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 in storage). 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 chickpea goes as whole seed to the subcontinent countries of India, Pakistan, Bangladesh and Sri Lanka for human consumption as whole seed, dahl (split seed) or besan. A small proportion is sold whole, split or milled into flour in Australia and consumed locally or sold to expatriate Indian communities in the UK, Canada and Fiji. There is an increasing interest in besan as an ingredient in food products, both domestically and internationally. Markets assess chickpea visually (subjectively) so colour, size and shape are important for buyers. Check with local buyers for specific market requirements.

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Pulse Australia website
(http://www.pulseaus.com.au/)

Prices in the subcontinent are lower in their post harvest period from April to June and Turkish imports fill the period from August to December. The Australian crop meets the off-season demand from December to March, although prices for chickpea in Australia in October and November are often higher than in December and January. Indian tariffs since 2017 have meant that the main market has shifted to Bangladesh where consistent colour and size are important considerations for buyers, so careful harvesting and storage is imperative for achieving top prices.

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 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 chickpea are exported to the 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 chickpea can be found on the Pulse Australia website.

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Further information

NSW DPI

Insect and mite control in field crops (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

Pulse Point 20, *Germination testing and seed rate calculation* (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/157442/pulse-point-20.pdf)

Managing ascochyta blight in chickpeas 2021 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0015/1220271/managing-ascochyta-blight-in-chickpeas-in-2021.pdf)

Managing Botrytis in chickpeas in 2021 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/1299969/Managing-Botrytis-in-chickpeas-in-2021.pdf)

Managing diseases in chickpeas in 2022 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/1398188/Managing-diseases-in-chickpeas-in-2022.pdf)

Phytophthora root rot yield loss tool (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/chickpeas/phytophthora-root-rot-yield-loss-tool)

Managing viruses in pulse crops in 2021 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/1299965/Managing-viruses-in-pulse-crops-in-2021.pdf)

Aphid management in pulse crops 2022 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/1422168/Aphid-management-in-pulse-crops-2022.pdf)

Phytophthora root rot management in chickpeas (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/1452082/Phytophthora-root-rot-management-in-chickpeas-2023.pdf)

GRDC

What causes and how can we manage grain quality defects in chickpeas (https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2019/03/what-causes-and-how-can-we-manage-grain-quality-defects-in-chickpeas)

Pulse Australia

2022–2023 Pulse Trading Standards (http://www.pulseaus.com.au/marketing/receival-trading-standards)

PA Bulletin, *Chickpea: High quality seed* (http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/high-quality-seed)

Northern Pulse Bulletin, *Chickpea: Effective crop establishment* (http://www.pulseaus.com.au/storage/app/media/crops/2011_NPB-Chickpea-crop-establishment.pdf)

PA Bulletin, *Chickpea: Integrated disease management* (http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/idm-strategies)

PA Bulletin, *Chickpea: Ascochyta blight management* (http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/ascochyta-blight)

PA Bulletin, *Chickpea: Botrytis grey mould management* (http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/botrytis-grey-mould)

PA Bulletin, *Chickpea: Phytophthora root rot management* (http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/phytophthora-root-rot)

PA Bulletin, *Chickpea: Identifying Sclerotinia* (http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/sclerotinia)

PA Bulletin, *Managing viruses in pulses* (http://www.pulseaus.com.au/growing-pulses/publications/manage-viruses)

PA Bulletin, *Chickpea: deep seeding strategies* (http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/deep-seeding)

PA Bulletin, *Chickpea harvest and seed storage* (http://www.pulseaus.com.au/storage/app/media/crops/2007_Chickpea-Harvest-Storage.pdf)

PA Bulletin, *Irrigated chickpea management* (http://www.pulseaus.com.au/storage/app/media/crops/2010_SPB-Chickpea-irrigation.pdf)

Department of Agriculture and Fisheries Qld (DAF)

Root lesion nematodes (https://www.daf.qld.gov.au/__data/assets/pdf_file/0010/58870/Root-Lesion-Nematode-Brochure.pdf)

Helicoverpa management in chickpea (https://www.daf.qld.gov.au/__data/assets/pdf_file/0005/76739/HelicoverpaManagement-InChickpea.pdf)

Table 63. 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 desi varieties CBA Captain, PBA Seamer or PBA HatTrick, which combine 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 chickpea.	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)	Initial infection appears as water-soaked tissue. Grey mycelial growth 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 have also reduced botrytis grey mould. Pre-emptive spraying might be possible; check current recommendations.
Sclerotinia wilt *Sclerotinia sclerotiorum*, S. trifoliorum, *S. minor* (fungi)	Beige–tan lesions on stems at ground level or higher. White–grey mould in wet or humid weather. Sclerotes (1–5 mm black bodies) usually form on, or inside stems, or on tap roots.	Basal stem rot usually occurs in late winter/ early spring. Canopy stem rot favoured by dense, luxuriant growth.	Sclerotes survive in soil for at least 8 years, germinate directly and infect roots and stem bases, or indirectly to release wind-blown spores. Very wide host range in broadleaf weeds and crops.	Rotate with cereals, maintain a 4-year break between broadleaf crops. Avoid sowing next to canola paddocks; control broadleaf weeds.
Virus diseases				
Turnip yellows virus (TYV ex 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 3 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 6 (previously Group C) herbicides (e.g. triazines) and sulfonylurea herbicides, and isoxaflutole (e.g. Balance®, Palmero®, Palmero® TX)	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 6 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).

Faba bean

Key considerations for 2023

- Test sowing seed for germination and vigour with time allowed to source replacement seed if required. Note there could be major problems in sourcing quality planting seed after the wet harvest conditions of 2022.
- Grade retained seed for sowing and check seed size to ensure the correct sowing rate.
- Inoculate seed thoroughly to achieve the highest possible nitrogen fixation and build soil nitrogen reserves for the following crop.
- Source key inputs, such as fungicides, early in the season to avoid any supply issues that might arise.

Crop management

Many dryland and irrigated grain growing areas are well suited for faba bean production. All current varieties are suitable for stockfeed or human consumption. However, in some warmer and drier environments, seed size and colour could limit the potential to achieve human consumption market specifications. The highest yield potential is achieved on deep, neutral–alkaline, well-structured soils. Avoid shallow, acidic (pH_{Ca} <5.2) or light to sandy textured soils with poor water holding capacity.

Good soil and paddock drainage are 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 sown on a minimum of 100 mm plant available water (PAW) at sowing.

Most pulses in southern NSW are grown in soils where pH stratification (acid soil layers) can affect root growth, nodulation, crop vigour and yield potential. Severely acidic layers (pH_{Ca} <4.5) are common at depths of 5–10 cm and 10–15 cm in the main cropping soils of central and southern NSW. Check for acidic layers by sampling soils at 5 cm intervals to 20 cm deep 2 years before sowing acid-sensitive pulses.

Where acidity is detected below the surface soil, the most rapid method to increase pH is to incorporate fine-grade lime to 10 cm deep, at least 12 months before sowing faba bean.

Well-nodulated 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 in late June if crops are sown early in northern NSW and can extend to mid October in southern NSW. High temperatures and hot, dry winds during flowering can affect pod formation and 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 is very likely. If retaining faba bean for seed, aim to separate crops of different varieties by 500 m or more 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 there are low naturalised honey bee or native bee populations.

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.

Crop stubbles and grain left on the ground 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 sowing equipment cannot successfully sow seed of this size and shape. It is important to test equipment with inoculated seed before sowing as the peat carrier increases seed bridging in seed boxes and air seeder bins. Ensure the air seeder sowing boots and hoses have the capacity 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 the seed evenly to the sowing boot. Ideally, sow faba bean into cereal stubble with low soil nitrogen for maximum nitrogen fixation, rotational benefits and to minimise aphid infestation. Sowing on wider 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 due to its hypogeal germination. 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 sowing 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. However, 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 64 below for the suggested sowing window 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 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.

Table 64. Suggested sowing times.

	April				May				June			
Region Week	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 than recommended, yield reduction likely.
Later than recommended, yield reduction likely.

Your calculation

100 seed weight # (grams)		target plant population		establishment percentage*		germination percentage		
.....	×	.....	× 1000 ÷	.....	×	.....	=	your sowing rate ..... kg/ha

\# To determine your seed weight, weigh 100 seeds in grams.
* Establishment percentage – 90% is a reasonable estimate, unless sowing into adverse conditions.

Table 65. Sowing rates for faba bean varieties.

Sowing rates	Average 100 seed weight (g)	Seed rate (kg/ha) 20 plants/m²	Seed rate (kg/ha) 30 plants/m²
Establishment %		**90**	**90**
Doza	50 (40–60)	111	166
FBA Ayla	65 (61–68)	144	216
PBA Warda	55 (52–57)	122	183
PBA Nanu	59 (57–61)	131	196
PBA Nasma	70 (61–79)	156	233
PBA Bendoc	64 (50–72)	142	212
Fiesta VF, Farah, Nura	68 (60–75)	151	226
PBA Marne, PBA Samira, PBA Amberley	74 (61–87)	164	246
PBA Rana, PBA Zahra	75 (65–85)	167	250

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

Table 66. Target plant density by region.

Plant population target	Plants/m²
North dryland	15–25
North irrigated	15–20
South dryland	20–35
South irrigated	20–30

Inoculation

Inoculation is essential on all soil types. Use the commercially available faba bean inoculant (Group F). Faba bean rhizobia are very sensitive to soil acidity. Some inoculants 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. To optimise all stages of the nodulation process, follow all the manufacturer's guidelines regarding storage and inoculant application.

Nutrition

Phosphorus (P) is the main nutrient that faba bean requires. Apply P 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 sowing, especially in soils that have grown rice within the previous 2 years. Yield responses to zinc (Zn) have been recorded on alkaline clay soils, but only where Zn had not been applied to other crops in the rotation. Select paddocks with a low level of residual nitrogen (N) to promote effective nodulation and N fixation. Consider applying molybdenum (Mo) to acid soils to aid nodulation. Fifty grams of actual Mo 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 large number of varieties are now available with different characteristics and most are suited to specific growing regions in NSW. Table 67 lists the variety characteristics.

Disease resistance classifications: R – resistant; MR – moderately resistant; MS – moderately susceptible; S – susceptible; VS – very susceptible.

Northern NSW

Doza[Φ]. 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[Φ] and Fiord; higher yielding than Cairo[Φ], with improved rust resistance. Smaller seed than Cairo[Φ], but more uniform; light buff colour. Licensed to Seednet; available through local seed suppliers. EPR is $3.63/tonne incl. GST.

FBA Ayla[Φ]. Released in spring 2021 for northern NSW and southern Queensland. Higher yield than all other faba bean varieties grown in this region. Rust and *Bean leafroll virus* resistance are similar to PBA Nanu[Φ], but it lacks resistance to chocolate spot and ascochyta blight. It has larger seed than PBA Warda[Φ], but smaller than PBA Nasma[Φ], placing it in the same category as PBA Nanu[Φ]. Flowering and maturity time are similar to PBA Nanu[Φ], but about a week earlier than Cairo[Φ]. FBA Ayla[Φ] is suggested as an alternative to PBA Warda[Φ] and PBA Nasma[Φ], both of which have seed size issues. Licensed to Seednet. EPR is $3.85/tonne incl. GST.

PBA Warda[Φ]. Released in 2012 for the northern region with higher yield and bigger seed than Doza[Φ]. Best adapted to eastern areas with higher rainfall. Similar to Doza[Φ] for earliness, chocolate spot and rust resistance, but has better tolerance than Doza[Φ] to *Bean leafroll virus* and vegetative frost damage. Its seed is more uniform and bigger than Doza[Φ] making it suitable for the human food market. Licensed to Seednet. EPR is $3.85/tonne incl. GST.

PBA NasmaΦ. Released in spring 2015 for northern NSW and southern Queensland with a higher yield than PBA WardaΦ. Larger and more uniform seed than PBA WardaΦ, making it readily acceptable into the human consumption market. Flowering, maturity time, resistance to chocolate spot and frost tolerance are similar to PBA WardaΦ. It also has improved resistance to *Bean leafroll virus* over PBA WardaΦ. Rust resistance is slightly inferior to DozaΦ. It is susceptible (S) to *Ascochyta*. Licensed to Seednet. EPR is $3.85/tonne incl. GST.

PBA NanuΦ. Released in spring 2018. Highest yielding variety in the state's north-east. It has good overall resistance to disease and is MR to rust and MR to *Bean leafroll virus*. It has similar agronomic traits to other northern varieties and is S to chocolate spot. PBA NanuΦ seed is smaller than PBA NasmaΦ but is larger than PBA WardaΦ so more suited to Middle Eastern markets. Licensed to Seednet. EPR is $3.85/tonne incl. GST.

Table 67. Faba bean variety characteristics and reactions to disease.

Variety	PBR	Maturity	Seed colour	Seed size (g/100 seeds)	Disease		
					Ascochyta blight	Chocolate spot	Rust
Doza	yes	early	light buff	40–60	VS	S	MR
Nura	yes	mid	light buff	50–65	MR ❶	MS	VS
FBA Ayla	yes	early	beige to brown	51–68	n.d.	S	MR
PBA Amberley	yes	mid	light buff	60–84	MR	MR–MS	VS
PBA Bendoc	yes	early–mid	light brown	50–71	MR	S	VS
PBA Marne	yes	early–mid	light buff	57–87	MS ❶	MS ❶	MR–MS
PBA Nanu	yes	early	beige to brown	57–61	n.d.	S	MR
PBA Nasma	yes	early	beige to brown	61–79	S	S	MR–MS
PBA Rana	yes	mid	light buff	62–94	MR–MS	MS	VS
PBA Samira	yes	mid	light buff	58–87	MR ❶	MS	S
PBA Warda	yes	early	beige to brown	58–70	S	S	MR–MS
PBA Zahra	yes	mid	light buff	58–91	MR–MS	MS	S

Source: NVT Disease Resistance Ratings based on 2022 data

n.d. no current data
❶ Provisional

VS Very susceptible
S Susceptible
MS Moderately susceptible

MR Moderately resistant
R Resistant

Table 68. Comparative performance of faba bean in northern NSW compared with PBA WardaΦ = 100%.

North west							
Variety	Yearly group mean					Regional mean	Number of trials
	2018	2019	2020	2021	2022		
% PBA Warda (t/ha)	**0.87**	**n.d.**	**2.57**	**3.57**	**3.28**	**2.97**	
Doza	74	n.d.	89	94	101	94	11
FBA Ayla	87	n.d.	102	99	106	101	11
PBA Nanu	69	n.d.	93	99	109	100	11
PBA Nasma	80	n.d.	98	89	99	94	11
PBA Warda	**100**	**n.d.**	**100**	**100**	**100**	**100**	**11**

North east							
Variety	Yearly group mean					Regional mean	Number of trials
	2018	2019	2020	2021	2022		
% PBA Warda (t/ha)	**n.d.**	**0.63**	**2.06**	**2.41**	**1.99**	**1.83**	
Doza	n.d.	97	90	93	92	92	5
FBA Ayla	n.d.	92	104	99	113	104	5
PBA Nanu	n.d.	88	101	94	112	101	5
PBA Nasma	n.d.	96	92	96	97	95	5
PBA Warda	**n.d.**	**100**	**100**	**100**	**100**	**100**	**5**

Table 69. Comparative performance of faba bean in southern NSW compared with PBA SamiraΦ = 100%.

South west ❶							
Variety	Yearly group mean					Regional mean	Number of trials
	2018	2019	2020	2021	2022		
% PBA Samira (t/ha)	**5.02**	**4.25**	**4.22**	**4.39**	**3.51**	**4.28**	
PBA Nura	91	92	90	96	65	88	5
PBA Amberley	99	100	100	102	97	100	4
PBA Bendoc	98	95	90	95	74	91	5
PBA Marne	99	107	99	112	91	102	5
PBA Rana	82	87	91	87	73	84	4
PBA Samira	**100**	**100**	**100**	**100**	**100**	**100**	**5**
PBA Zahra	101	101	95	94	102	98	4

❶ Please note that the south west trials were irrigated in the MIA 2017–2019.
❷ Trial moved to a dryland site south of Lockhart from 2020.

Southern NSW

NuraΦ. 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 blight. Later flowering than Fiesta VF, however, it has similar maturity. Suited to the medium–high rainfall areas of southern NSW; not recommended for northern NSW. Shorter height than Farah$^{\Phi}$ and Fiesta VF and less likely to lodge. Seed is slightly smaller than Farah$^{\Phi}$ and coloured light buff. Licensed to Seednet; available through local seed suppliers. EPR is $3.30/tonne incl. GST.

PBA RanaΦ. 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 MR–MS to *Ascochyta.* Large, plump, light-brown seed that is bigger than current varieties. Investigate marketing options as PBA Rana$^{\Phi}$ needs to be segregated to achieve a premium for its larger seed size. Licensed to Seednet. EPR is $3.85/tonne incl. GST.

PBA SamiraΦ. Released in spring 2014. Adapted to a wide range of environments in the southern region. It is mid flowering and matures at the same time as Farah$^{\Phi}$ and Fiesta VF. MR (provisional) to *Ascochyta* and MS to chocolate spot. Seed is slightly larger than Farah$^{\Phi}$ and Fiesta VF, but the same colour and should be suitable for co-mingling with other varieties for human consumption. Licensed to Seednet. EPR is $3.85/tonne incl. GST.

PBA ZahraΦ. 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. MR–MS to *Ascochyta* in most districts in the southern region. 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$^{\Phi}$ so these 2 varieties could be co-mingled for a large-seeded category in the Middle Eastern market. Licensed to Seednet. EPR is $3.85/tonne incl. GST.

PBA BendocΦ. Released in spring 2018. The first faba bean variety with tolerance to some imidazolinone herbicides. A minor use permit (PER14726, expiry 30/09/24) is currently available for applying imazamox post emergence. PBA Bendoc$^{\Phi}$ is adapted to southern NSW, Victoria and SA. It is MR to *Ascochyta*, and S to chocolate spot. It flowers at the same time as Nura$^{\Phi}$ and PBA Samira$^{\Phi}$. Seed is a similar size to Nura$^{\Phi}$ and suited to the Middle Eastern market. PBA Bendoc$^{\Phi}$ is not recommended for northern NSW as it is not adapted to the short growing season and is VS to rust. Licensed to Seednet. EPR is $4.29 /tonne incl. GST.

PBA MarneΦ. Released in spring 2018. It is adapted to the lower rainfall or shorter season environments of southern NSW, Victoria and SA. It is MS (provisional) to *Ascochyta*. It is more resistant to rust than other southern varieties, and is classified as MR–MS. However, it is provisionally MS to chocolate spot. PBA Marne$^{\Phi}$ has good stem strength and standing ability. Seed is similar in size to PBA Samira$^{\Phi}$ and should be suitable to co-mingle with other major varieties for the Middle Eastern market. Commercialised by Seednet. EPR is $3.85 /tonne incl. GST.

PBA AmberleyΦ. Released in 2019. It is adapted to the medium–high rainfall and longer season environments of southern NSW, Victoria and SA. It is the first faba bean variety rated MR–MS to chocolate spot and is MR to ascochyta blight. It has the best chocolate spot resistance of all faba bean varieties. It flowers and matures at about the same time as Nura$^{\Phi}$ and PBA Samira$^{\Phi}$. PBA Amberley$^{\Phi}$ has excellent stem strength and standing ability. Seed size is similar to PBA Samira$^{\Phi}$ and should be suitable to co-mingle with other major varieties for the Middle Eastern market. Licensed to Seednet. EPR is $3.85/tonne incl. GST.

Irrigation

Faba bean can be 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.

GO TO PAGE

PER14726 (https://permits.apvma.gov.au/PER14726.PDF)

North

Plant population can be lowered to 15 plants/m^2 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.

South

Plant population can be lowered to 20 plants/m^2 without yield penalties, provided plant establishment is even.

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.

Furrow irrigation is preferred over spray irrigation as overhead watering encourages more foliar disease. The bankless channel system of furrow irrigated beds inside flat bays is now the dominant layout in the Murrumbidgee Valley. Border check layouts increase the risk of waterlogging during and after irrigation. In these layouts, irrigation and drainage should be completed within 8 hours.

Weed control

To maximise rotational benefits, effective weed control is essential. Herbicides can damage faba bean, so use only registered products and follow 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. Residues could persist longer in soils that have received surface-applied lime to raise soil pH.
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® or Tordon® applied to previous summer fallows. Under dry conditions fallow herbicide breakdown 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.

Also, 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 further information on current weed control recommendations, plantback periods and correct spray unit decontamination procedures.

Insects

A range of pests can attack faba bean plants and pods, but they all have natural predators that can help keep them in check. Monitoring pest and beneficial populations will show if chemical control is needed as it is important in improving crop health and vigour. The **2 critical times** when pests need monitoring are at **establishment** and from **flowering to grainfill**.

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 or whitening on the leaves. Symptoms can be confused with frost damage.

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. Its activity is usually limited with high humidity and mild temperatures. Hot spots can occur along weedy fence lines and around trees and rocky outcrops in paddocks. A border spray around crop boundaries will often be enough to control lucerne flea.

Detecting and controlling mite and flea damage early improves crop health and vigour.

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. All 3 aphid species are vectors of a range of faba bean viruses.

Identifying the faba 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 eastern Asia (Korea, China, Taiwan, 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 and 2018 seasons at the Liverpool Plains Field Station showed 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 have so far indicated that the aphid has a limited host range. Faba bean and vetches are its preferred hosts, and it can also survive and reproduce on field pea and lentils. The aphid can probe lucerne but does not feed on chickpea, mungbean or lupin. Its risk to the faba bean industry is primarily through feeding damage, but virus transmission studies demonstrated its ability to be a vector of viruses such as *Bean yellow mosaic virus* (BYMV) and *Pea seed-borne mosaic virus* (PSbMV).

The aphid was found in commercial crops in northern NSW, in private gardens and the Sydney region in 2020 and, for the first time in southern Queensland in 2021. By 2022, faba bean aphid was detected at multiple sites including north-western and central-western NSW, the Riverina and Victoria, indicating the pest has spread quickly to become established across much of NSW. It is now also commonly found on vetches in pastures, providing a source for newly-sown faba bean crops.

Economic thresholds for faba bean aphid have not been established. Aphidex® 800 (pirimicarb 800 g/kg) is the only product currently registered to control the faba bean aphid, as well as the cowpea, pea and blue-green aphid.

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 flowering. 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 and yield. Mirids are quite mobile within the crop and currently there are no spray thresholds for control.

***Helicoverpa* spp.** – 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 square metre 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 check the resistance status for your region.

The recommended strategy for limiting resistance is:

- check crops regularly to detect eggs and small caterpillars
- correctly identify the species present
- spray caterpillars when they are less than 10 mm long
- rotate insecticides from different chemical groups according to the *Helicoverpa* strategy for each region.

See the NSW DPI guide *Insect and mite control in field crops* for more detailed information on pest control measures and thresholds and the GRDC website.

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NSW DPI guide *Insect and mite control in field crops* (www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

GRDC website (https://grdc.com.au/resources-and-publications/all-publications/publications/2018/resistance-management-strategy-for-helicoverpa-armigera-in-australian-grains)

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 4 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 stubble
- controlling volunteer faba bean
- using clean, ascochyta-free seed
- growing locally adapted varieties that are the most resistant to the major regional diseases.

Fungicide control

Mancozeb, carbendazim, chlorothalonil, tebuconazole + azoxystrobin, azoxystrobin + cyproconazole, prothioconazole + bixafen, fludioxonil + pydiflumetofen, copper, metiram, tebuconazole, tank mix of azoxystrobin with prothioconazonle, tank mix of azoxystrobin with Orius® 430SC, and procymidone are all registered. 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 emerged, untreated foliage will not be protected. The newly registered fungicides Veritas® Opti, Aviator® Xpro® and Miravis® Star have excellent protectant as well as limited curative activity. Carbendazim, procymidone and tebuconazole have very limited curative action and work best when applied before infection occurs. These fungicides are not translocated from sprayed leaves so foliage that develops after applying fungicide is not protected. Refer to the Pulse Australia fungicide guides.

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Pulse Australia fungicide guides (https://www.pulseaus.com.au/blog/post/2022-fungicide-guide)

Spray on time

Organise spraying ahead of schedule so that fungicides can be applied as soon as a decision is made. Frequently viewing the 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 2 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 in southern NSW

Research and commercial evaluation have shown that strategic spraying with mancozeb, carbendazim, chlorothalonil or procymidone is effective for disease management. Very wet conditions in southern NSW in spring 2022 resulted in high levels of chocolate spot development, even in crops that had received foliar fungicide applications. Crops with dense canopy development and poor conditions for fungicide application conspired to favour rapid and damaging levels of disease. This means inoculum levels will be high in 2023. Seed-borne infection levels could also be high due to late rains during podding.

The recommended fungicide program includes applying mancozeb or chlorothalonil 4–6 weeks after emergence to control seed-borne *Ascochyta* and early chocolate spot. Mancozeb, carbendazim, chlorothalonil, procymidone and newer chemistries can then be applied for continued chocolate spot control throughout the growing season. Under registration restrictions, carbendazim must not be applied for more than 2 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. following canopy closure, mild temperatures and frequent rain). Check crops every few days when conditions are favourable.

Most fungicides are effective for up to 14 days. Severe disease pressure will reduce the protection period, as will rapid growth, which will be totally unprotected. A final fungicide application should be considered for rust and late control of *Ascochyta*, which can cause blemishes on the seed. Use mancozeb or tebuconazole earlier if rust becomes a problem, as carbendazim has no control of *Ascochyta*.

Mancozeb or chlorothalonil are broad-spectrum fungicides and might need to be used throughout 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.

In trials, the newly registered fungicides have shown excellent chocolate spot and rust control. However, they are more expensive than the older products and also have strict limitations on applications number and timing. Growers are strongly advised to follow these restrictions as fungicide residues in the grain could have implications on the grain price.

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 to manage seed-borne disease.

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, which is particularly important for managing chocolate spot.

3rd critical period – at the end of flowering and early pod fill. Fungicide applications 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.

Rust and chocolate spot disease management in 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 mancozeb spray 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 chocolate spot and rust infection.

Monitor crops for signs of rust and chocolate spot. It is very important to protect the crop during flowering and early pod set.

Spraying just before canopy closure is more effective than after as the fungicide can still reach the lower parts of the plant. Mancozeb is still the preferred fungicide for disease control in northern NSW because of its proven effectiveness against both rust and chocolate spot and because there are no restrictions on the number of applications. Note that mancozeb has no translaminar activity, so good leaf coverage is essential.

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. At late crop stages consult your agronomist, as disease levels, seasonal conditions and outlook, crop development stage, yield potential and grain prices determine spraying economics. In high rainfall years, chocolate spot can cause severe crop losses. For chocolate spot control follow the recommendations listed above for disease management control in southern NSW.

During 2016, high incidences of stemphylium blight were noted in several paddocks. Initial research indicated that this disease might only be a problem in years with very high rainfall. However, there was no disease observed in 2021. There are large differences in susceptibility among faba bean varieties, with PBA Warda[ф] among the more susceptible. Currently no advice can be given on fungicide use to control stemphylium blight.

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.

During the 2020 season unusually severe virus symptoms were observed in many paddocks in northern NSW. Extensive testing of symptomatic samples showed that the symptoms were caused mainly by BYMV and in some cases by a co-infection of BYMV with *Alfalfa mosaic virus* (AMV). The level of infection was related to high aphid numbers early in the season (mainly cowpea aphids). Late summer rains, following a two-year drought, triggered the emergence of naturalised pasture legumes on which the aphid vectors could multiply before crops emerged.

Crop management techniques to reduce aphids entering faba bean crops include:

- retaining standing cereal stubble to deter aphids
- sowing at the recommended times for your district but, where possible, avoiding autumn flights of aphids
- sowing at recommended sowing rates for early canopy closure
- separate faba bean crops as much as possible from lucerne or clover and medic pastures, that can act as reservoirs for aphid species that vector 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 from persistently transmitted viruses such as *Bean leafroll virus* (BLRV). The imidacloprid seed dressing will not prevent the infection by non-persistently transmitted viruses such as BYMV and AMV. However, the treatment could slow aphid multiplication in the crop during early growth and limit secondary infections. Further research is needed to demonstrate economic benefits of insecticidal seed treatments in faba bean.

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. The DPI website has further information including *Managing viruses in pulse crops 2021* and *Aphid management in pulse crops 2022.*

Harvesting

Faba bean should be harvested to give 14% seed moisture at delivery (maximum receival standard). 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, direct sunlight can darken them or rainfall can stain them. 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 potentially 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.

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Managing viruses in pulse crops 2021 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/1299965/Managing-viruses-in-pulse-crops-in-2021.pdf)

Aphid management in pulse crops 2022 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/1422168/Aphid-management-in-pulse-crops-2022.pdf)

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 set concave clearance 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.

Run a harvest test on the crop and check what is being collected and what is lost at the back of the header – adjust settings as necessary to optimise both yield and quality.

Grain damaged during harvest or subsequent auger movement can be downgraded and have a lower germination percentage and lower seedling vigour. Lower grain moisture reduces grain soundness, which is more easily damaged. Rotary harvesters and belt conveyers are gentler on the grain and generally cause less grain damage than conventional augers.

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Windrowing faba bean (http://www.dpi.nsw.gov.au/___data/assets/pdf_file/0018/157203/pulse-point-09.pdf)

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 aquaculture, and some is split for human consumption. Faba bean is assessed visually (subjectively) by the market so size, colour and shape are important for buyers. It is difficult to achieve food quality standards where disease or insects have not been controlled, seed is damaged or defective, or after prolonged storage. Check with local buyers for market requirements.

Australian exporters are well regarded in export markets as reliable shippers. Exported grain has low moisture content, and crops are harvested in the northern hemisphere's offseason. Northern NSW and southern-Queensland-grown crops often have smaller seed than the main growing areas in southern Australia. This situation has improved with the release of larger seeded varieties PBA Nasma$^{\Phi}$ and PBA Ayla$^{\Phi}$. Small seed is a marketing disadvantage, however, good quality grain marketed before the southern harvest can achieve human consumption export grade and premium prices. After this window of opportunity, northern beans will normally be traded domestically at reduced prices. Faba bean seeds darken quickly, particularly in heat, so grain storage is generally not recommended if targeting export human consumption markets.

Domestic uses of faba bean as a source of protein include the aquaculture, pig, poultry, sheep meat and horse industries and hence it competes with field pea, fishmeal, lupin, soybean meal and other protein supplements. There are several newly opened processing plants in Victoria and South Australia that have started sourcing domestic faba beans for protein extraction for their operations.

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

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The current marketing specifications (www.pulseaus.com.au/marketing/receival-trading-standards)

Pulse Australia (www.pulseaus.com.au/) website.

Further information

NSW DPI

Insect and mite control in field crops (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

Agfact P4.2.7, *Faba bean* (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/157729/faba-bean-pt1.pdf)

Agnote DAI 128, *Honey bees in faba bean pollination* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/117110/bee-faba-bean-pollination.pdf)

Pulse Point 7, *Reducing your disease risk* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/157144/pulse-point-07.pdf)

Pulse Point 9, *Windrowing faba bean* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0018/157203/pulse-point-09.pdf)

Pulse Point 12, *Seeding equipment problems with faba beans* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/157306/pulse-point-12.pdf)

Pulse Point 20, *Germination testing and seed rate calculation* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/157442/pulse-point-20.pdf)

Primefact 1163, *Nitrogen benefits of chickpea and faba bean* (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/general-information/nitrogen-chickpea-faba-bean)

Managing viruses in pulse crops 2021 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/1299965/Managing-viruses-in-pulse-crops-in-2021.pdf)

Aphid management in pulse crops 2022 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/1422168/Aphid-management-in-pulse-crops-2022.pdf)

GRDC

NSW DPI and GRDC Bulletin: *Legumes in acidic soils – maximising production potential in south eastern Australia*, (https://grdc.com.au/resources-and-publications/all-publications/publications/2018/legumes-in-acidic-soils)

Pulse Australia

Faba bean production: Southern and western region 2016 (http://pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/southern-guide)

Australian Pulse Trading Standards (http://www.pulseaus.com.au/marketing/receival-trading-standards)

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Table 70. Disease and crop injury guide – faba bean (page 1 of 2).

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–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. 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 high risk. 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 eturmiunum*	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.	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.
Virus diseases				
Virus yellowing diseases: *Bean leafroll virus* *Soybean dwarf virus*, synonym, *Subterranean clover redleaf virus*), *Subterranean clover stunt virus*	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 4 days or longer).	Follow best management recommendations including: • retaining standing cereal stubble (deters aphids) • using recommended sowing rates • sowing on time • 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 virus spread. Seek advice from your agronomist.
Virus mosaic diseases: *Bean yellow mosaic virus*, *Alfalfa mosaic virus*	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 BYMV and AMV infections can be lethal to faba bean.	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 4 hours in aphids and usually less.	Follow best management recommendations including: • retaining standing cereal stubble (deters aphids) • using recommended sowing rates • sowing on time • 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*	Large dark lesions are formed on the leaves and later dark brown streaks develop on the upper stem, often on one side. The shoot's growing point is often killed. Seed production from affected plants is severely reduced.	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 70. Disease and crop injury guide – faba bean (page 2 of 2).

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Herbicide injury				
Group 1 (previously 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 2 (previously 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 6 (previously 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 4 (previously 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.

Field pea

Key considerations for 2023

- Select an appropriate variety to suit regional sowing time and maturity windows.
- Sow as early as possible within the recommended window to maximise yield potential.
- Sow high quality seed that has been tested for both germination and vigour before sowing.
- Check seed size to ensure the correct sowing rate to achieve optimum plant density.
- Post-sowing rolling to flatten clods and stones will help to produce good quality seed at harvest.
- Timely weed and insect control are critical management factors to produce high yields.
- Ensure timely harvest as soon as seed moisture content is 14%, using header settings optimised for each individual crop.

Crop management

Field pea is a valuable pulse crop rotation option in cereal farming systems. The crop fixes nitrogen (N) from the atmosphere and conserves soil mineral N. It uses less subsoil water than other crops 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. Alternatively, field pea can be grown for hay or silage, or used as a brown manure crop, providing a double-break crop. 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 produced for both stockfeed and human consumption.

Sowing time

Field pea is one of the few crops that can yield well from a later sowing window relative to other pulse crops, giving it the edge in dry autumns, plus an extended pre-sowing weed control period. Sowing as early as possible within the recommended window for each region will maximise yield potential. 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.

The suggested sowing times in Table 71 below apply to average to wet years. Grower experience and research over the past 2 decades clearly show positive yield responses from sowing up to 2 weeks earlier in dry seasons when disease in spring has not been a problem.

There is now a wide 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.

Table 71. Field pea sowing times.

	May				June			
Region	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.

Figure 10. Map of NSW showing field pea growing zones.

Sowing rate

Optimum plant populations vary depending on the height and vigour of the specific variety, and on sowing time. Population targets for tall, vigorous, scrambling types such as Morgan$^{\Phi}$, 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 crops, establish at least 40–50 plants/m^2 to maximise biomass. For the shorter, less vigorous group of varieties (see Table 74. Field pea variety characteristics and reaction to diseases. on page 142) such as PBA Pearl$^{\Phi}$, PBA Oura$^{\Phi}$, and GIA Ourstar$^{\Phi}$, 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 GIA Kastar$^{\Phi}$, Kaspa$^{\Phi}$, PBA Butler$^{\Phi}$, PBA Taylor$^{\Phi}$ 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 Your calculation on page 138 to calculate the desired sowing rate based on target density, seed size, germination and the estimated establishment percentage of the 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 to 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 seed's impact on the seed distributor heads and other hard surfaces. Adjust ground speed to avoid 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 72. Sowing rate (kg/ha) based on 100% germination and 80% establishment.

Field pea type	Variety	100 seed weight (g)	Target plant density/m²			
			30	40	50	60
Tall scrambling	Morgan	18	68	90	–	–
	Sturt	19	71	95	–	–
	PBA Percy	23	86	115	–	–
Medium–tall semi-leafless	GIA Ourstar, PBA Noosa	19	71	95	119	–
	PBA Oura, PBA Pearl	20	75	100	125	150
Kaspa types	GIA Kastar, PBA Butler, PBA Wharton	18	68	90	112	–
	PBA Gunyah, PBA Taylor, PBA Twilight	19	71	95	119	–
	Kaspa	20	75	100	125	–

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

Sowing depth

Field pea seed should be sown 3–5 cm deep. Seed can emerge from deeper sowing (up to 7 cm) provided moisture is adequate for consistent germination. Do not sow dry or deep sow if there is uneven moisture, as crops will germinate unevenly causing management difficulties, such as herbicide timing. 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/F field pea inoculant. Check for effective nodulation 6–10 weeks after sowing to ensure inoculation has been successful.

Take care with seed inoculation. If seed is to be treated with a fungicide before sowing, apply fungicide first as a separate operation then apply inoculant just before sowing. An alternative method that gives better rhizobia survival, is to use inoculum slurry sprayed directly into the furrow at sowing, thus avoiding contact with the fungicide.

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. In turn, this causes blocked hoses and patchy establishment across the paddock, which can then also lead to weed issues. The seed will need to dry in the short period before being sown.

Several 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 the paddock cropping history and potential crop yield for your area. A long history of P use can build up soil P levels; at high levels little or no additional P will be required.

Select paddocks with a low level of residual nitrogen (N) to promote effective nodulation and N fixation. Consider applying molybdenum (Mo) to acid soils to aid nodulation. Fifty grams of actual Mo per hectare applied every 5 years is recommended.

Paddock rolling

Rolling paddocks after sowing levels the ground and presses loose stones and sticks into the soil, avoiding header damage and reducing grain contamination from soil 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:

- the seed type's (dun, white, blue) end-use
- varietal maturity and sowing date
- disease resistance, standing ability
- seed shattering resistance, ease of harvest
- yield potential in your region
- market outlets and seed availability.

Many varieties are available, with a wide range of characteristics, however, some are only suited to specific growing regions in NSW and growers should select varieties carefully based on local advice. For characteristics of the different varieties, including latest NVT disease resistance ratings, refer to Table 74. Field pea variety characteristics and reaction to diseases on page 142.

Field pea yield performance 2018–2022.

Table 73. Comparative performance of field pea in southern NSW compared with PBA Wharton(ф) = 100%

South east							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% PBA Wharton (t/ha)	**0.97**	**0.79**	**2.33**	**2.03**	**1.21**	**1.47**	
Kaspa-type dun field peas							
GIA Kastar	98	95	81	76	68	81	6
Kaspa	74	50	103	108	111	96	10
PBA Butler	81	61	110	122	136	108	10
PBA Taylor	96	86	113	114	118	109	10
PBA Wharton	**100**	**100**	**100**	**100**	**100**	**100**	**10**
Dimpled type dun field peas							
GIA Ourstar	95	99	71	84	89	84	6
Morgan	86	88	88	94	94	90	2
PBA Oura	93	91	91	104	115	99	10
PBA Percy	90	81	83	111	134	100	10
White field peas							
PBA Pearl	85	78	100	127	151	112	10
Sturt	92	88	88	105	119	98	10
Blue field peas							
PBA Noosa	85	86	103	107	109	101	10

South west							
	Yearly group mean						
Variety	2018	2019	2020	2021	2022	Regional mean	Number of trials
% PBA Wharton (t/ha)	**n.d.**	**0.49**	**1.99**	**2.43**	**1.49**	**1.53**	
Kaspa-type dun field peas							
GIA Kastar	n.d.	92	90	90	63	85	7
Kaspa	n.d.	71	103	104	108	101	10
PBA Butler	n.d.	84	110	109	134	112	10
PBA Taylor	n.d.	99	106	107	111	107	10
PBA Wharton	**100**	**100**	**100**	**100**	**100**	**100**	**10**
Dimpled type dun field peas							
GIA Ourstar	n.d.	87	93	90	108	94	7
Morgan	n.d.	79	96	96	118	99	3
PBA Oura	n.d.	92	102	100	125	105	10
PBA Percy	n.d.	90	105	101	144	110	10
White field peas							
PBA Pearl	n.d.	87	112	108	172	120	10
Sturt	n.d.	90	102	100	131	106	10
Blue field peas							
PBA Noosa	n.d.	82	102	102	131	106	10

n.d. No current data.

Kaspa-type dun field pea

GIA Kastar[Φ]. Released in 2019 by Grains Innovation Australia (GIA). First Kaspa-type variety with improved tolerance to common in-crop and residual Group 2 (previously Group B) imidazolinone herbicides. Similar plant type to PBA Wharton[Φ] with semi-leafless erect growth habit and distinctive pink–white flowers. Mid flowering (similar to PBA Wharton[Φ]) and early to mid maturing, suitable for crop-topping. Pod shatter resistance at maturity. Disease resistance similar to PBA Wharton[Φ]. Produces a medium size, non-dimpled, red–brown coloured seed; marketed as a Kaspa-type grain for human consumption in the Indian/Asian subcontinent. Commercialised by AG Schilling and Co. EPR is $3.30/tonne incl. GST.

Kaspa[Φ]. Benchmark variety when released in 2002, but now outclassed for yield and disease ratings. High yield potential in average to good seasons but has performed poorly across southern Australia in harsh finishes, due to late flowering and maturity. Dun seed type with round (no dimples) light brown–red seeds. Licensed to Seednet. EPR is $2.20/tonne incl. GST.

PBA Butler[Φ]. Released in 2017 by Pulse Breeding Australia (PBA). Broadly adapted Kaspa-type that performs best in medium to long season climates. Mid–late flowering with early–mid maturity, erect, semi-dwarf, semi-leafless type. Sugarpod trait, resistant to pod shattering at maturity. Produces a medium size, non-dimpled, tan coloured seed; marketed as a Kaspa-type grain to suit Asian subcontinent human consumption requirements (dahl, flour and roasted snack foods). Licensed to Seednet. EPR is $2.97/tonne incl. GST.

PBA Gunyah[Φ]. Released in 2010 by PBA. Kaspa-type variety adapted to low and medium rainfall zones of southern and central western NSW. Similar plant type to Kaspa[Φ] with distinctive pink–white flowers, semi-dwarf and semi-leafless plant habit, medium height and early vigour. Early to mid season flowering (earlier than Kaspa[Φ]), but flowers for longer than PBA Twilight[Φ] and Kaspa[Φ], particularly in shorter growing seasons. Matures earlier than Kaspa[Φ]. Sugarpod trait, resistant to pod shattering at maturity. Produces a non-dimpled dun seed; marketed as a Kaspa-type grain to suit Asian subcontinent human consumption requirements. Licensed to Seednet. EPR is $2.75/tonne incl. GST.

PBA Taylor[Φ]. New variety released in 2021 by PBA (tested as OZP1408). A broadly adapted Kaspa-type variety, mid flowering and early to mid maturing, slightly later than PBA Wharton[Φ] but earlier than Kaspa[Φ]. Similar plant type as Kaspa[Φ] with semi-leafless and semi-dwarf plant architecture, non-shattering pods and Kaspa-type seed. PBA Taylor[Φ] produces medium sized spherical grain. Seed coat has a uniform tan colour similar to Kaspa[Φ] and is suitable for dahl and split pea production. Licensed to Seednet. EPR is $2.97/tonne incl. GST.

PBA Twilight[Φ]. Released in 2010 by PBA. Adapted to the lower rainfall, short season zones of southern and central western NSW. Similar plant type to Kaspa[Φ] with distinctive pink–white flowers, semi-dwarf and semi-leafless plant habit, medium height and early vigour. Early flowering (one week earlier than Kaspa[Φ]), with a shorter flowering duration than PBA Gunyah[Φ], but longer than Kaspa[Φ]. Matures earlier than Kaspa[Φ]. Sugarpod trait, resistant to pod shattering at maturity. Produces a non-dimpled dun seed; marketed as a Kaspa-type grain to suit Indian subcontinent human consumption requirements. Licensed to Seednet. EPR is $2.75/tonne incl. GST.

PBA Wharton[Φ]. Released in 2013 by PBA. Kaspa-type variety well suited to all field pea production regions of NSW, including central and northern NSW, due to powdery mildew and virus resistance. Recommended as a replacement for Kaspa[Φ], PBA Gunyah[Φ] and PBA Twilight[Φ] across all production regions of NSW. Similar plant type to Kaspa[Φ] with semi-leafless erect growth habit and distinctive pink–white flowers. Early–mid flowering (similar to PBA Gunyah[Φ]) and early maturing. Sugarpod trait, resistant to pod shattering at maturity. Produces medium size, non-dimpled, tan coloured seed; marketed as a Kaspa-type grain to suit Asian subcontinent human consumption requirements (dahl, flour and roasted snack foods). Licensed to Seednet. EPR is $2.86/tonne incl. GST.

Dimpled type dun field pea

GIA OurstarΦ. Released in 2019 by GIA. First dun-type variety with improved tolerance to common in-crop and residual Group 2 (previously Group B) imidazolinone and sulfonylurea herbicides. Similar plant type to PBA OuraΦ with semi-leafless semi-erect growth habit and purple flowers. Early to mid flowering with a long flowering window; early to mid maturing, suitable for crop-topping. Pod shatter resistance at maturity. Produces a medium size, dimpled, green–tan coloured seed; marketed as Australian dun-type grain for human consumption or stockfeed. Commercialised by AG Schilling and Co. EPR is $3.30/tonne incl. GST.

MorganΦ. 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 PercyΦ. NVT field pea national disease ratings not available as Morgan is no longer included. 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 OuraΦ. Released in 2011 by PBA. Broadly adapted across all major field pea production regions; performs well in short growing seasons and low-rainfall zones. Erect semi-dwarf, semi-leafless type with vigorous early growth, medium height and purple flowers. Early–mid flowering (earlier than KaspaΦ) and early maturing. Suitable for crop-topping in longer seasons. Fair to good lodging resistance; moderate pod shatter resistance at maturity. Produces a light green, medium size, dimpled dun-type seed of similar size to KaspaΦ. Marketed as Australian dun-type grain, which is exported to the Asian subcontinent to produce dahl (splits) and pea flour; also sold for stockfeed. Licensed to Seednet. EPR is $2.86/tonne incl. GST.

PBA PercyΦ. Released in 2011 by PBA. Broadly adapted across all major field pea production regions; performs well in short growing seasons and low-rainfall zones. Conventional tall type with vigorous early growth and purple flowers. Very early flowering (one week earlier than PBA OuraΦ) and early maturing. Suitable for crop-topping in longer seasons. Lodges at maturity; moderate pod shatter resistance at maturity. Produces a tan–green, very large, dimpled dun-type seed. Marketed as Australian dun-type grain, which is exported to the Asian subcontinent for dahl production (splits) and pea flour; also sold for stockfeed. Licensed to Seednet. EPR is $2.86/tonne incl. GST.

White field pea

PBA PearlΦ. Released in 2012 by PBA. Broadly adapted across all major field pea production regions. Semi-leafless, semi-dwarf erect growing variety with white flowers. Early–mid flowering (10 days earlier than KaspaΦ, 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. 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 incl. GST.

SturtΦ. Released in 2005. 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. No EPR.

Blue field pea

PBA NoosaΦ. New variety released in 2021 by PBA (tested as OZB1308). PBA NoosaΦ has high yield potential and competes well with other varieties in field pea production zones throughout Australia. Its high early vigour makes it well suited to some of the drier field pea environments. Has performed well in southern NSW National Variety Trials over several years; replacement for Excell variety in this region. Early to mid flowering (similar to PBA GunyahΦ and PBA WhartonΦ) with early to mid maturity, making it slightly later to finish in longer seasons than these varieties. Sugar pod trait reduces harvest losses due to shattering and semi-dwarf semi-leafless trait improves standability and harvesting. PBA NoosaΦ will require a strong focus on managing pea weevil and timely harvest to achieve a premium grain product suited to human consumption markets. Licensed to PB Seeds. EPR is $7.15/tonne incl. GST.

Table 74. Field pea variety characteristics and reaction to diseases.

Variety	Standing at maturity	Leaf type	Height	Maturity	Shatter resistance	Disease					Viruses ❻	
						Bacterial blight ❷	Downy mildew ❸		Powdery mildew ❹	Blackspot ❺	*Pea seed-borne mosaic virus*	*Bean leafroll virus*
						Pseudomonas syringae	Kaspa strain	Parafield strain				
Kaspa-type dun field peas												
GIA Kastar	4	SL	M	4	R	S	S	S	R-MR	MS ❶	R	n.d.
Kaspa	4	SL	M	8	R	S	S	S	S	MS	S	S
PBA Butler	4	SL	M	5	R	MS	S	S	S	MS	S	S
PBA Gunyah	4	SL	M	5	R	S	S	S	S	MS	S	S
PBA Taylor	4	SL	M	5	R	S	S	S	S	MS	R	R
PBA Twilight	4	SL	M	4	R	S	S	S	S	MS	S	S
PBA Wharton	4	SL	M	5	R	S	S	S	R-MR	MS	R	R
Dimpled type dun field peas												
GIA Ourstar	4	SL	M	4	MR	S	S	S	S	MS ❶	S	n.d.
Morgan	3	SL	T	9	MR	n.d.	n.d.	n.d.	n.d.	n.d.	S	S
PBA Oura	4	SL	M	5	MR	MS	S	S	S	MS	S	MR
PBA Percy	2	C	T	5	MR	MR–MS	S	S	S	MS	S	S
White field peas												
PBA Pearl	5	SL	M	4	MR	MS	S	S	MS	MS	S	R
Sturt	2	C	T	5	MR	MS	S	S	MS	MS	S	S
Blue field peas												
PBA Noosa	4	SL	M	5	R	S	MS	MS	S	MS	S	R

Source: NVT field pea national disease ratings

n.d. no current data.

❶ Provisional rating.

❷ Bacterial blight ratings are from 2021 data.

❸ Downy mildew ratings (Kaspa strain and Parafield strain) are from 2022 data.

❹ Powdery mildew ratings are from 2021 data.

❺ Blackspot ratings are from 2020 data.

❻ Virus ratings are from 2020 data.

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

<5 best for crop-topping.

Shatter resistance and disease resistance ratings

R Resistant

MR Moderately resistant

MS Moderately susceptible

S Susceptible

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$^{\Phi}$ and the availability of earlier maturing varieties such as PBA Oura$^{\Phi}$ and PBA Twilight$^{\Phi}$ that enable crop-topping to be synchronised with maturity. Additional weed control options are now available with the release of 2 new varieties. GIA Kastar$^{\Phi}$ has improved tolerance to in-crop and residual Group 2 (previously Group B) imidazolinone herbicides. GIA Ourstar$^{\Phi}$ has improved tolerance to in-crop and residual Group 2 imidazolinone and sulfonylurea herbicides.

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. Residues could persist longer in soils that have received surface-applied lime to raise soil pH.

Insect control

Field pea is host to several common pests so careful monitoring is required to ensure they do not cause economic damage. These pests all have a number of natural predators that can help keep them in check. Regular monitoring with good record keeping will keep track of the population dynamics so that controls can be applied when needed.

Redlegged earth mite, blue oat mite and lucerne flea – monitor closely from emergence up to the 4-node stage. If crop damage becomes apparent, undertake appropriate control measures.

Aphids – monitor 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.

For more information see *Aphid management in pulse crops (2022)* on the NSW DPI website.

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Aphid management in pulse crops 2022 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/1422168/Aphid-management-in-pulse-crops-2022.pdf)

Pea weevil – 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 crops are grown in a known 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 to prevent late insect pressure
- 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* on the NSW DPI website.

***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 registered pesticides, refer to the NSW DPI guide *Insect and mite control in field crops 2022* and pesticide labels.

Disease management

Disease effects on field pea production can be minimised by:
- sowing disease-free and virus-free seed
- using a fungicide seed dressing in disease risk situations
- planning sensible crop rotations (not growing field pea in the same paddock more than once every 5 years)
- eliminating volunteer field pea plants
- not sowing near, or immediately downwind of the previous season's field pea paddock
- if sowing field pea into cereal stubble, leave the stubble standing
- avoiding frost prone paddocks.

The following diseases have the potential to cause severe yield losses when conditions are favourable.

Bacterial blight – This disease is very sporadic and often unpredictable. It is caused by the bacterium *Pseudomonas syringae*. There are 2 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. Note that fungicide products are not effective to control bacterial diseases.

Pseudomonas 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 moving 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.

Operations favouring rapid pea trash breakdown can greatly reduce the bacterium's survival rate. Controlling volunteer pea plants is equally important to manage this disease between seasons. Survival can be up to 3 years on seed in storage.

Bacterial blight will often begin to develop in frost-prone, low-lying areas of crops. Be aware that frosts can trigger disease development so check these areas first for symptoms. Avoid sowing field pea crops in paddocks prone to frequent frosts.

Traditionally, major outbreaks of bacterial blight in NSW result from early frosting coinciding with wet conditions. Outbreaks of bacterial blight were not widespread in NSW in 2022 due to the few damaging frosts in winter.

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Pulse Point 4: *Managing pea weevil* (http://www.dpi.nsw.gov.au/___data/assets/pdf_file/0020/157034/pulse-point-04.pdf).

Insect and mite control in field crops (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

Management factors that favour a bacterial blight outbreak include sowing field pea crops earlier than recommended, 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 very prone to frost injury and are highly predisposed to developing bacterial blight. If field pea crops are to be sown into cereal stubble, leave the stubble standing.

The varieties PBA Oura$^{\Phi}$ and PBA Percy$^{\Phi}$ were released in 2011 with significantly improved resistance to *P. syringae* pv *syringae*. PBA Butler$^{\Phi}$ (released 2017) is now also recommended for bacterial-blight-prone regions. In the older varieties, Morgan$^{\Phi}$ and Sturt$^{\Phi}$ display the best field tolerance.

Kaspa$^{\Phi}$ is one of the most susceptible varieties to bacterial blight. The safest strategy is to grow the more resistant varieties and only use seed from crops inspected as visibly free of symptoms. Sow field pea into paddocks that are not prone to frost injury. Under conditions favouring disease development, even very low levels of seed-borne bacterial blight can lead to an epidemic.

Blackspot and septoria blotch – These 2 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. Wet conditions in 2022 resulted in high levels of blackspot developing widespread across NSW. This means there will be high levels of inoculum in paddocks in 2023. In 2022 under ideal conditions, these diseases developed quickly, even from very low levels of disease, and caused significant yield loss, even in low-disease-risk districts. The highest levels of disease traditionally develop in crops sown early and/or adjacent to last year's field pea stubble, or with a recent history (past 3 years) of field pea in the same paddock.

Effects from these fungal diseases can vary with proximity to old field pea stubble and paddock rotation history. Using a fungicidal seed dressing, crop rotation and separation from last year's field pea stubble by at least 500 m will reduce disease potential. In recent years, blackspot has been observed at high levels in some districts, mainly in field pea crops sown early for manuring. Dry summer conditions in combination with early sowing opportunities and wet winter/spring conditions favour a disease epidemic.

Foliar fungicides are available to manage blackspot, but economic returns are limited to crops in medium to high rainfall zones with a high yield potential. There are currently no fungicides registered to control septoria blotch disease.

Downy mildew – Cool and wet conditions favour fast disease 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. This disease was reported as widespread in 2022 during early crop establishment. The fungus *Peronospora viciae* causes the disease, which can survive in soil, on old field pea trash and 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.

Options for managing downy mildew include using a fungicide seed dressing containing metalaxyl, crop rotation (at least 4 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 rapid development of the disease within days. 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 have varying degrees of susceptibility. Foliar fungicides can be used to manage the disease in more susceptible varieties, but must be applied early before the disease becomes damaging.

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 preventative as infected plants cannot be cured. Plants might often have a virus, but do not show symptoms until plants come under stress (most commonly from moisture or nutrients).

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 the National Field Pea breeding program is making rapid progress in developing varieties with adequate resistance to the most important field pea viruses.

For more information see *Managing viruses in pulse crops 2021* and *Aphid management in pulse crops 2022* on the NSW DPI website.

Pea seed-borne mosaic virus (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, PBA Wharton$^{\Phi}$ and the 2 new varieties GIA Kastar$^{\Phi}$ and PBA Taylor$^{\Phi}$ are resistant to PSbMV.

Bean leafroll virus (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. The 2 new varieties PBA Noosa$^{\Phi}$ and PBA Taylor$^{\Phi}$, as well as the older varieties PBA Oura$^{\Phi}$, PBA Pearl$^{\Phi}$ and PBA Wharton$^{\Phi}$ have good resistance, while a number of other breeding lines with good BLRV resistance are in advanced testing.

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Managing viruses in pulse crops in 2021 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/1299965/Managing-viruses-in-pulse-crops-in-2021.pdf)

Aphid management in pulse crops 2022 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/1422168/Aphid-management-in-pulse-crops-2022.pdf)

Desiccation and harvest

Desiccation

Desiccation advances pea maturity and harvest by up to 10 days, reducing problems caused by uneven ripening and/or late weed growth. However, desiccation must be strategically timed when field pea pod and seed development have finished so that grain yield and quality are not compromised. Desiccating seeds that have not yet reached physiological maturity can result in reduced seed size or defective 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 (470/570/600 g/L) ± saflufenacil (700 g/kg), or diquat (200 g/L). Ensure that harvest withholding periods (WHP) are observed according to the label of the desiccation product used (i.e. 7 days for glyphosate/saflufenacil products; nil for diquat products). Crops desiccated with glyphosate should not be kept for sowing seed as desiccation can reduce seed viability.

Desiccation timing

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 development and colour changes within the pod. From the end of flowering, days to desiccation 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 and rubbery, and split rather than squash when squeezed
- the shells are thin and leathery.

Field 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*.

HARVESTING AT DAWN

Harvesting early (from dawn) can help to reduce shattering as humidity is often higher and temperatures cooler.

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Pulse Point 5, *Desiccation and harvest of field pea* (http://www.dpi.nsw.gov.au/___data/assets/pdf_file/0004/157099/pulse-point-05.pdf)

Harvest

Field pea should be harvested to give 14% seed moisture at delivery to grain traders in order to maximise yield and minimise grain damage during harvest and subsequent handling. This normally occurs well ahead of the wheat harvest and seed moisture can fall rapidly if not harvested preferentially to other cereal and oilseed crops.

Delayed harvest leads to:

- seed quality loss and shattering, thus reducing both yield and price
- harvest clashes with other crops
- more severe crop lodging with greater soil contamination
- increased pod splitting and seed loss
- pea weevil emergence in the field
- problems with late weed growth
- increased vulnerability to late-season rain and hail damage.

The important message is to plan to start harvest as soon as the seed moisture content is less than 14%. Harvesting early (from dawn) can help to reduce shattering as humidity is often higher and temperatures cooler.

Grain damage during harvest can be minimised by reducing harvest speed and lowering the drum speed. Some growers have found that fitting cross-augers to their header has improved harvest speed and crop catchment. Running a test strip in each crop and examining what is captured by the header and what is discarded can guide setting adjustments so that optimum quality grain is collected with minimum contamination from defective screenings and foreign material. Optimising harvest settings will reduce the need for subsequent seed cleaning before delivery.

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 future 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 either drought conditions or wet weather at harvest resulting in 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 robust of the pea types, with both food- and feed-market opportunities, and remains the preferred type to be exported to Asia and the subcontinent. The smooth, non-dimpled Kaspa-type varieties such as PBA Butler$^{\phi}$ 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 soil in samples. These issues will trigger price penalties (refer to the Australian Pulse Trading Standards for the allowable tolerances).

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Australian Pulse Trading Standards (http://www.pulseaus.com.au/marketing/receival-trading-standards)

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 field pea crop supplies a small but increasing 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 manage carefully in order to avoid price penalties.

The Pulse Australia website has the current marketing specifications for the different grades of field peas. Field peas are currently assessed by buyers using visual (subjective) standards, so colour, size and shape are still important quality parameters.

Further information

NSW DPI

Insect and mite control in field crops (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

Pulse Point 4, *Managing pea weevil* (3rd edition) (http://archive.dpi.nsw.gov.au/__data/assets/pdf_file/0020/157034/pulse-point-04.pdf)

Pulse Point 5, *Desiccation & harvest of field pea* (2nd edition) (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/157099/pulse-point-05.pdf)

Pulse Point 7, *Reducing disease risk* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/157144/pulse-point-07.pdf)

Pulse Point 13, *Strategies to minimise bacterial blight in field pea* (http://archive.dpi.nsw.gov.au/__data/assets/pdf_file/0006/157335/pulse-point-13.pdf)

Pulse Point 14, *Powdery mildew in field peas: A growers guide to management* (http://archive.dpi.nsw.gov.au/__data/assets/pdf_file/0011/157349/pulse-point-14.pdf)

Pulse Point 20, *Germination testing and seed rate calculation* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/157442/pulse-point-20.pdf)

Managing viruses in pulse crops in 2021 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/1299965/Managing-viruses-in-pulse-crops-in-2021.pdf)

Aphid management in pulse crops 2022 (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/1422168/Aphid-management-in-pulse-crops-2022.pdf)

GRDC website

GrowNotes™ *Field pea southern region* (https://grdc.com.au/resources-and-publications/grownotes/crop-agronomy/field-pea-southern-region-grownotes)

GrowNotes™ *Field pea northern region* (https://grdc.com.au/resources-and-publications/grownotes/crop-agronomy/fieldpeasgrownotesnorth)

NSW DPI and GRDC Bulletin: *Legumes in acidic soils – maximising production potential* (https://grdc.com.au/resources-and-publications/all-publications/publications/2018/legumes-in-acidic-soils)

Pulse Australia

Pulse Australia website (http://www.pulseaus.com.au/)

Australian Pulse Trading Standards (http://www.pulseaus.com.au/marketing/receival-trading-standards)

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Table 75. Field pea variety disease guide.

Disease/cause	Symptoms	Occurrence	Survival/spread	Control
Seedling disease				
Damping off *Pythium* spp., *Rhizoctonia* spp.	Seedlings collapse within a few days of emergence. Stem/taproot near ground level sunken, water soaked.	Cool, wet, poorly drained soils. Late sowing leading to slow germination.	Spores survive in soil for extended periods. Wide host range among other broadleaf crops.	Sow on time into well-drained soils. Treat seed with fungicide seed dressing. Cultivate below seed sowing depth.
Root diseases				
Foot rot *Phoma medicaginis* var. *pinodella* *Mycosphaerella pinodes*	Purplish–black rot of lower stem. Black rot of upper tap root.	Cool, damp weather. Paddocks with a recent field pea history or adjacent paddocks.	Survives on infected pea trash and as spores in soil for several years. Also seed-borne at low levels.	Crop rotation –4 years between pea crops and avoid sowing into paddocks 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 –4 years between field pea crops. Aim to sow on time. Avoid poorly-drained paddocks.
Foliar diseases				
Black spot complex *Mycosphaerella pinodes*, *Ascochyta pisi*, *Phoma medicaginis* var. *pinodella*	Dark brown to black spots on leaves, with reddish/purplish margin, often with an irregular outline. Girdling of lower stem and tendrils with a dark lesion. Bluish–black sunken spots on pods.	Cool, wet conditions. More severe on early-sown crops.	Spores survive in soil and plant debris. Spread by rain splash and wind-blown rain.	Avoid early sowing. Crop rotation –4 years between field pea crops and avoid sowing into paddocks adjacent to last year's field pea crop.
Septoria blotch *Septoria pisi*	Spreading, light brown, angular leaf lesions containing very small, dark brown to black spots. Tends to appear on moisture-stressed crops in spring.	Cool, wet 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 4 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.	Humid conditions following rain in spring. Worse in early sown and 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. Fungicides will not control bacterial blight disease.
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 result in stunting, stem necrosis and premature death.	Uncommon in the major pea growing areas.	Range of weed and pasture species. AMV also in lucerne. Spread by aphids.	Follow best management recommendations including retaining standing stubble to deter aphids from landing in the crop.

Lentil

Australia's lentil industry has benefited from the release of improved varieties offering wider adaption and improved agronomic features including herbicide tolerance, plant physiology, plant architecture and yield. These varieties, along with improved crop management techniques, provide growers with the confidence to incorporate lentil into farming systems. Lentil is a high value pulse food crop with the major market being the Indian subcontinent countries, as well as the Middle East. The grain can also be livestock feed when the grain does not meet market specifications, is damaged, or when prices are low. In many cases lentil is a paddock to plate product where the harvested grain is cooked and served as whole grain, so visual appearance is important.

Lentil is a relatively recent crop introduction to Australia, only being grown since the late 1980s. Production is mainly based on the alkaline soils of South Australia and Victoria with smaller but increasing areas in Western Australia's southern coastal region and in southern NSW. In NSW, lentil varieties have been grown intermittently on small areas across parts of the main cropping belt over the past 20–25 years, but NSW is well behind Victoria and South Australia in agronomy research. Research into sowing dates, plant population targets and row spacing for specific varieties started around 10 years ago. More recent research has investigated what drives crop development, critical growth period and optimum flowering windows for different varieties across the contrasting environments of southern and central west NSW. Outcomes of this work are incorporated into this chapter.

Soil types

Lentil prefers neutral to alkaline soils (pH_{Ca} 6.0–8.0) of high fertility and good water holding capacity. In Victoria, lentil is grown on the medium to heavy clays of the northern Wimmera through to the loamy sands of the Mallee. In NSW, the crop is currently grown on soil types that range from light loams through to sandy loams, but the crop could be grown on other soil types such as the common clay loam. Soil types for lentil require good drainage that are not prone to waterlogging. Hard-setting, dispersive soils should be avoided, as should soils that are sodic in the root zone.

Most pulses in southern NSW are grown in soils where pH stratification (acid soil layers) can affect root growth, nodulation, crop vigour and yield potential. Severely acidic layers (pH_{Ca} <4.5) are common at depths of 5–10 cm and 10–15 cm in the main cropping soils of central and southern NSW. Check for acidic layers by sampling soils at 5 cm intervals to 20 cm deep 2 years before sowing acid-sensitive pulses.

Where acidity is detected below the surface soil, the most rapid method to increase pH is to incorporate fine-grade lime to 10 cm deep, at least 12 months before sowing lentil, with a goal to maintain pH_{Ca} >5.5 in the top 0–10 cm.

Paddock selection

Paddocks that have an even soil type are easier to manage and are preferred for lentil. Changes in soil type across a paddock can lead to uneven crop maturation, harvest delays and increased grain losses from shattering. Suitable paddocks must:

- have a relatively even soil surface, as unevenness could reduce harvest efficiency
- be free of stones, large clods and sticks
- have a low broadleaf weed burden.

It is very important to select paddocks with a low weed burden with no damaging herbicide residues. Consider selecting a suitable herbicide-tolerant variety where Group 2 (formerly Group B) chemical residues are suspected of carrying over from previous crops.

Sowing

Sowing depth

Lentil has hypogeal emergence, the same as chickpea, field pea and faba bean, so can be sown deeper than lupin for example. Sowing 4–6 cm deep will place the seed into better soil moisture and will be at less risk from herbicide washing into the sowing furrow.

Stubble

Sowing lentil directly into previous cereal stubble is the preferred method of establishment. The benefits of retained stubble enable more timely sowing in the early part of the sowing window. Standing stubble provides crop canopy support and enhances harvest efficiency. Sowing configuration can be GPS guided inter-row sowing or adjusted closer to the previous year's cereal stubble row. Stubble management starts at harvest the previous year.

Sowing rate

Target plant densities for lentil in NSW are 110–130 plants/m^2. Due to variation in variety seed size and seasonal production variations, seed rates could range from 45–55 kg/ha for small-seeded varieties, to 55–70 kg/ha for medium-seeded varieties.

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

Most current stubble retention, no-till farming systems in southern and central NSW are set up on row spacings of 22, 30 or 33 cm that enable inter-row sowing and stubble trash flow when sowing. A row spacing of about 30 cm with retained standing stubble will provide some trellising support for the plant.

Rolling

Rolling the seedbed after sowing is a key management step to maximise harvest efficiency. The lentil plant grows to between 20 cm and 60 cm high depending on sowing time and seasonal conditions, especially rainfall. Rolling with a round steel roller pushes stones and clods into the soil, which helps the harvester front to capture the lowest setting pods without major soil contamination problems.

Sowing time

Mid May is the preferred sowing time in southern and central NSW. In western areas, sowing can start 7–10 days earlier. Later sowing exposes the crop to more heat and moisture during the critical flowering and pod filling phases. Sowing the crop too early can lead to bulky growth, which increases the risk of disease, especially botrytis grey mould. It also increases the risk of frost damage.

Inoculation

Lentil inoculant is the same Group F that is required for field pea and faba bean.

Nutrition

In most situations, a phosphorus-based fertiliser is all that is required. The application rate will depend on soil test results and potential crop removal, but in general will be similar to that applied to field pea. It is important to apply some phosphorus, even at low rates, close to the seed at sowing.

Variety selection

Varieties have been listed according to type and in alphabetical order. The agronomic characteristics in these descriptions are provided as a guide only and have been compiled from breeder observations, NVT, agronomic research projects and/or seed companies.

When selecting a variety, growers are encouraged to consider their individual farm and paddock situation along with access to markets and their requirements. NSW NVT data is limited, so growers are advised to take note of variety performance in the northern Wimmera and the southern Mallee regions of Victoria. Other sources of agronomy information should be sought through grower group publications, GRDC Update papers, *NSW Southern Research Results book* as well as Online Farm Trials.

Table 76. Agronomic characteristics of lentil varieties.

The agronomic characteristics in this table are provided as a guide only and have been compiled from breeder observations, agronomic research projects and seed companies.

Variety	Grain type	Seed coat	Seed size	Flowering time	Maturity	Lodging	Shattering	Salinity
Small red lentil								
GIA Lightning	red	grey	small	mid–late	mid	MR	R–MR ❶	–
GIA Sire	red	grey	small	mid–late	mid	MR	R–MR ❶	–
GIA Thunder	red	grey	small	mid	mid	MR–MS	R–MR ❶	–
PBA Highland XT	red	grey	small	early	early–mid	MR	MR	MI
PBA Hurricane XT	red	grey	small	mid	mid	MR	R	I
Medium red lentil								
GIA Leader	red	grey	medium	mid–late	mid–late	MR	R–MR ❶	–
GIA Metro	red	grey	medium–large	late	mid–late	MR	R–MR ❶	–
PBA Ace	red	grey	medium	mid	mid	MR–MS	MR–MS	I
PBA Blitz	red	grey	medium	early	early	MR	MR	I
PBA Bolt	red	grey	medium	early–mid	early–mid	R	R	MI
PBA Hallmark XT	red	grey	small–medium	mid	mid	MR	R	MI
Large red lentil								
PBA Jumbo2	red	grey	large	mid	mid	MR–MS	R	I
PBA Kelpie XT	red	grey	large	early–mid	early–mid	MR–MS	R	MI
Medium green lentil								
PBA Greenfield	yellow	green	medium	mid	mid–late	MS	MR	MI
Large green lentil								
PBA Giant	yellow	green	large	mid	mid–late	MS	MR–MS	I

Adapted from the *2022 Victorian crop sowing guide*.

❶ Provisional rating.
R resistant
R–MR resistant to moderately resistant
MR moderately resistant
MR–MS moderately resistant to moderately susceptible
MS moderately susceptible
S susceptible
VS very susceptible.
I intolerant
MT moderately tolerant
MI moderately intolerant.
– denotes no rating available.

Lentil yield performance experiments from 2018–2022

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 2018–2022. Further results are on the NVT website.

Table 77. Comparative performance of lentil in southern NSW. Compared with PBA Ace = 100%.

Performance data for varieties is limited due to changes in NVT that precluded breeder trials from 2020 to be included in the NVT analysis. Yield data from 2021 should be treated with extreme caution due to varying seasonal conditions.

South east					
	Yearly group mean				
Variety	2020	2021	2022	Regional mean	Number of trials
PBA Ace t/ha	**2.21**	**1.09**	**3.08**	**2.13**	
Small red lentils					
GIA Lightning	105	81	128	112	3
GIA Sire	–	48	105	91	2
GIA Thunder	129	87	136	126	3
PBA Highland XT	116	80	118	111	3
PBA Hurricane XT	109	77	119	108	3
Medium red lentils					
GIA Leader	105	80	117	106	3
GIA Metro	–	61	70	81	2
PBA Ace	**100**	**100**	**100**	**100**	**3**
PBA Bolt	106	85	100	99	3
PBA Hallmark XT	104	73	120	106	3
Large red lentils					
PBA Jumbo2	134	113	102	115	3
PBA Kelpie XT	138	73	115	116	3

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Online farm trials (https://grdc.com.au/research/trials,-programs-and-initiatives/online-farm-trials)

GRDC Update papers (https://grdc.com.au/resources-and-publications/grdc-update-papers?grdc=true)

NSW Southern Research Results book (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/southern-nsw-research-results)

Table 78. Comparative performance of lentil in Victoria's Mallee and Wimmera regions. Compared with PBA Ace = 100%.

	Mallee							Wimmera						
	Yearly group mean					Regional mean	Number of trials	Yearly group mean					Regional mean	Number of trials
Variety	2018	2019	2020	2021	2022			2018	2019	2020	2021	2022		
PBA Ace t/ha	–	**2.11**	**1.76**	**2.79**	**2.83**	**1.88**		**2.75**	**2.02**	**2.57**	–	**2.04**	**2.33**	
Small red lentils														
GIA Lightning	–	–	105	106	106	104	7	–	–	97	–	89	99	3
GIA Sire	–	–	–	96	70	78	4	–	–	–	–	40	80	1
GIA Thunder	–	–	105	103	139	117	7	–	–	104	–	141	109	3
PBA Highland XT	–	99	94	102	105	100	12	98	100	98	–	94	98	6
PBA Hurricane XT	–	97	93	99	–	102	9	101	97	93	–	106	98	6
Medium red lentils														
GIA Leader	–	97	95	97	–	104	6	–	97	93	–	113	99	5
GIA Metro	–	–	–	–	82	75	3	–	–	–	–	85	83	1
PBA Ace	–	**100**	**100**	**100**	**100**	**100**	**12**	**100**	**100**	**100**	–	**100**	**100**	**6**
PBA Bolt	–	96	90	100	86	91	12	95	98	97	–	76	94	6
PBA Hallmark XT	–	96	92	98	113	101	12	102	96	90	–	105	96	6
Large red lentils														
PBA Jumbo2	–	102	99	98	128	111	12	97	103	112	–	148	112	6
PBA Kelpie XT	–	95	81	98	113	98	12	93	97	99	–	110	99	6

Red lentil

Small red

GIA Lightning[Φ]. Imidazoline herbicide-tolerant, small red lentil. Similar Group 2 (IMI and SU) herbicide tolerance to existing XT varieties. GIA Lightning[Φ] has an upright plant type that improves harvestability. GIA Lightning[Φ] is mid to late flowering, with mid maturity and moderate tolerance to pod drop and lodging. Good resistance to shattering at maturity. Released in 2022. Bred by Grains Innovation Australia (GIA) with seed available from PB Seeds. EPR $5.94/tonne incl. GST.

GIA Sire[Φ]. It is the first IMI-tolerant lentil with improved tolerance to clopyralid herbicide soil residues from a previous crop, when applied according to product label directions. A very small rounded red lentil with a grey seed coat, suitable for the Indian subcontinent's small-sized lentil markets. GIA Sire[Φ] is best suited to early sowing and favourable lentil growing areas to maximise growth, height and yield. Avoid low fertility sandy soils and low-rainfall, frost-prone environments. Released in 2022. Bred by GIA with seed under a small-scale release by PB Seeds, not widely available for the 2023 season.

GIA Thunder[Φ]. Imidazoline herbicide-tolerant, small red lentil derived from a cross between popular varieties PBA Bolt[Φ] and PBA Hurricane XT[Φ]. Similar Group 2 (IMI and SU) herbicide tolerance to existing XT varieties. GIA Thunder[Φ] is a mid flowering and mid maturity variety. Exhibits moderate to good vegetative frost tolerance compared with many of the current varieties. Bred by GIA with seed available from PB Seeds. EPR $5.94/tonne incl. GST.

PBA Highland XT[Φ]. Herbicide tolerant, small red lentil variety that will complement other tolerant varieties such as PBA Hallmark XT[Φ] and PBA Hurricane XT[Φ]. Tolerant to Intercept® herbicide, improved tolerance to the herbicide flumetsulam plus reduced sensitivity to some sulfonylurea and imidazolinone herbicide residues from earlier crop applications. Early–mid maturing, a point of difference to other Group 2 herbicide-tolerant lines. Performs well in drier regions. High early vigour and early flowering traits. It has improved resistance to ascochyta blight (MR) and maintains this level of resistance against an increasingly prevalent pathogen isolate that is virulent on other Group 2-tolerant varieties. A good alternative herbicide-tolerant variety with high yielding capability, particularly in drier regions and seasons. Released 2019. Seed available from PB Seeds. EPR $5.94/tonne incl. GST.

PBA Hurricane XT[Φ]. A small-seeded red lentil, mid flowering and mid maturing. Tolerant to Intercept® herbicide, improved tolerance to the herbicide flumetsulam plus reduced sensitivity to some sulfonylurea and imidazolinone herbicide residues from earlier crop applications. Plant height and early vigour are improved over Nipper[Φ], improving weed control and harvestability. Released 2013. Seed available from PB Seeds. EPR $5.50/tonne incl. GST.

Medium red

GIA Leader[Φ]. An imidazolinone (IMI) tolerant red lentil variety with high disease resistance (to both botrytis grey mould and ascochyta blight). It has medium-sized seed with a grey coat. A mid–late maturing spreading plant type that can help pod protection at maturity. Suited to early sowing. Released 2021. Seed available from PB Seeds. EPR $5.94/tonne incl. GST.

GIA Metro[Φ]. A medium–large-sized red lentil by 100 grain weight with a large seed diameter and a grey seed coat. GIA Metro[Φ] is the first lentil to combine imidazoline and metribuzin herbicide tolerances. This combination of herbicide tolerance expands production and weed control options in lentils, particularly on light textured soils prone to damage from applications of metribuzin herbicide. Metribuzin is now registered under Permit 92810 for application to GIA Metro[Φ] at the 3–6 node plant growth stage. Grain yields are lower than existing lentil varieties in the absence of weed pressure or where weeds are effectively controlled without crop damage from metribuzin a Group 5 herbicide. Released in 2022. Bred by GIA using a metribuzin trait from a project funded by GRDC and SARDI with seed available from PB Seeds. EPR $8.25/tonne incl. GST.

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PER92810 (https://permits.apvma.gov.au/PER92810.PDF)

PBA Ace[Φ]. Vigorous, medium-sized, mid season red lentil with a grey seed. A replacement for PBA Jumbo[Φ]. Intolerant to salinity. High milling quality. Released 2012. Seed available from PB Seeds. EPR $5.50/tonne incl. GST.

PBA Blitz[Φ]. Medium-sized red lentil with a grey seed coat. Early flowering and suited to short growing seasons. Improved early vigour and an erect growth habit, suited to no-till and inter-row sowing. Intolerant of salinity. Released 2010. Seed available from PB Seeds. EPR $5.50/tonne incl. GST.

PBA Bolt[Φ]. A medium-sized red lentil with grey seed coat. Early–mid maturity and improved boron and salinity tolerance. Its susceptibility to botrytis grey mould (BGM) makes it less suited to medium to high rainfall areas. A good variety for crop topping to control weeds. Erect habit and good lodging resistance make it easier to harvest in dry seasons. Released 2012. Seed available from PB Seeds. EPR $5.50/tonne incl. GST.

PBA Hallmark XT[Φ]. A mid season maturing variety, medium-sized seed and grey seed coat. Greater early vigour and improved resistance to BGM compared with PBA Hurricane XT[Φ]. Tolerant to Intercept® herbicide, improved tolerance to the herbicide flumetsulam plus reduced sensitivity to some sulfonylurea and imidazolinone herbicide residues from earlier crop applications, and improved tolerance to Brodal®. The variety provides an alternative market class option to the popular small red lentil PBA Hurricane XT[Φ]. Released 2018. Seed available from PB Seeds. EPR $5.94/tonne incl. GST.

Large red

PBA Jumbo2[Φ]. Highest yielding large-seeded red lentil; approximately 9–13% higher than PBA Jumbo[Φ]. A direct replacement for Jumbo[Φ] and Aldinga. Similar seed size to Jumbo[Φ] and Aldinga, with a grey seed coat. Mid flowering with maturity similar to PBA Jumbo[Φ]. Well suited to no-till inter-row sowing into standing stubble. Tolerance to soil boron is similar to PBA Bolt[Φ]. Suited to medium to higher rainfall regions where it produces uniform larger seed size, well suited to premium, large red, split markets. Released 2014. Seed available from PB Seeds. EPR $5.50/tonne incl. GST.

PBA Kelpie XT[Φ]. Large-seeded herbicide-tolerant lentil variety. PBA Kelpie XT[Φ] is 93% of PBA Jumbo2[Φ] for seed size, with a grey seed coat and red cotyledon. Moderate to good early vigour, early–mid flowering and maturing, it is widely adapted to the lentil-growing regions of Australia. Released 2020. Seed available from Seednet. EPR $5.94/tonne incl. GST.

Green lentil

PBA Giant[Φ]. The largest seeded green lentil in Australia. PBA Giant[Φ] is broadly adapted but best suited to the medium-rainfall growing regions. Similar yield to Boomer with improved shattering resistance, though timely harvest is still required to minimise shattering. Less susceptible to lodging at maturity than Boomer. Released 2014. Seed available from PB Seeds. EPR $5.50/tonne incl. GST.

PBA Greenfield[Φ]. A medium-sized green lentil broadly adapted but best suited to the medium-rainfall growing regions. It is the highest yielding green lentil variety with yields similar to PBA Ace[Φ]. Improved salinity tolerance and resistance to shattering, although timely harvest is still required. Released 2014. Seed available from PB Seeds. EPR $5.50/tonne incl. GST.

Weed control

Lentil is viewed as a relatively poor competitor against weeds with few herbicide control options, especially for broadleaf weeds. Expanded weed control options over the past few years, as well as breeding imidazolinone-tolerant varieties, has enabled more reliable and effective weed control.

In most situations it is essential to apply a pre-sowing or pre-emergent herbicide with residual activity. This strategy gives good early weed control when the lentil plant is slowly establishing and reduces the reliance on the post-sowing broadleaf herbicide for complete weed control.

Herbicide control options for lentils are limited, so check current pesticide registrations for problem weeds in your paddock.

Injury from herbicide residues

Lentil is extremely sensitive to some residual herbicides. Residues might come from the previous crop, the crop 2 years earlier, or from fallow weed control.

Most lentil varieties are very sensitive to soil carryover of Group 2 and Group 4 herbicides. Group 2 herbicides include sulfonylurea and imidazolinone. Chlorsulfuron (Glean®), triasulfuron + butafenacil (Logran® B-Power), metsulfuron methyl (Associate®) and metosulam (Eclipse®) are all SU herbicides, while imazamox + imazapyr (Intercept®) and imazethapyr (e.g. Spinnaker®) are examples of imidazolinone herbicides. Clopyralid (Lontrel®), a Group 4 herbicide applied to preceding wheat crops, can be carried over in stubble and cause damage to seedling lentil.

Herbicide tolerance has been incorporated into newer varieties for Group 2, with new releases in 2022 having tolerance to Group 4 (clopyralid) and Group 5 (metribuzin) improving soil/stubble herbicide residue management and in-crop weed control.

Insects

Like other winter pulses and canola, redlegged earthmite, blue oat mite, cutworm, aphids, lucerne flea and slugs are potential establishment pests that might warrant control in any one season. Lentils are a favoured host for multiple aphid species. Aphids can cause damage by direct feeding, but the main risk for the crop is through aphids spreading viruses , particularly early in the season.

However, it is *Etiella* (also known as lucerne seed web moth), and *Helicoverpa* spp. that are the main pests of lentil later in the growing season. These two pests will attack when seeds are beginning to form inside the pods. Following egg laying and hatching, the first instar of *Etiella* larvae bore into pods and begin feeding on developing seeds, whereas *Helicoverpa*, as young larvae, often feed on leaves before any damage to pods.

Etiella requires close monitoring for the very small larvae. A hand lens is useful to detect the larvae as once inside the pods they cannot be controlled.

See *Insect and mite control in field crops* for control options for pests of lentil.

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Insect and mite control in field crops (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

Diseases

Lentil needs a good disease management strategy to ensure a quality, blemish-free seed product for human consumption markets. Botrytis grey mould (BGM) and ascochyta blight (AB) are the two important foliar diseases of lentil.

Botrytis grey mould – Botrytis grey mould is more likely to develop in bulky crops that have been sown too early and/or have been sown on narrower row spacings. Crops that have a thick canopy by late winter are more prone to developing the disease. Prolonged wet conditions following canopy closure will also favour disease development. Lodging within crops can also significantly increase disease risk. Symptoms appear initially as small dark-green, tan or white spots on lower leaves. Light brown or blanched stem lesions later develop and become covered in grey mould, girdling the stems and leading to dead patches within the crop. Small black sclerotes can form on the stem lesions. Infected flowers lead to flower drop and lesions can also develop on pods, leading to seed abortion or shrivelled and discoloured seed.

Ascochyta blight – The initial symptoms of AB are lesions on the leaves and stems of young plants shortly after emergence. A distinguishing feature is the fungal fruiting structures (small black dots) visible within the centre of pale lesions, although these might not be visible in the first few days of lesion development.

Infected seedlings can deteriorate quickly and plant parts above the lesion can break off, making symptoms difficult to detect. Closely monitor crops following rain or heavy dews. New varieties have good resistance to AB when released, but resistance status can change over time, hence the need for ongoing monitoring.

There are three **critical periods** for fungicide application:

1. **just before canopy closure** so that the fungicide penetrates lower into the canopy
2. **at mid-flowering/early pod fill** if the weather is conducive to disease infection and development
3. **at the end of flowering/mid pod fill** where protection of the pods from AB might be needed to ensure good seed quality.

There is a range of fungicides available to control both BGM and AB. Selecting the most appropriate fungicide will depend on the level of disease pressure, fungicide efficacy and cost effectiveness. Older registered fungicides for both BGM and AB that have protectant properties include mancozeb and chlorothalonil, while the newly registered fungicides Aviator® Xpro, Miravis® Star and Veritas® Opti have protectant as well as limited curative activity. Be aware of the restrictions on the number of applications of a fungicide per season. Carbendazim and procymidone are the two most cost-effective protectant fungicides against BGM, applied just before canopy closure.

Fungicide seed dressings

Both AB and BGM are highly seed borne, so using a fungicide seed treatment is recommended. P-Pickel-T (thiram + thiabendazole) is registered for use on lentil and will significantly reduce disease transmission.

Virus

A wide range of viruses similar to those that infect other pulse species can infect lentil. There are 4 main viruses that are known to have the potential to cause serious damage: *Alfalfa mosaic virus* (AMV), *Cucumber mosaic virus* (CMV), *Bean leafroll virus* (BLRV) and *Turnip yellows virus* (TuYV). CMV largely depends on seed transmission for survival. Sowing seed, therefore, should be tested for this virus if there are any doubts. All lentil viruses are spread by aphids, from other grain or forage legumes or from weeds. The effect on the crop from the virus infection depends on the lentil variety and virus species, with early infection being particularly dangerous.

Aphid population development and movement are very unpredictable, hence it is very difficult to predict virus epidemic years.

Table 79. Lentil disease ratings.

Variety	Ascochyta blight Pathotype 1 – Nipper	Ascochyta blight Pathotype 2 – Hurricane	Botrytis grey mould (BGM)	Root lesion nematode (*Pratylenchus*) ❷	
				P. neglectus	*P. thornei*
Small red lentil					
GIA Lightning	R	MR–MS	MS	R	MR
GIA Sire	R	MR–MS ❶	MS	MR	MR
GIA Thunder	R	MR–MS	MR–MS	MR	R
PBA Highland XT	MR	MR	MS	MR	MR–MS
PBA Hurricane XT	R–MR	MR–MS	MS	MR–MS	MR–MS
Medium red lentil					
GIA Leader	MR	MR	MR–MS ❶	R	MR
GIA Metro	MR	R–MR	MR–MS	MR	MR–MS
PBA Ace	R	MR	MS	MR	MR–MS
PBA Blitz	MR–MS	MR	MS ❶	MR	MR–MS
PBA Bolt	MR	MR–MS	S	MR	MR
PBA Hallmark XT	R–MR	MR–MS	MR–MS ❶	MR	MR–MS
Large red lentil					
PBA Kelpie XT	MR–MS	MR–MS	MS ❶	MR–MS	MR–MS
PBA Jumbo2	R	R–MR ❶	MR ❶	MR	MR–MS
Medium green lentil					
PBA Greenfield	–	–	MR	MR	MR
Large green lentil					
PBA Giant	–	–	MS	MR	MR–MS

Source: NVT lentil national disease ratings.

❶ Provisional ratings – treat with caution.
❷ Root lesion nematode ratings are 2021 ratings.
R Resistant
R–MR Resistant to moderately resistant
MR Moderately resistant
MR–MS Moderately resistant to moderately susceptible
MS Moderately susceptible
S Susceptible
VS Very susceptible.

Desiccation

Desiccating the crop is an essential prerequisite for a successful harvest. Rarely do crops mature evenly, and with a high value commodity in the paddock, desiccation brings harvest forward, improving harvest efficiency and grain quality. Desiccation timing is critical to ensure grain yield and quality are not compromised. Desiccating too early can lead to significant yield penalties and grain size problems. As a guide, desiccate when 60% of pods in the top third of the canopy are coloured yellow–buff. Seek advice from an experienced agronomist on registered products.

See *Harvest aid or salvage spraying winter crops* for currently registered herbicides for crop desiccation.

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Harvest aid or salvage spraying winter crops (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/weed-control-winter-crops)

Harvesting

The harvesting process should focus on maximising grain quality as lentil is graded on visual standards. Lentil should be harvested as soon as the crop is mature. Start harvesting as soon as the seed moisture drops to 14% and the lowest pods on the plant start to turn light brown and gently shaking the pod produces a rattle. An early harvested crop will have better grain quality and fewer harvest losses from pod splitting and pod drop. Delaying harvest due to unfavourable weather such as rain and strong winds will increase losses.

Harvest success comes from having the correct harvesting equipment. A flex-front with air reels can result in limited shatter on the knife front, providing the speed is maintained. Modifications to the header front have been made by some growers to improve harvest efficiency.

Marketing

The bulk of the Australian lentil crop is exported (>95%). Most is sold to the subcontinent countries of India, Bangladesh and Sri Lanka, and the Middle East for human consumption as whole seed or splits. A small proportion is sold whole or split in Australia and consumed locally, or sold to Indian diaspora communities in the UK, Asia and Fiji. Canada is the largest lentil exporter, but this is mainly large green lentil; Australia has a niche market for the small/medium red lentil.

All pulses are graded on visual standards. Grain size, shape and colour are key factors, with no disease or insect blemishes. The grain appearance is very important for buyers and Australia has a good reputation for high quality grain.

Prices in the Indian subcontinent are often lower in their postharvest period from April to June; Turkish or East African imports fill the period from August to December. Indian tariffs since 2017 have meant that the main market has been Bangladesh where even colour, size and shape (rounds or footballs) are important considerations for buyers, so careful harvesting and storage is imperative for achieving high returns. The COVID 19 pandemic has caused logistical problems worldwide and the Australian pulse trade has been affected by container and booking shortages for bulk shipping. Before the pandemic, the lentil trade was based on container transport, but bulk shipments are becoming more common.

Demand for lentil is strong for 2023 with reduced tariffs from India and prices have been steady, but trade conditions will remain challenging for the foreseeable future, meaning potential price volatility and higher risk for traders. Lentils store well encouraging growers to wait for marketing opportunities.

Further information

NSW DPI

Harvest aid or salvage spraying winter crops (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/weed-control-winter-crops)

Insect and mite control in field crops (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

Pulse Point 20, *Germination testing and seed rate calculation* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/157442/pulse-point-20.pdf)

VIC DPI

Growing lentil in Victoria (https://agriculture.vic.gov.au/crops-and-horticulture/grains-pulses-and-cereals/growing-grains-pulses-and-cereals/growing-lentil-in-victoria)

GRDC

GrowNotes™ – *Lentil southern region* (https://grdc.com.au/resources-and-publications/grownotes/crop-agronomy/lentil-southern-region-grownotes)

Victorian crop sowing guide (https://grdc.com.au/resources-and-publications/all-publications/nvt-crop-sowing-guides/vic-crop-sowing-guide)

NSW DPI and GRDC Bulletin: *Legumes in acidic soils – maximising production potential in south eastern Australia* (https://grdc.com.au/resources-and-publications/all-publications/publications/2018/legumes-in-acidic-soils)

Pulse Australia

Lentil – Best management guide (https://www.pulseaus.com.au/growing-pulses/bmp/lentil)

Australian Pulse Trading Standards (http://www.pulseaus.com.au/marketing/receival-trading-standards)

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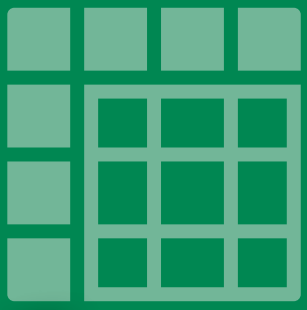

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Lupin

Crop management

Lupin is a profitable pulse crop well suited to the lighter soil types in central and southern NSW. It has many advantages in both cropping and mixed cropping-livestock farming systems. Lupin can be used to extend cereal crop rotations by acting as a break crop (non-host) for cereal diseases, weeds and insect pests. Crop rotation 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 (25–36%) that can be valuable as part of a profitable livestock enterprise and is gaining acceptance for human consumption.

Two species of lupin, narrow-leaf (*Lupinus angustifolius*) and albus (*L. albus*), are widely grown. Although narrow-leaf lupin tolerates moderately acid soils (pH_{Ca} 4.5–5.5) and high levels of exchangeable aluminium and manganese, its vigour and yield potential can be affected when soil pH_{Ca} drops below 5.0. Most pulses in southern NSW are grown in soils where pH stratification (acid soil layers) can affect root growth, nodulation, crop vigour and yield potential. Severely acidic layers (pH_{Ca} <4.5) are common at depths of 5–10 cm and 10–15 cm in the main cropping soils of central and southern NSW. Check for acidic layers by sampling soils at 5 cm intervals to 20 cm deep 2 years before sowing acid-sensitive pulses.

Where acidity is detected below the surface soil, the most rapid method to increase pH is to incorporate fine-grade lime to 10 cm deep, at least 12 months before sowing lupin.

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 (pH_{Ca} 7.0–8.0) 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 yields average 5–15% higher than narrow-leaf lupin under high rainfall conditions. The lupin anthracnose biosecurity zone in place for southern NSW 2016–2018 was lifted in 2019, meaning there are no restrictions on where albus lupin can be grown.

Sowing

Direct drilling lupin into cereal stubble is a successful crop establishment method. Stubble conserves soil moisture, reduces brown leaf spot incidence, and discourages aphid infestations which, in turn, minimises virus infection and transfer.

Dry sowing lupin is an option in higher rainfall areas, with grower experience showing it to be successful in timely crop establishment (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, but new granular inoculants can be used.

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 sufficient water, resulting in non-viable 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 lupin.

Low vigour seed and sowing late into soils with low temperatures results in poor establishment and often crop failure, especially in albus lupin.

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Pulse Point 6, *Dry sowing* (https://www.dpi.nsw.gov.au/___data/assets/pdf_file/0004/157117/pulse-point-06.pdf)

Sowing time

All current lupin varieties are susceptible to frost damage. Lupin is 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[4] increases the risk of frost damage.

Table 80. Suggested sowing times for **narrow-leaf lupin**.

	April				May			
Week	1	2	3	4	1	2	3	4
Low rainfall			■	■	■	■		
Medium rainfall				■	■	■	■	
High rainfall					■	■	■	■

Table 81. Suggested sowing times for **albus lupin**.

	April				May			
Week	1	2	3	4	1	2	3	4
Low rainfall				■	■	■		
Medium rainfall					■	■	■	
High rainfall						■	■	■

■ Preferred sowing time
■ Later than recommended, yield reduction likely depending on spring conditions

Seed quality

Profitable crops start with quality planting seed (i.e. high germination and vigour). Always do a germination test on seed and adjust the sowing rate accordingly. Mature lupin crops exposed to heavy rain before harvest are at high risk of producing low-viability seed even though the seed can appear normal. 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 than conventional headers. 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, also 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*.

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Pulse Point 20, *Germination testing and seed rate calculation* (https://www.dpi.nsw.gov.au/___data/assets/pdf_file/0005/157442/pulse-point-20.pdf).

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.

Table 82. 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.

Bitterness in albus lupin seed

To maintain the seed quality standards for the 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 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 albus threshold standards set for both human consumption and stockfeed use.

Albus lupin is an out-crossing crop, so only grow one albus 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 caused by foraging honey bees. Test all sowing seed for bitterness every year. Do not buy any albus seed without a testing certificate showing that the seed is free from bitterness.

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 5 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 due to its proteoid root system. Be careful when using higher rates of high-analysis fertilisers as lupin seed is sensitive to fertiliser burn. Select paddocks with a low level of residual nitrogen to promote effective nodulation and nitrogen fixation.

Wider rows and narrow tynes exacerbates the risk of fertiliser burn, as the seed and fertiliser can be concentrated together in a narrow band. 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 soil pH_{Ca} is below 5.0, molybdenum might be deficient. In this case an application every 5 years is recommended for effective nitrogen fixation by legume rhizobia. 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 reaction to disease, refer to Table 83 on page 163.

Narrow-leaf lupin

Coyote$^{\Phi}$. Released in 2019 by AGT in Western Australia. High and stable yielding, early maturing variety performing well across a very broad range of soil types, rainfall zones and yield potentials. It has performed very well in NSW trials. Rated susceptible to stem phomopis. Where the risk of stem phomopsis is high, monitor livestock when grazing stubbles or remove grazing livestock completely. Coyote$^{\Phi}$'s resistance to stem phomopsis is lower than that of PBA Bateman$^{\Phi}$, PBA Jurien$^{\Phi}$ and Mandelup$^{\Phi}$. Tolerance to metribuzin is equal to Mandelup$^{\Phi}$. Seed is available from Australian Grain Technologies (AGT) Affiliates. EPR is $3.30/tonne incl. GST.

Lawler[Φ]. Released in 2022. High and stable yield in NSW growing regions, with maturity slightly quicker than Mandelup[Φ] and quicker than Coyote[Φ]. Tolerance to metribuzin is similar to PBA Jurien[Φ]. Good tolerance to pod shattering and reduced risk of seed splitting compared with PBA Jurien[Φ]. Lawler[Φ] offers improved resistance to stem phomopsis compared with Coyote[Φ], similar to Wonga[Φ] and PBA Barlock[Φ]. Released by AGT, seed is available from AGT Affiliates. Protected by PBR, EPR is $4.40/tonne incl. GST.

PBA Barlock[Φ]. Released in 2013 by Pulse Breeding Australia (PBA) in Western Australia, to replace Mandelup[Φ] and Tanjil in all WA lupin-growing zones. Compared with Mandelup[Φ], PBA Barlock[Φ] 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[Φ]. Tolerance to metribuzin is equal to Mandelup[Φ]. Commercialised by Seednet, protected by PBR. EPR is $2.75/tonne incl. GST.

PBA Bateman[Φ]. Released in 2018 by PBA. It offers significant yield improvements over current varieties, particularly in the eastern cropping zones of NSW where virus infection from CMV and *Bean yellow mosaic virus* (BYMV) can cause significant yield loss in susceptible varieties when seasonal conditions are conducive to high aphid numbers. Commercialised by Seednet. EPR is $2.86/tonne incl. GST.

PBA Gunyidi[Φ]. 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[Φ] has superior resistance to pod shatter and good lodging resistance, allowing later harvest without incurring significant shatter losses. Tolerance to metribuzin is equal to Mandelup[Φ], but is more susceptible to damage from Eclipse®. Commercialised by Seednet, protected by PBR. EPR is $2.75/tonne incl. GST.

PBA Jurien[Φ]. Released in 2015 by PBA in Western Australia. It is a broadly adapted high-yielding variety. It tolerates metribuzin (superior to PBA Barlock[Φ]) with early flowering and maturity similar to other current varieties. NSW trials have shown it to be more susceptible to plant lodging than other 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 incl. GST.

Albus lupin

Luxor[Φ]. 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). Luxor[Φ] is 7 days later flowering than Ultra, but earlier flowering than its sister line Rosetta[Φ]. Suited to the medium–low rainfall zones of NSW. Commercialised by Seednet, protected by PBR. EPR is $3.08/tonne incl. GST.

Murringo[Φ]. Released in 2017 by NSW DPI. Its phenology is similar to Luxor[Φ], while slightly later in maturity but earlier than Rosetta[Φ]. It is early–mid flowering with moderate resistance to pleiochaeta root rot and phomopsis. Commercialised by Seednet. EPR is $3.52/tonne incl. GST.

Rosetta[Φ]. Released in 2005 by NSW DPI, it is a high yielding albus lupin, later flowering and taller than Luxor[Φ], suited to longer season environments. Moderately resistant to pleiochaeta root rot, but less resistant than Luxor[Φ]. Commercialised by Seednet, protected by PBR. EPR is $3.08/tonne incl. GST.

Table 83. Lupin variety characteristics and reaction to diseases.

Variety	Flowering time	Pod loss, shatter resistance	Lodging resistance	Seed size (g/100 seeds)	Disease					
					Brown leaf spot ❷	Pleiochaeta root rot ❷	Phomopsis stem infection	Phomopsis pod infection	CMV seed transmission	Anthracnose resistance
Narrow-leaf										
Coyote	early	G	MG	14	MS	MR	S	MR–MS	MR–MS	MR–MS
Jenabillup	early	G	MG	14	MR–MS	MR	MS	MR	MR–MS	MS
Lawler	very early	G	MG	14	MS ❶	MR ❶	MR	MS	MR–MS	MR
Mandelup	very early	G	MP	14	MS	MR–MS	R–MR	S	MR–MS	MR–MS
PBA Barlock	early	VG	G	13	MS	MR–MS	MR	MR	MR	R–MR
PBA Bateman	very early	G	MP	14	MS	MR	R–MR	MS	MR	MR–MS
PBA Gunyidi	very early	VG	G	13	MS	MR	R–MR	MR–MS	MR–MS	MR–MS
PBA Jurien	early	G	MG	13	MS	MR	R–MR	MR	MS	R–MR
Quilinock	early	G	MP	16	MS	MR	S	S	MS	VS
Wonga	early–mid	G	MG	13	MS	MR	MR	MR	MR	R–MR
Albus ❸										
Luxor	early–mid	G	G	35	MR	R	MR	–	Immune	VS
Murringo	early–mid	G	G	32	MR	MR	MS	–	Immune	VS
Rosetta	mid	G	G	35	R	MR	R	–	Immune	VS

Source: NVT lentil national disease ratings.

❶ Provisional rating
❷ Ratings are based on 2020 and breeder data.
❸ Disease resistance screening in albus lupin is no longer conducted. The ratings for albus are from 2016.
– Insufficient or 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

Table 84. Comparative performance of lupin in northern NSW compared with PBA Bateman(ⵔ) = 100%.

North west							
Variety	Yearly group mean					Regional mean	Number of trials
	2018	2019	2020	2021	2022		
PBA Bateman t/ha	–	–	**1.93**	**4.31**	**2.88**	**3.07**	
Coyote	–	–	98	–	111	104	3
Jenabillup	–	–	99	–	88	94	3
Lawler	–	–	–	103	109	103	3
Mandelup	–	–	95	101	101	99	5
PBA Barlock	–	–	93	99	93	96	5
PBA Bateman	**–**	**–**	**100**	**100**	**100**	**100**	**5**
PBA Gunyidi	–	–	104	–	94	98	3
PBA Jurien	–	–	94	–	101	100	3
Quilinock	–	–	95	94	87	93	5
Wonga	–	–	90	91	80	89	5

Table 85. Comparative performance of lupin in southern NSW compared with PBA Bateman(ⵔ) = 100%.

South east							
Variety	Yearly group mean					Regional mean	Number of trials
	2018	2019	2020	2021	2022		
PBA Bateman t/ha	**1.00**	**0.50**	**2.95**	**3.11**	**3.36**	**2.14**	
Coyote	100	–	97	101	92	97	9
Jenabillup	97	92	102	–	100	100	10
Lawler	–	–	–	101	92	96	5
Mandelup	–	97	93	101	96	97	10
PBA Barlock	–	78	91	100	103	97	10
PBA Bateman	**100**	**100**	**100**	**100**	**100**	**100**	**12**
PBA Gunyidi	–	107	107	101	98	102	10
PBA Jurien	–	81	91	99	105	98	10
Quilinock	92	87	96	101	98	97	12
Wonga	86	87	92	103	92	94	12

– Insufficient or no data.

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. S**ulfonylurea herbicides** (e.g. Glean® or Logran B-Power®) applied to preceding cereal crops. Take special note of label instructions concerning crop rotation and plantback intervals, particularly on high pH and/or compacted soils, and after prolonged periods of low rainfall or drought. Residues could persist longer in no-till system soils that have received surface-applied lime to raise soil pH.
2. **Triazine herbicides** (e.g. simazine, terbuthylazine). 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 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 plantback intervals, refer to pesticide labels.

Insect control

A range of pests can be found in lupins, but all have several natural predators that will help keep populations in check. With regular monitoring and good record keeping, population dynamics will show if pest populations are increasing and if chemical control might be needed.

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 frost damage, so correct identification is required before control measures are used. Early detection and control improve crop health and vigour.

Lucerne flea – damage is common and is characterised by clear membranous windows chewed into cotyledons and skeletonised leaf surfaces. Early detection and control improve crop health and vigour.

Cutworms, **armyworms** and **pasture cockchafers** – these larvae pests can cause sporadic damage to seedlings and young plants and are often seen in patches rather than across the whole paddock. 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 2 potentially serious lupin viruses: CMV and 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 seed-borne in albus lupin, but not in narrow-leafed lupin, whereas the opposite is the case with CMV; high seed-borne transmission has been found in narrow-leafed lupins but not in albus lupin. Lupin varieties differ in their susceptibility to viruses (see the Disease section on *Cucumber mosaic virus* on the following page). PBA Bateman[◊] appears 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.

***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.

Refer to the NSW DPI guide *Insect and mite control in field crops* for more detailed information on pest control measures and thresholds.

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Insect and mite control in field crops (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

Diseases

Anthracnose – This destructive fungal disease was detected for the first time in commercial lupin crops in NSW in 2016. A thorough surveillance program showed no reoccurrence of the disease since 2016, so the disease was declared eradicated in NSW in 2019. PBA Jurien(Φ) and PBA Barlock(Φ) are rated resistant–moderately resistant while the new variety Lawler(Φ) is moderately resistant. All 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 survival and spread. Infected seed will lead 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 stem bending is due to lesions formed 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 rain splash of spores, patches of deformed plants will form within the crop 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.

The movement of lupin (seed and plant material) and machinery into NSW from South Australia and Western Australia (including seed for livestock feed) is prohibited by law and carries the high risk of introducing anthracnose into NSW.

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 soil surface and in paddocks with a recent narrow-leaf lupin history. 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. Proactive crop management can prevent losses from BLS. There are no foliar fungicides currently registered to manage the disease. Preventative measures to protect crops in high disease risk situations, particularly in areas with intensive lupin production include:

- crop rotation (at least 4 years between lupin crops)
- paddock separation from last year's lupin crop
- cereal stubble cover and minimum tillage
- using a fungicide seed dressing.

Pleiochaeta root rot (PRR) – Albus lupin is reasonably tolerant to PRR when grown on red–brown loamy soils. The variety Luxor$^{\Phi}$ is resistant, while Rosetta$^{\Phi}$ and Murringo$^{\Phi}$ are rated moderately resistant to the disease however, the older varieties (Ultra and Kiev Mutant) are susceptible. PRR is caused by the fungus, *Pleiochaeta setosa*, with soil-borne spores infecting the albus plant taproot causing stunting and premature death. 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 4 years in the same paddock.

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Managing viruses in pulse crops 2021 (https://www.dpi.nsw.gov.au/___data/assets/pdf_file/0005/1299965/Managing-viruses-in-pulse-crops-in-2021.pdf)

***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. 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. Very severe CMV infections were found in several narrow-leafed lupin crops in central and northern NSW during 2020. Testing of seed harvested from these paddocks showed high levels of CMV seed transmission. Growers who keep their own seed should be aware there is a risk of virus infection build-up in their seed stock, particularly in years with severe virus infection levels; consider purchasing fresh, virus-free, seed. The DPI website has further information including *Managing viruses in pulse crops 2021*. 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 3 types of symptoms:

1. When infected before pod set, the most common symptom is necrosis 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).

No BYMV seed-transmission has been found in narrow-leafed lupin in Australia, however, BYMV seed transmission can occur in albus lupin. Management practices, including retaining standing cereal stubble and weed control (to deter aphids), will reduce disease incidence.

In contrast to 2020, very little aphid activity was noted during the 2021 and 2022 season and virus seed transmission of BYMV and CMV (albus and narrow-leafed lupins respectively) is likely to be reduced compared with 2020 seed lots. Nevertheless, growers are encouraged to have their seed lots tested before sowing.

Phomopsis and lupinosis – Be aware of the potential danger to stock grazing in lupin stubble, and seed infected with the phomopsis stem blight fungus. The fungus that causes the disease infects lupin plants in winter, but the disease does not express and develop in plants until maturity. Often early development of the fungus and toxin production can occur following moisture stress before harvest, while summer rain stimulates fungal growth and toxin production on stubble.

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Reducing the risk of lupinosis and the incidence of phomopsis (http://www.dpi.nsw.gov.au/animals-and-livestock/sheep/health/other/lupinosis-phomopsis)

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. Albus lupin varieties have a good level of resistance to stem infection from the Phomopsis pathogen, but are susceptible to pod and seed infection especially after heavy rain, wind, or hail close to harvest. Be aware the disease can develop in lupin crops before harvest as a result of plant stress, e.g. water stress or herbicide injury. This results in lupin stubble being toxic before harvest and so cannot be safely grazed. 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 4 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. The disease can occur in individual plants or patches within a crop. Disease occurrence can be associated with soil hard pans or perched water tables as 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 the fungus survives for an extended period in the soil. Methods to minimise disease occurrence include crop rotation and avoiding paddocks with a known waterlogging problem.

Sclerotinia stem rot (SSR) – This disease is caused by the same fungus that infects canola and other broadleaf species. Prolonged wet conditions in late winter followed by periods of prolonged leaf wetness during flowering favour disease development. Districts with reliable spring rainfall and long flowering periods for lupin appear to develop the disease more frequently. In 2022, the disease was widespread in commercial lupin crops in southern NSW with very high levels of infection. Dense lupin crop canopies and frequent late season rainfall were ideal for SSR to develop. SSR outbreaks in lupin crops in 2022 will increase the populations of sclerotia in those paddocks. Crop sequences that include lupin and canola in close rotation will increase soil-borne sclerotia and hence, disease pressure in future years.

The environmental conditions for SSR to develop are very specific and will not occur every year, so even when the fungus is present the disease could fail to develop if dry conditions occur in spring. Burning canola or lupin stubble will not effectively control SSR 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. The foliar fungicide Miravis® Star is registered to manage SSR in lupin and should be applied just before canopy closure during early flowering.

Botrytis grey mould – This disease is becoming more common in commercial lupin crops in southern NSW. The fungus *Botrytis cinerea* causes the disease and is normally associated with lentil, chickpea and faba bean. BGM outbreaks are initiated on senescent plant tissues, such as old leaves and flower parts, before developing into larger, more damaging lesions. The disease develops rapidly following canopy closure and frequent rainfall. Symptoms of the disease include stem and leaf infections, and infections of old flower parts and pods. While the disease can be confused with sclerotinia stem rot, the fluffy mycelium produced by the fungus is grey rather than white and no sclerotia are produced. Currently the foliar fungicides Veritas® Opti and Miravis® Star are registered to manage this disease and should be applied just before canopy closure.

Harvest

Lupin seed should be harvested to give 14% moisture at delivery (maximum receival standard). Timing is critical to maximise yields. Pods are prone to shelling out and 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. Grain damage during harvest can be minimised by reducing harvest speed and reducing the header drum speed . Grower experience suggests 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 update *Harvest aid or salvage spraying winter crops*. As desiccation timing is similar to windrowing, seek advice from your local agronomist if unsure.

Marketing

Narrow-leaf lupin seeds are round, speckled and slightly smaller than field pea with a protein content around 32%. It is a readily marketable, high protein stockfeed and is sold domestically for use in pig, poultry, dairy, aquaculture and feedlot rations. A significant quantity is exported, but the price is driven by competition with soymeal. Currently there are export market opportunities in Europe (Netherlands).

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Windrowing lupin (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/lupins/windrowing-lupins)

Harvest aid or salvage spraying winter crops (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/weed-control-winter-crops)

Albus lupin seeds are white, squarish and flat, and larger than narrow-leaf lupin, containing a slightly higher protein content (~36%). Albus varieties are suitable to export for human consumption provided grain quality requirements are met. The main export market for Australian albus is Egypt.

There is increased demand from domestic users for human consumption. Grain quality is largely determined by visual standards. Grain size, shape and colour are key factors. Preference is for large, even size and shape, and light-coloured grain with no disease or insect blemishes. 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, increasing the protein content to ~46% for use in feed mixes, while the hulls provide a fibre source.

Further information

NSW DPI website

Harvest aid or salvage spraying winter crops (https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/weed-control-winter-crops)

Insect and mite control in field crops (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/insect-mite-crops)

Primefact 1308, *Reducing the risk of lupinosis and the incidence of phomopsis* (http://www.dpi.nsw.gov.au/animals-and-livestock/sheep/health/other/lupinosis-phomopsis)

Pulse Point 6, *Dry sowing* (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/general-information/dry-sowing)

Pulse Point 10, *Windrowing lupin* (http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/lupins/windrowing-lupins)

Pulse Point 17, *Phytophthora root rot of lupin* (http://archive.dpi.nsw.gov.au/__data/assets/pdf_file/0019/157411/pulse-point-17.pdf)

Pulse Point 18, *Cucumber mosaic virus in lupins* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/157433/pulse-point-18.pdf)

Pulse Point 20, *Germination testing and seed rate calculation* (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/157442/pulse-point-20.pdf)

Lupin anthracnose (https://www.dpi.nsw.gov.au/biosecurity/plant/insect-pests-and-plant-diseases/lupin-anthracnose).

GRDC website

NSW DPI and GRDC Bulletin: *Legumes in acidic soils – maximising production potential in south eastern Australia* (https://grdc.com.au/resources-and-publications/all-publications/publications/2018/legumes-in-acidic-soils)

Pulse Australia

Variety Management Packages (VMP) for all new varieties (http://www.pulseaus.com.au/growing-pulses/bmp/lupin)

Australian Pulse Trading Standards (http://www.pulseaus.com.au/marketing/receival-trading-standards)

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Table 86. 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; 4 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; 4 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 premature 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)	Narrow-leafed lupins: Plants yellow with blackened, flat pods. Plants wilt and die. The non-necrotic strain causes downturned leaflets. Albus lupins: Severe stunting (depending on the time of infection), yellowing, less pods	Mainly in mild conditions during spring. Often seen at crop margins.	Survives in many legume and weed species. Spread by several aphid species. Seed-borne in Albus lupins	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

Keeping stored grain free from insect damage is becoming increasingly important, with increased on-farm silo storage and use of temporary storage system such as grain bags.

Growers need to be aware of the options available to keep grain free from grain insect infestation and damage, which can render grain unsaleable. Additional reading on grain storage and fumigation practices can be found in the following publications:

GROWNOTES™ - *Grain storage* (https://storedgrain.com.au/grdc-grownotes-grain-storage/)

Grain fumigation – a guide (https://storedgrain.com.au/wp-content/uploads/2016/10/GRDC-GSFS-14_GrainFumigationGuide_R2.pdf)

Further information

GROWNOTES™:
Grain storage
Grain fumigation – a guide

Any queries, please seek information from Joanne Holloway
NSW DPI Grain Storage Unit, Wagga Wagga
t: 02 6938 1605.

Table 87. Insecticides for disinfesting empty grain storages and grain handling equipment.

Purpose	Insecticide	Mixing rate	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/L (1 L/20 m^2) 200 g/L (1 L/33 m^2) 120 g/L (1 L/20 m^2) 120 g/L (1 L/20 m^2) 240 mL/L (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 10 m^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 Fenitrothion 1000 Chlorpyrifos-methyl + S methoprene e.g. Relyon Plus®	11 or 22 mL/L 10 mL/L 20 mL/L	Actellic® 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. **Note**: None of these chemicals are to be used in storages where canola and other oilseeds or pulses are to be stored. **Note**: These products are anti-cholinesterase compounds.
	Insectigas-D®	200 g/300 m^3	Self-propelled gas. **Note**: Do not re-enter treated area for at least 4 days after treatment – follow label directions. **Note**: This product is an anti-cholinesterase compound.

Table 88. 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 or 3 tablets/2 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 2 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 cereal grains and oilseeds by fumigation	Vapormate® Fumigant (420 or 660 g/m^3) (420 g/m^3–24 hours exposure or 660 g/m^3–3 hours exposure)	Rate depends on exposure time (3 or 24 hours; see label). To be dispensed into sealed/gas-tight storage. **Note**: For use only by people trained under a BOC training program.
Disinfest cereals only by fumigation	Sulfuryl fluoride (Profume®)	Requires a licensed fumigator trained to use Profume® and a gas-tight storage.

PEST ALERT: Have you seen this pest?

Khapra beetle

Contact: Exotic Plant Pest Hotline: 1800 084 881
for more information
(https://www.dpi.nsw.gov.au/biosecurity/plant/insect-pests-and-plant-diseases/khapra)

Figure 11.
A: Khapra beetle adult and larva on grains of rice (Science and Surveillance Group, Department of Agriculture, Water and the Environment);
B: Adult khapra beetle, dorsal view (Simon Hinkley and Ken Walker, Museum Victoria);
C: Adult khapra beetle, side view (Simon Hinkley and Ken Walker, Museum Victoria).

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

Lesser grain borer – *Rhyzopertha dominica*

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

Rust-red flour beetle – *Tribolium castaneum*

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

Rice weevil – *Sitophilus oryzae*

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

Saw-toothed grain beetle – *Oryzaephilus surinamensis*

Key features: dark brown, 3 mm long, fast moving, saw tooth pattern on side of body behind head.

Flat grain beetle or rusty grain beetle – *Cryptolestes ferrugineus*

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

India meal moth – *Plodia interpunctella*

Key features: distinctive bicoloured wings, 5–7 mm long, larvae create webbing on grain surface.

A – Images courtesy Department of Agriculture, Fisheries and Forestry, Queensland.
B – Image courtesy K Walker, PaDIL www.padil.gov.au

Figure 11. Common stored grain insects

Registered insecticides as at February 2023

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.

Table 89. 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) 1 L in 100 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 maximum residue limits (MRL) for grain protectant compounds. Apply at the rate of 1 L diluted spray per tonne of grain for up to 9 months protection. One application per parcel of grain. To control *Sitophilus* spp. (e.g. rice weevil) tank mix with a compatible product suitable for your grain type (see product labels).
	K-Obiol® EC Combi (50 g/L deltamethrin + 400 g/L piperonyl butoxide) 2.0 L in 100 L of water PLUS an additional registered grain protectant* at the recommended rate.		Ensure treatment is acceptable to buyer. K-Obiol® can be used against all the major stored grain insect pests. However, K-Obiol® is restricted to one application per parcel of grain. This product can only be used by **approved users**. For further information go to Bayer:K-Obiol (https://www.au.envu.com/K-Obiol). Apply at the rate of 1 L of diluted spray per tonne of grain entering storage. Apply through standard grain spraying equipment. The output of spray through the nozzle must be regulated according to the flow rate. Ensure an even coverage of the grain. * Choose an additional grain protectant which contains fenitrothion or chlorpyrifos-methyl and registered for your grain type (check pesticide labels). See mixing/application instructions on label. This treatment will provide up to 9 months protection. Treat only non-infested grain with protectants. Check labels for withholding period (WHP). **Warning**: Resistant or tolerant strains of some grain insects might be present and could require adding a second insecticide to achieve control.
Protect cereal grain except malt barley	GROUP A	Actellic® 0.45 L fenitrothion 1.2 L	Ensure treatment is acceptable to buyer. 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. **Note**: Resistance in lesser grain borer to IGR is widespread.
	GROUP B	Rizacon-S® 0.2 L IGR grain protectant (methoprene) various rates	
	Twin pack pre-mixed Various brands	Two-component packs e.g. ACP Grain Protect Plus IGR 2.0 L❶ e.g. Methograin Delta IGR Grain Protectant 2.0 L❸	Ensure treatment is acceptable to buyer. Different twin pack premixed formulations might be available and can be used to control all stored grain insect pests. **Note**: Resistance in lesser grain borer to IGR is widespread.
Protect malting barley	K-Obiol® EC Combi 2.0 L❷		See directions above. **Note**: Using chlopyrifos-methyl as a mixing partner is not permitted on malting barley.
	Grain-guard Duo (600 g/L fenitrothion + 60 g/L S-methoprene) 1.0 L.		Ensure treatment is acceptable to buyer. Different twin pack premixed formulations may be available and can be used to control all stored grain insect pests. 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. **Note**: Resistance in lesser grain borer to IGR is widespread.
	Conserve™ Plus ❷ 1 L		See directions above
Protect cereal grain (for treating cereal grain to be retained and used on farm only)	Dryacide® 1 kg/tonne Perma-Guard® D-10 1 kg/tonne Absorba-cide® 1 kg/tonne Cut 'N Dry® 1 kg/tonne		Apply dusts evenly and reduce auger rate to prevent choking. Not accepted off-farm by most traders. DO NOT treat grain to be delivered to grain handling authorities.
Protect organic cereal grain	Dryacide® 1 kg/tonne Perma-Guard® D-10 1 kg/tonne Absorba-cide® 1 kg/tonne Cut 'N Dry® 1 kg/tonne		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 chlopyrifos-methyl and S-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.
❸ A premixed formulation of deltamethrin and S-methoprene.

Cereal seed dressings control smuts and bunt, and some can suppress certain leaf and root diseases. Outbreaks of bunt and flag smut in wheat, loose smut in barley, emphasise the need for annual seed treatment to avoid diseases 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, into a poor seedbed or under dry conditions.

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	Smuts controlled: B – Bunt; C – Covered smut; L – Loose smut				F – wheat flag smut		Diseases suppressed								
								Wheat	Wheat	Wheat				Wheat/barley	Barley			Grazing
				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	withholding period (weeks)
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	100 g	4.21	BL	CL	–	–	F	F	✓	✓	–	–	–	✓	✓	–	4
Tebuconazole 25 g/kg + triflumuron 4 g/kg	Conquest Veto T – Conquest Agrichemicals	100 g	2.26	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	4
Triadimenol 150 g/kg + cypermethrin 4 g/kg	Triadimenol 150+® SD – 4 Farmers	100 g 150 g	2.93 4.40	BL BL	CL CL	CL CL	– –	F F	F F	– ✓	✓ ✓✓	– –	– –	– –	✓ ✓✓	✓ ✓✓	– –	5 5
Flowable liquids – water based – various trade names sometimes available under these active ingredients, concentrations and formulations. See specific labels for details.																		
Carboxin 400 g/L + cypermethrin 3.2 g/L	Vitaflo® C ST – UPL Australia Ltd ❸	125 mL 250 mL	4.16 8.33	B BL	C CL	CL –	– L	F ❸ F	– –	– –	– –	– –	– –	– –	– –	– –	– –	7 7
Carboxin 200 g/L + thiram 200 g/L	Vitavax® 200 FF ST – UPL Australia Ltd ❸	250 mL 375 mL 500 mL	8.11 12.16 16.21	B B BL	C C CL	CL – –	– – L	F ❸ F F	– – F	– – –	– – –	– – –	– – –	– – –	– – –	– – –	✓ ✓✓ ✓✓✓	7 7 7

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

❶ Prices quoted are GST inclusive at February 2023 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.

❸ Also controls seed-borne flag smut in triticale. There is no registered seed treatment for cereal rye.

❹ *Barley yellow dwarf virus* (BYDV). Hombre® Ultra provides early season control of BYDV.

❺ Plus Raxil® T with Jockey® Stayer® at 100 mL/100 kg seed

❻ Also provides control of pythium root rot.

❼ Also provides control of pythium root rot, leaf rust and net blotch in barley and suppression of yellow spot.

❽ Suppresses rhizoctonia root rot in oats.

❾ Suppression only.

❿ Withholding period – livestock producing milk for human consumption 12 weeks.

⓫ Feed treated with this product must not be used for animal consumption, poultry feed or mixed with animal feed. DO NOT mix leaves treated with this product with feed intended for animal consumption.

⓬ Rancona® Dimension is registered for the suppression of crown rot and rhizoctonia root rot, at 320 mL/100kg.

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

⓮ Vibrance® registered at 90–180 mL/100 kg seed for control of covered and loose smut in barley. Use the higher rate when known levels of loose smut infection are present within the seedlot or when treating a highly susceptible barley variety.

⓯ 180–360 mL/100 kg seed will give suppression of rhizoctonia root rot in barley.

⓰ EverGol® Energy is registered for the suppression of crown rot and pythium root rot for seed treatment, see label for rates.

⓱ EverGol® Energy is registered for the suppression of crown rot and pythium root rot for in-furrow application at 300 mL/ha. Only apply direct into sowing furrow, do not apply EverGol® Energy to solid fertiliser.

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

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

Seed dressings and foliar fungicides

Table 90. Cereal seed dressings – 2023: control of seed-borne disease (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 ($) ❶	Smuts controlled: B – Bunt; C – Covered smut; L – Loose smut				F – wheat flag smut		Diseases suppressed								
								Wheat	Wheat	Wheat				Wheat/barley	Barley			Grazing
				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	withholding period (weeks)
Difenoconazole 66.2 g/L + metalaxyl-M 16.5 g/L + sedaxane 13.8 g/L	Vibrance® – Syngenta ❻	90 mL 180 mL 360 mL	3.98 7.96 15.91	B BL BL	CL ⓮ CL CL	L L L	BL BL BL	F F F	F F F	– – –	– – –	– – –	– – –	– ✓ ⓯ ✓ ❽	– – –	– – –	– ✓ ✓✓	6 6 6
Fluquinconazole 167 g/L	Jockey® Stayer® – Bayer CropScience ❷	300 mL 450 mL	21.39 32.09	BL BL	CL ❺ –	– –	– –	F F	F F	✓ ✓✓	✓✓✓ ✓✓✓✓	✓ ✓✓	– ✓	– –	✓✓✓ ❺ –	✓✓ ❺ –	– –	6, 12 ❿ 6, 12 ❿
Flutriafol 6.25 g/L	Vincit® Zinc FSD – FMC	400 mL	10.12	BL	CL	CL	L	F	F	–	–	–	–	–	–	–	–	4
Flutriafol 25 g/L + cypermethrin 4 g/L	Vincit® C FSD – FMC	100 mL	3.31	BL	CL	CL	L	F	F	–	–	–	–	–	–	–	–	4
Flutriafol 100 g/L + cypermethrin 4 g/L	Arrow® C FSD – NuFarm	100 mL	2.61	BL	CL	–	–	F	F	✓	✓	–	–	–	✓	✓	–	4
Flutriafol 6.25 g/L + metalaxyl-M 15 g/L + imidacloprid 180 g/L	Pontiac® Seed Treatment– NuFarm ❹	400 mL	15.11	BL	CL	CL	L	F	F	–	–	–	–	✓❾	–	–	–	9
Fluxapryroxad 333g/L	Systiva – BASF	150 mL	37.52	B	L	–	–	–	–	✓	–	–	–	✓❾	✓✓✓	✓✓✓	✓✓✓	4
Ipconazole 20 g/L + cypermethrin 4 g/L	Rancona® C – UPL Australia Ltd	100 mL	3.65	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	6
Ipconazole 25 g/L + metalaxyl 20 g/L	Rancona® Dimension ❻ ⓬ – UPL Australia Ltd	80 mL 200 mL 320 mL ⓬	4.02 10.05 16.07	BL – –	CL L –	CL – –	– – –	F – –	F – –	– – –	– – –	– – –	– – –	– – ✓	– – –	– – –	– – –	10 10 10
Penflufen 240 g/L	EverGol® Prime – Bayer CropScience	40 mL 80 mL	6.93 13.86	BL BL	CL CL	CL CL	– –	F F	F F	– –	– –	– –	– –	✓ ✓✓	– –	– –	– –	5 5
Penflufen 38.4 g/L + metalaxyl 61.4 g/L + prothioconazole 76.8 g/L	EverGol® Energy⓰ Bayer CropScience	65 mL 100 mL 130 mL 260 mL	4.02 6.18 8.03 16.06	B – L –	C – L –	– – L –	– – L –	– – F –	– – F –	– – – –	– – – –	– – – –	– – – –	– – ✓ ✓✓	– – – –	– – – –	– – – –	6 6 6 6
Tebuconazole 25 g/L + cypermethrin 4 g/L	various	100 mL	1.65	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	0
Tebuconazole 12.5 g/L + imidacloprid 360 g/L	Hombre® Ultra – Bayer CropScience Proguard® Ultra – UPL Australia Ltd❹	200 mL	8.73	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	9
Tebuconazole 25 g/L + triflumuron 4 g/L	Raxil® T FSD – Bayer CropScience	100 mL	2.38	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	4
Triadimenol 150 g/L + cypermethrin 4 g/L	Foliarflo® C ST – UPL Australia Ltd	100 mL 150 mL	2.53 3.80	BL BL	CL CL	CL –	– –	F F	F F	– ✓	✓ ✓✓	– –	– –	– –	✓ ✓✓	✓ ✓✓	– –	5 5
Triadimenol 56 g/L + imidacloprid 180 g/L	4 Farmers Imid-Triadimenol Seed Dressing – 4 Farmers Australia ❹	400 mL	9.39	BL	CL	CL	–	F	F	✓✓	✓✓	–	–	–	✓✓	✓✓	–	9
Triadimenol 150 g/L + triflumuron 4 g/L	Baytan® T FSD – Bayer CropScience	100 mL 150 mL	2.93 4.40	BL BL	CL CL	CL –	– –	F F	F F	– ✓	✓ ✓✓	– –	– –	– –	✓ ✓✓	✓ ✓✓	– –	5 5
Triticonazole 25 g/L + cypermethrin 4 g/L	Premis® Pro C – BASF	100 mL	3.65	BL	CL	CL	–	F	F	–	–	–	–	–	–	–	–	Nil

Table 90. Cereal seed dressings – 2023: control of seed-borne disease (page 3 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 ($) ❶	Smuts controlled: B – Bunt; C – Covered smut; L – Loose smut				F – wheat flag smut		Diseases suppressed								
								Wheat	Wheat	Wheat				Wheat/barley	Barley			Grazing
				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	withholding period (weeks)
In furrow treatments – various trade names sometimes available under these active ingredients, concentrations and formulations. See specific labels for details.																		
		Rate and approximate cost $/ha																
Azoxystrobin 322 g/L + metalaxyl-M 124 g/L	Uniform®– Syngenta❼	200 mL/ha	9.02	–	–	–	–	–	–	–	–	–	–	✓	–	–	–	6
		300 mL/ha	13.53	–	–	–	–	–	–	–	✓✓	–	–	✓✓	–	✓	–	6
		400 mL/ha	18.04	–	–	–	–	–	–	–	✓✓✓✓	–	–	✓✓✓	–	✓✓	–	6
Flutriafol 250 g/L	various	200 mL/ha	2.64	–	–	–	–	–	–	–	✓✓	–	–	–	✓	✓	–	4
		400 mL/ha	5.28	–	–	–	–	–	–	✓	✓✓✓✓	–	✓	–	✓✓	✓✓	–	4
Flutriafol 500 g/L	Intake® HiLoad Gold NuFarm ❷	100 mL/ha	4.31	–	–	–	–	–	–	–	✓✓	–	–	–	✓	✓	–	4
		200 mL/ha	8.62	–	–	–	–	–	–	✓	✓✓✓	–	✓	–	✓✓	✓✓	–	4
		400 mL/ha	17.23	–	–	–	–	–	–	✓	✓✓✓✓	–	✓	–	✓✓	✓✓	✓	4
Penflufen 240 g/L	EverGol® Prime – Bayer CropScience	60 mL/ha	10.40	BL ⓭	CL ⓭	CL ⓭	–	F ⓭	F ⓭	–	–	–	–	✓✓	–	–	–	5
		120mL/ha	20.80											✓✓✓				5
Penflufen 38.4 g/L + metalaxyl 61.4 g/L + prothioconazole 76.8 g/L	EverGol® Energy ⓱ Bayer CropScience	300 mL/ha	18.53	–	–	–	–	–	–	–	–	–	–	✓✓✓	–	–	–	6
Triadimefon 500 g/kg	Triadimefon 500 WG – FMC	200 g/ha	5.32	–	–	–	–	–	–	–	✓✓	✓	–	–	–	✓	–	No grazing ⓫
Triadimefon 500 g/kg	Triadimefon 500 DRY – 4 Farmers	200 g/ha	7.04	–	–	–	–	–	–	–	✓✓	✓	✓	–	–	✓	–	No grazing ⓫

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

❶ Prices quoted are GST inclusive at February 2023 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.

❸ Also controls seed-borne flag smut in triticale. There is no registered seed treatment for cereal rye.

❹ *Barley yellow dwarf virus* (BYDV). Hombre® Ultra provide early season control of BYDV.

❺ Plus Raxil® T with Jockey® Stayer® at 100 mL/100 kg seed

❻ Also provides control of pythium root rot.

❼ Also provides control of pythium root rot, leaf rust and net blotch in barley and suppression of yellow spot.

❽ Suppresses rhizoctonia root rot in oats.

❾ Suppression only.

❿ Withholding period – livestock producing milk for human consumption 12 weeks.

⓫ Feed treated with this product must not be used for animal consumption, poultry feed or mixed with animal feed. DO NOT mix leaves treated with this product with feed intended for animal consumption.

⓬ Rancona® Dimension is registered for the suppression of crown rot and rhizoctonia root rot, at 320 mL/100kg.

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

⓮ Vibrance® registered at 90–180 mL/100 kg seed for control of covered and loose smut in barley. Use the higher rate when known levels of loose smut infection are present within the seedlot or when treating a highly susceptible barley variety.

⓯ 180–360 mL/100 kg seed will give suppression of rhizoctonia root rot in barley.

⓰ EverGol® Energy is registered for the suppression of crown rot and pythium root rot for seed treatment, see label for rates.

⓱ EverGol® Energy is registered for the suppression of crown rot and pythium root rot for in-furrow application at 300 mL/ha. Only apply direct into sowing furrow, do not apply EverGol® Energy to solid fertiliser.

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

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

Table 91. Cereal insecticide seed dressings for aphid and *Barley yellow dwarf virus* (BYDV) control 2023. Always check the label before using farm chemicals.

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 – UPL Australia Ltd	200 mL	8.89	✓	✓	9
Imidacloprid 180 g/L + triadimenol 56 g/L	4 Farmers Imid-Triadimenol Seed Dressing – 4 Farmers Australia	400 mL	9.39	✓	✓	9
Imidacloprid 180 g/L + flutriafol 6.25 g/L + metalaxyl 15 g/L	Pontiac® – NuFarm	400 mL	14.93	✓	✓	9
Imidacloprid 600 g/L	Gaucho® 600 Red – Bayer CropScience Senator® 600 RED– NuFarm	120–240 mL	5.98–11.95	✓	✓	9
Lambda-cyhalothrin 37.5 g/L +Thiamethoxam 210 g/L	Cruiser® Opti – Syngenta	165–330 mL	17.60–35.20	✓	–	8
Thiamethoxam 350 g/L	Cruiser® 350FS	100–200 mL	5.15–10.30	✓	✓	8

✓ Affords useful suppression in early crop growth stages.

❶ Prices quoted are GST inclusive at February 2023 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 92. Cereal foliar fungicides – 2023 currently registered products (NSW) – winter cereals (page 1 of 4).

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 ❶	Adjuvant (as per label)	Diseases controlled ❷										Registered for aerial application
	Product	Manu-facturer	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 625 g/L	Mirador® 625 (requires a fungicide mixing partner)	Adama Australia	3	Depends on fungicide mixing partner 0–6	$37.40 (only for MIrador®625 not mixing partners which are applied at label rates)	May be required for some diseases at lower rates. Refer to label.	65–250 mL (rate dependent on mixing partner. Refer to label) $2.67–10.29	65–250 mL (rate dependent on mixing partner. Refer to label) (wheat and oats) $2.67–10.29	65–250 mL (rate dependent on mixing partner. Refer to label) (wheat and barley) $2.67–10.29	65–250 mL (rate dependent on mixing partner. Refer to label) $2.67–10.29	65–250 mL (rate dependent on mixing partner. Refer to label) $2.67–10.29	65–250 mL (rate dependent on mixing partner. Refer to label) $2.67–10.29	65–250 mL (rate dependent on mixing partner. Refer to label) $2.67–10.29	65–250 mL (rate dependent on mixing partner. Refer to label) $2.67–10.29	65–250 mL (rate dependent on mixing partner. Refer to label) $2.67–10.29	65–250 mL (rate dependent on mixing partner. Refer to label) $2.67–10.29	Yes
Azoxystrobin 250 g/L	Accolade® (requires a fungicide mixing partner)	Sipcam	3	6	$36.19 (only for Accoloade not mixing partners which are applied at label rates)	May be required for some diseases at lower rates. Refer to label.	160–320 mL $5.79–11.58 + 430 g/L tebuconazole fungicide (wheat) or 320–640 mL $11.58–23.16 + 125g/L epoxiconazole (wheat)	160–320 mL $5.79–11.58 + 430 g/L tebuconazole fungicide (wheat)	160–320 mL $5.79–11.58 + 430 g/L tebuconazole fungicide (wheat) or 320–640 mL $11.58–23.16 + 125g/L epoxiconazole (wheat and barley)	–	160–320 mL $5.79–11.58 + 430 g/L tebuconazole fungicide (wheat)	160–320 mL $5.79–11.58 + 430 g/L tebuconazole fungicide (wheat) or 320–640 mL $11.58–23.16 + 125 g/L epoxiconazole (wheat)	160–320 mL $5.79–11.58 + 430 g/L tebuconazole fungicide (wheat)	160 mL $5.79 + 430 g/L tebuconazole fungicide or 320–640 mL $11.58–23.16 + 125 g/L epoxiconazole (barley)	320–640 mL $11.58–23.16 + 125 g/L epoxiconazole (barley) ❺	160–320 mL $5.79–11.58 + 430 g/L tebuconazole fungicide (barley) or 320–640 mL $11.58–23.16 + 125g/L epoxiconazole (wheat & barley)	Yes
Azoxystrobin 200 g/L + cyproconazole 80 g/L	Amistar® Xtra	Syngenta	3	6	$42.81	Barley – addition of Adigor® at 2% v/v improves disease control at lower rate.	400–800 mL (wheat) $17.12–34.25	400–800 mL (wheat) $17.12–34.25	400–800 mL (wheat) & 200–800 mL (barley) $8.56–34.25	400–800 mL (oats) $17.12–34.25	400–800 mL (wheat) $17.12–34.25	400–800 mL (wheat) $17.12–34.25	400–800 mL (wheat) $17.12–34.25	400–800 mL (barley) $17.12–34.25	200–800 mL (barley) $8.56–34.25	400–800 mL (wheat & barley) $17.12–34.25	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 Propiconazole and propiconazole + tebuconazole is registered for suppression of septoria leaf blotch in oats.
❹ Spot form of net blotch.
❺ Net form of net blotch only.
❻ Tazer®Expert™ is registered for control of septoria leaf blotch in oats.
❼ Registered for the control of fusarium head blight.
❽ Suppression only.
❾ Various formulations and active ingredient concentrations of propiconazole and tebuconazole are available.
❿ Do not mix leaves treated with this product with feed intended for animal consumption.
⓫ 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, can 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 92. Cereal foliar fungicides – 2023 currently registered products (NSW) – winter cereals. (Page 2 of 4)

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	Manu-facturer	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 80 g/L + epiconazole 31.25 g/L	Tazer® Xpert™ ❻	Nufarm	3		$31.04	Plus Banjo® 1% v/v for some diseases. Adding Banjo® may improve efficacy at lower rates. Refer to label.	1000–2000 mL (wheat) $31.04–62.07 or 500 mL + Banjo® at 1% v/v (wheat) $15.52	1000– 2000 mL (wheat & barley) $31.04–62.07 or 500 mL + Banjo® at 1% v/v (wheat & barley) $15.52 1000 mL (oats) $31.04 or 500 mL (oats) + Banjo® 1% at v/v $15.52	1000– 2000 mL (wheat & barley) $31.04–62.07 or 500 mL (wheat) 500–1000 mL (barley) + Banjo® 1% at v/v $15.52–31.04	–	1000 mL (wheat) $31.04 or 500 mL/ha + Banjo® at 1% v/v (wheat) $15.52	1000–2000 mL (wheat) $31.04–62.07	1000–2000 mL (wheat) $31.04–62.07	1000–2000 mL (barley) $31.04–62.07	1000–2000 mL (barley) $31.04–62.07 or 500–1000 mL + Banjo® 1% at v/v (barley) $15.52–31.04	1000–2000 mL (wheat & barley) $31.04–62.07 or 500–1000 mL + Banjo® 1% at v/v (barley only) $15.52–31.04	Yes
Azoxystrobin 75 g/L + epoxiconazole 75 g/L	Radial®	Adama Australia	3 + ESI	NR	$46.82	Can improve efficacy at lower rates for some diseases.	420–840 mL (wheat) $19.66–39.33	420–840 mL (wheat) $19.66–39.33	420–840 mL (wheat & barley) $19.66–39.33	–	420–840 mL (wheat) $19.66–39.33	420–840 mL (wheat) $19.66–39.33	420–840 mL (wheat) $19.66–39.33	420–840 mL (barley) $19.66–39.33	420–840 mL (barley) $19.66–39.33	420–840 mL (wheat & barley) $19.66–39.33	Yes
Azoxystrobin 120 g/L + tebuconazole 200 g/L	Veritas®	Adama Australia	3 +ESI	6	$33.43	–	315 mL or 630 mL (wheat) $10.53 or $21.06	315 mL or 630 mL (wheat) $10.53 or $21.06	315 mL or 630 mL (wheat & barley) $10.53 or $21.06	–	315 mL or 630 mL (wheat) $10.53 or $21.06	315 mL or 630 mL (wheat) $10.53 or $21.06	315 mL or 630 mL (wheat) $10.53 or $21.06	315 mL (barley) $10.53	315 mL or 630 mL (barley ❽) $10.53 or $21.06	315 mL or 630 mL (barley) $10.53 or $21.06	Yes
Azoxystrobin 222 g/L + tebuconazole 370 g/L	Veritas® Opti	Adama Australia	3 +ESI	6	$72.80	–	170 mL or 340 mL (wheat) $12.38 or $24.75	170 mL or 340 mL (wheat) $12.38 or $24.75	170 mL or 340 mL (wheat & barley) $12.38 or $24.75	–	170 mL or 340 mL (wheat) $12.38 or $24.75	170 mL or 340 mL (wheat) $12.38 or $24.75	170 mL or 340 mL (wheat) $12.38 or $24.75	170 mL (barley) $12.38	170 mL or 340 mL (barley ❽) $12.38 or $24.75	170 mL or 340 mL (barley) $12.38 or $24.75	Yes
Azoxystrobin 133 g/L + prothioconazole 100 g/L	Maxentis® EC	Adama Australia	3	5	$63.94	Can improve efficacy at lower rates for some diseases	300–600 mL (wheat) $19.18–38.36	300–600 mL (wheat & oats) $19.18–38.36	300–600 mL (wheat & barley) $19.18–38.36	300–600 mL (oats) $19.18–38.36	300–600 mL (wheat & oats) $19.18–38.36	300–600 mL (wheat) $19.18–38.36	300–600 mL (wheat) $19.18–38.36	300–600 mL (barley) $19.18–38.36	300–600 mL (barley) $19.18–38.36	300–600 mL (wheat & barley) $19.18–38.36	Yes
Benzovindiflupyr 40 g/L + propiconazole 250 g/L	Elatus® Ace	Syngenta	10 days	NR	$42.03	–	500 mL (wheat) $21.02	500 mL (wheat) $21.02	500 mL (wheat & barley) $21.02	–	500 mL (wheat) $21.02	–	500 mL (wheat) $21.02	500 mL (barley) $21.02	500 mL (barley) $21.02	500 mL (wheat & barley) $21.02	No
Epoxiconazole 125 g/L	Opus® 125	BASF	6 + ESI	6	$30.46	200 mL/100 L Chemwet may assist in certain conditions	250–500 mL (wheat) $7.62–15.23	–	500 mL (wheat) 250–500 mL (barley) $7.62–15.23	–	–	250 – 500 (wheat) $7.62–15.23	–	250 mL (barley) $7.62	250–500 mL (barley net form ❺) $7.62–15.23	250 mL (wheat & barley) $7.62	Yes

Table 92. Cereal foliar fungicides – 2023 currently registered products (NSW) – winter cereals. (Page 3 of 4)

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	Manu-facturer	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	
Flutriafol 250 g/L	Various	–	7-W 10-B	7-W 10-B	$13.20	200 mL/100 L BS1000®	250–500 mL (wheat) $3.30–6.60	–	250–500 mL (wheat) $3.30–6.60	–	250–500 mL (wheat) $3.30–6.60	250–500 mL (wheat) $3.30–6.60	–	–	–	250–500 mL (barley) $3.30–6.60	Yes
Flutriafol 500 g/L	Jubilee® Loaded	Adama Australia	7-W 10-B	7-W 10-B	$25.77	200 mL/100 L BS1000®	125–250 mL (wheat) $3.22–6.44	–	125–250 mL (wheat) $3.22–6.44	–	125–250 mL (wheat) $3.22–6.44	125–250 mL (wheat) $3.22–6.44	–	–	–	125–250 mL (barley) $3.22–6.44	Yes
Propiconazole 250 g/L ❾	Various	–	1	4	$21.62	Not required	250–500 mL (wheat) $5.40–10.81	500 mL (wheat & oats) $10.81	150–500 mL (wheat) $3.24–10.81	250–500 mL (oats) $5.40–10.81	250–500 mL (wheat & oats ❸) $5.40–10.81	150–500 mL (wheat) $3.24–10.81	250–500 mL (wheat) $5.40–10.81	500 mL (barley) $10.81	250–500 mL (barley) $5.40–10.81	150–500 mL (wheat & barley) $3.24–10.81	Yes
Propiconazole 435 g/L	PropiMax®	Corteva Agri-Science	1	4	$38.50	Not required	145 mL or 285 mL (wheat) $5.58 or $10.97	285 mL (wheat & oats) $10.97	85–285 mL (wheat) $3.27–10.97	145–285 mL (oats) $5.58–10.97	145–285 mL (wheat & oats ❸) $5.58–10.97	145–285 mL (wheat) $5.58–10.97	145–285 mL (wheat) $5.58–10.97	285 mL (barley) $10.97	285 mL (barley ❹) $10.97	85–285 mL (wheat & barley) $3.27–10.97	Yes
Propiconazole 500 g/L	Throttle®500	Nufarm	1	4	$41.31	Not required	125–250 mL (wheat) $5.16–10.33	250 mL (wheat & oats) $10.33	75–250 mL (wheat) 125–250 mL (barley) $3.10–10.33	125–250 mL (oats) $5.16–10.33	125–250 mL (wheat & oats ❸) $5.16–10.33	75–250 mL (wheat) $3.10–10.33	125–250 mL (wheat) $5.16–10.33	250 mL (barley) $10.33	125–250 mL (barley) $5.16–10.33	75–250 mL (wheat & barley) $3.10–10.33	Yes
Propiconazole 250 g/L + tebuconazole 250 g/L	Cogito®	Syngenta	2	5	$29.19	Not required	125 – 250 mL (wheat) $3.65–7.30	125–250 mL (wheat) 250 mL (oats) $3.65–7.30	125–250 mL (wheat & barley) $3.65–7.30	125–250 mL (oats) $3.65–7.30	125–250 mL (wheat & oats ❸) $3.65–7.30	125–250 mL (wheat) $3.65–7.30	125–250 mL (wheat) $3.65–7.30	250 mL (barley) $7.30	125–250 mL (barley) $3.65–7.30	125–250 mL (wheat & barley) $3.65–7.30	Yes
Prothioconazole 250 g/L	Proviso® ❼ (requires a fungicide mixing partner)	Adama Australia	2	5	$86.90	May improve efficacy for some diseases. Refer to label.	125–250 mL (rate dependent on mixing partner and disease pressure. Refer to label) $11.95–23.90	125–250 mL (rate dependent on mixing partner and disease pressure. Refer to label) (wheat and barley) $11.95–23.90	125–250 mL (rate dependent on mixing partner and disease pressure. Refer to label) $11.95–23.90	250 mL (+ ORIUS® at 145 mL) $23.90	125–250 mL (rate dependent on mixing partner and disease pressure. Refer to label) $11.95–23.90	125–250 mL (rate dependent on mixing partner and disease pressure. Refer to label) $11.95–23.90	125–250 mL (rate dependent on mixing partner and disease pressure. Refer to label) $11.95–23.90	125–250 mL (rate dependent on mixing partner and disease pressure. Refer to label) $11.95–23.90	125–250 mL (rate dependent on mixing partner and disease pressure. Refer to label) $11.95–23.90	125–250 mL (rate dependent on mixing partner and disease pressure. Refer to label) $11.95–23.90	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 Propiconazole and propiconazole + tebuconazole is registered for suppression of septoria leaf blotch in oats.
❹ Spot form of net blotch.
❺ Net form of net blotch only.
❻ Tazer®Expert™ is registered for control of septoria leaf blotch in oats.
❼ Registered for the control of fusarium head blight.
❽ Suppression only.
❾ Various formulations and active ingredient concentrations of propiconazole and tebuconazole are available.
❿ Do not mix leaves treated with this product with feed intended for animal consumption.
⓫ 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, can 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 92. Cereal foliar fungicides – 2023 currently registered products (NSW) – winter cereals. (Page 4 of 4)

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	Manu-facturer	Grazing	Harvest			Stripe rust	Stem rust	Leaf rust	Crown (leaf) rust	Septoria tritici blotch	Septoria nodorum blotch	Yellow spot	Barley scald	Net blotch	Powdery mildew	
Prothioconazole 150 g/L + bixafen 75 g/L	Aviator® Xpro®	Bayer CropScience	4	NR	$67.04		300–500 mL (wheat) $20.11–33.52		400–500 mL (barley) $26.82–33.52		300–500 mL (wheat) $20.11–33.52	300–500 mL (wheat) $20.11–33.52	300–500 mL (wheat) $20.11–33.52	300–500 mL (barley) $20.11–33.52	300–500 mL (barley) $20.11–33.52	300–500 mL (wheat & barley) $20.11–33.52	Yes
Prothioconazole 210 g/L + tebuconazole 210 g/L	Prosaro® 420 SC ❼	Bayer CropScience	2	5	$95.64	Various (adjuvants required for some diseases.) As per label directions	150–300 mL (wheat & triticale) $14.35–28.69	150–300 mL (wheat) 300 mL (oats) $14.35–28.69	150–300 mL (wheat & barley) $14.35–28.69	300 mL (oats) $28.69	–	150–300 mL (wheat, oats) $14.35–28.69	150–300 mL (wheat) $14.35–28.69	150–300 mL (barley) $14.35–28.69	150–300 mL (barley) $14.35–28.69	150–300 mL (wheat & barley) $14.35–28.69	Yes
Pyraclostrobin 85 g/L + epoxiconazole 62.5 g/L	Opera®	BASF	3 + ESI	NR	$37.83	Non-ionic surfactant may assist in improving coverage	500 mL (wheat) $18.92	500 mL (wheat) $18.92	500–1000 mL (wheat) 500 mL (barley) $18.92–37.83	–	500 mL (oats) $18.92	500 mL (wheat) $18.92	–	500 mL (barley) $18.92	500–1000 mL (barley) $18.92–37.83	500 mL (wheat) 500–1000 mL (barley) $18.92–37.83	Yes
Tebuconazole 430 g/L ❾	Various	–	2	5	$21.19	Adding mineral crop oil at 1% may improve performance	145 or 290 mL (wheat) $3.07 or $6.15	145 or 290 mL (wheat & oats) $3.07 or 6.15	145 or 290 mL (wheat) $3.07 or 6.15	145 or 290 mL (oats) $3.07 or $6.15	290 mL (wheat) $6.15	145 or 290 mL (wheat) $3.07 or $6.15	145 or 290 mL (wheat) $3.07 or $6.15	145 mL (barley) $3.07	–	145 or 290 mL (barley) $3.07 or 6.15	Yes
Tebuconazole 45 g/kg + sulfur 700 g/kg	Unicorn 745 WG	Sulphur Mills Aust. Limited	2	5	–	–	1370 g or 2750 g (wheat)	1370 g or 2750 g (wheat & oats)	1370 g or 2750 g (wheat)	1370 g or 2750 g (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 EC	FMC	Not stated, see foot-note ⓫	4	$8.20	Not required	500 mL or 1000 mL (wheat) $4.10–8.20	–	–	–	–	–	–	1000 mL (barley) $8.20	–	1000 mL (barley) $8.20	Yes
Triadimefon 500 g/kg	Triadimefon 500 WG	FMC	Not stated ❿	4	$32.06	Not required	125–250 g (wheat) $4.01–8.01	–	125–250 g (wheat) $4.01–8.01	–	125–250 g (wheat – southern NSW only) $4.01–8.01	–	–	–	–	250 g (barley) $8.01	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 Propiconazole and propiconazole + tebuconazole is registered for suppression of septoria leaf blotch in oats.
❹ Spot form of net blotch.
❺ Net form of net blotch only.
❻ Tazer®Expert™ is registered for control of septoria leaf blotch in oats.
❼ Registered for the control of fusarium head blight.
❽ Suppression only.
❾ Various formulations and active ingredient concentrations of propiconazole and tebuconazole are available.
❿ Do not mix leaves treated with this product with feed intended for animal consumption.
⓫ 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, can 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 93. Canola and pulse seed dressings – 2023. (Page 1 of 2)

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 ($) ❷	Canola	Chickpea	Field pea	Faba bean	Lentil	Lupin	WHP weeks grazing
Thiragranz ❶ – Nufarm	thiram (800 g/kg)	150 g	2.25	–	Seed-borne botrytis, seed-borne ascochyta blight	–	–	–	–	–
		125–150 g	1.85-2.25	–	–	–	–	–	Seed-borne anthracnose	–
Gaucho® 600 Red Flowable – Bayer CropScience	imidacloprid (600 g/L)	400 mL	20.45	Redlegged earth mite, blue oat mite, aphids	–	–	–	–	–	6
		300 mL	15.35	–	–	–	–	–	Redlegged earth mite, blue oat mite	16
		240 mL	12.30	–	–	–	–	Aphids		
		120 mL	6.15	–	–	–	Aphids	–	–	
		60 mL	3.05	–	–	Aphids	–	–	–	
Cosmos® – BASF	fipronil (500 g/L)	400 mL	291.90	Redlegged earth mite	–	–	–	–	–	9
Cruiser® Opti – Syngenta	thiamethoxam (210 g/L) + lambda-cyhalothrin (37.5 g/L)	500–1000 mL	55.35–110.70	Green peach and grey cabbage aphid	–	–	–	–	–	6
		1000 mL	110.70	Suppression of: redlegged earth mite, lucerne flea	–	–	–	–	–	6
Jockey® Stayer® – Bayer CropScience	fluquinconazole (167 g/L)	2 L	147.90	Blackleg (suppression)	–	–	–	–	–	8
Apron® XL 350 ES – Syngenta	metalaxyl-M (350 g/L)	75 mL	37.55	–	Phytophthora root rot	Damping-off, downy mildew	–	–	–	–
Maxim® XL – Syngenta	fludioxonil (25 g/L) + metalaxyl-M (10 g/L)	200–400 mL	87.90–175.80	Damping-off (*Pythium* spp.), *Rhizoctonia solani*	–	–	–	–	–	6
		400 mL	175.80	Seedling blackleg suppression						
P-Pickel T® – Nufarm	thiram (360 g/L) + thiabendazole (200 g/L)	200 mL	7.75	–	Seed-borne 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.)	–	–	–

❶ Wettable granule formulation.
❷ Prices quoted are GST Inclusive at 31 January 2023 and approximate only. Prices will vary depending on pack size purchased, seed treatment services and special marketing arrangements.

Table 93. Canola and pulse seed dressings – 2023. (Page 2 of 2)

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 ($) ❷	Canola	Chickpea	Field pea	Faba bean	Lentil	Lupin	WHP weeks grazing
Poncho® Plus – BASF	clothianidin (360 g/L) + imidacloprid (240 g/L)	500 mL	144.35	Wireworm, cutworm, aphids, redlegged earth mite, blue oat mite, lucerne flea (suppression)	–	–	–	–	–	8
Saltro® Duo – Syngenta	pydiflumetofen (200 g/L) +(fludioxonil 25 g/L + metalaxyl-M 10 g/L)	200 mL Saltro + 200 mL Maxim-L	221.95	Seedling blackleg, Damping-off and root rot (*Pythium* spp. and *Rhizoctonia solani*)	–	–	–	–	–	8
ILeVO® – BASF	fluopyram (380 g/L)	800 mL	224.50	Seedling blackleg (suppression)	–	–	–	–	–	8
Thiram 600 Flowable Fungicide – Nufarm	thiram (600 g/L)	200 mL	3.00	–	Damping-off (*Pythium* spp.), seed-borne botrytis and ascochyta blight	–	–	–	–	–
		170–200 mL	2.55–3.00	–	–	–	–	–	Seed-borne anthracnose	–
Rovral® Liquid Seed Dressing – FMC	iprodione (250 g/L)	100–500 mL	4.75–23.75	–	–	–	–	–	Brown leaf spot	–
In furrow treatments		**Rate per hectare**	**Cost per hectare ($)**							
Intake® Hiload gold – Nufarm	flutriafol (500 g/L)	200–400 mL	8.45–16.90	Blackleg	–	–	–	–	–	4

❶ Wettable granule formulation.
❷ Prices quoted are GST Inclusive at 31 January 2023 and approximate only. Prices will vary depending on pack size purchased, seed treatment services and special marketing arrangements.

Table 94. Canola and pulse foliar fungicides – 2023. (Page 1 of 3)

Example foliar fungicide trade name and manufacturer	Active ingredient	Withholding period (WHP) – /days		Rate to apply per hectare (L/ha or kg/ha)	Cost of product per hectare ($)❼	Canola	Chickpea	Field pea	Faba bean	Lentil	Lupin
		Harvest	Grazing								
Spin Flo® – Nufarm	carbendazim (500 g/L) ❶	28 days	28 days	500 mL	7.05	–	Botrytis grey mould	–	Chocolate spot	Botrytis grey mould	–
Bravo® Weather Stik – Syngenta	chlorothalonil (720 g/L)	14 days	14 days	1.4–2.3 L	27.10–44.55	–	–	–	Chocolate spot, rust	–	–
				1.0–2.0 L	19.35–38.70	–	Ascochyta blight	–	–	Ascochyta blight, botrytis grey mould	–
				1.5 L	29.05	–	–	–	–	–	Anthracnose (PER82209, expiry 30/06/26)
Echo® 900 Fungicide – Sipcam	chlorothalonil (900 g/kg)	14 days	14 days ❸	1.2–1.9 kg	19.55–30.95	–	–	–	Chocolate spot, rust	–	–
				0.8–1.6 kg	13.00–26.00	–	Ascochyta blight	–	–	Ascochyta blight, botrytis grey mould	–
				1.1 kg	17.90	–	–	–	–	–	Anthracnose (PER82209, expiry 30/11/26)
Rovral® Liquid – FMC	iprodione (250 g/L)	42 days	42 days	2.0 L	87.00	Sclerotinia stem rot	–	–	–	–	–
Dithane® Rainshield® Neo Tec® – Corteva Agriscience	mancozeb (750 g/kg)	28 days	14 days	1.0–2.2 kg	13.85–30.50	–	Ascochyta blight, botrytis grey mould	Ascochyta blight, black spot, botrytis grey mould, rust	Ascochyta blight, chocolate spot, *Cercospora*, rust	Ascochyta blight, botrytis grey mould	Anthracnose, botrytis grey mould
Sumisclex® 500 – Sumitomo	procymidone (500 g/L) ❷	Not required	63 days	1.0 L	21.10	Sclerotinia stem rot	–	–	–	–	–
		9 days	Not stated	0.5 L	9.55	–	–	–	Chocolate spot	Botrytis grey mould	–
Prosaro® 420 SC – Bayer	prothioconazole (210 g/L) + tebuconazole (210 g/L)	Not required	14 days	375–450 mL	35.75–42.95	Blackleg, sclerotinia stem rot	–	–	–	–	–

❶ Health warnings are in place for potential effects on male fertility.
❷ Health warnings are in place for women of child-bearing age.
❸ Do not feed to livestock producing milk for human consumption.
❹ Rate when combined with use of a seed treatment or in-furrow fungicide treatment.
❺ Price includes the prescribed tank-mix partner herbicide
❻ The grazing withholding period for lupin is 35 days, as per the other pulses
❼ Prices quoted are GST Inclusive at 31 January 2023 and approximate only. Prices will vary depending on pack size purchased.

Table 94. Canola and pulse foliar fungicides – 2023 (page 2 of 3).

Example foliar fungicide trade name and manufacturer	Active ingredient	Withholding period (WHP) – /days		Rate to apply per hectare (L/ha or kg/ha)	Cost of product per hectare ($)[7]	Canola	Chickpea	Field pea	Faba bean	Lentil	Lupin
		Harvest	Grazing								
Aviator® Xpro® – Bayer	prothioconazole (150 g/L) + bixafen (75 g/L)	Not required	28 days	550–650 mL	36.75–43.40	Blackleg	–	–	–	–	–
				650 mL	43.40	Blackleg Upper canopy infection	–	–	–	–	–
				550–800 mL	36.75–53.45	Sclerotinia stem rot	–	–	–	–	Sclerotinia stem rot (PER91123, expiry 31/10/24)[6]
				650 mL	43.40	Alternaria blackspot. Suppression of pod infection; Powdery mildew suppression.	–	–	–	–	–
			35 days	400–600 mL	26.70–40.05	–	Ascochyta blight	–	Ascochyta blight, *Cercospora*	Ascochyta blight, botrytis grey mould	–
				600 mL	40.05	–	–	Black spot complex	Chocolate spot, rust	–	–
Miravis® Star – Syngenta	fludioxonil (150 g/L) + pydiflumetofen (100 g/L)	Not required	42 days	600–900 mL[4]	38.95–58.45	Blackleg, white leaf spot	–	–	–	–	–
				900–1000 mL	58.45–64.90	Upper canopy blackleg	–	–	–	–	–
				750–1000 mL	48.70–64.90	Sclerotinia stem rot	–	–	–	–	–
				250–500 mL	16.25–32.45	–	Ascochyta blight	Ascochyta blight	Ascochyta blight	Ascochyta blight	–
				750–1000 mL	48.70–64.90	–	Botrytis rot	Botrytis rot	Botrytis rot, chocolate spot, cercospora leaf spot	Sclerotinia stem rot, botrytis grey mould, chocolate spot	Sclerotinia stem rot
Mirador® 625 – Adama	azoxystrobin (625 g/L)	Not required	14 days	160–190 mL in a tank mix with 300–360 mL Proviso®	32.05–38.40[5]	Blackleg seedling and upper canopy infections, sclerotinia stem rot	–	–	–	–	–
		Not required	28 days	150–190 mL in a tank mix with 350–460 mL Orius® 430 SC	14.90–19.30[5]	–	Botrytis grey mould, ascochyta blight	Botrytis grey mould, black spot	Botrytis grey mould, ascochyta blight, chocolate spot	Botrytis grey mould, ascochyta blight, chocolate spot	Botrytis grey mould,
Proviso® – Adama	prothioconazole (250 g/L)	Not required	14 days	320–380 mL in a tank mix with 400 mL Veritas®	41.20–46.40[5]	Blackleg seedling infections; upper canopy blackleg (suppression only), sclerotinia stem rot	–	–	–	–	–

Table 94. Canola and pulse foliar fungicides – 2023 (page 3 of 3).

Example foliar fungicide trade name and manufacturer	Active ingredient	Withholding period (WHP) – /days		Rate to apply per hectare (L/ha or kg/ha)	Cost of product per hectare ($)❼	Canola	Chickpea	Field pea	Faba bean	Lentil	Lupin
		Harvest	Grazing								
Amistar® Xtra – Syngenta	azoxystrobin (200 g/L) + cyproconazole (80 g/L)	56 days	28 days	400–800 mL	17.10–34.25	–	Ascochyta blight, botrytis grey mould	Ascochyta blight, botrytis grey mould	Ascochyta blight, botrytis grey mould, cercospora leaf spot, rust, chocolate spot (suppression)	–	–
				400–600 mL	17.10–25.70	–	–	–	–	Ascochyta blight, botrytis grey mould	–
Maxentis® EC – Adama	azoxystrobin (133 g/L) + prothioconazole (100 g/L)	Not required	14 days	750–900 mL	48.50–58.20	Blackleg, including upper canopy infection, sclerotinia stem rot	–	–	–	–	–
Orius® 430 SC – Adama	tebuconazole (430 g/L)	21 days	14 days	145 mL	3.85	–	–	–	*Cercospora*, rust	–	–
Veritas® Opti – Adama	tebuconazole (370 g/L) + azoxystrobin (222 g/L)	Not required	14 days	540 mL	39.75	Blackleg-vegetative and upper canopy, sclerotinia stem rot	–	–	–	–	–
		28 days	28 days	400–540 mL	29.45–39.75	–	Botrytis grey mould, ascochyta blight	Botrytis grey mould, black spot	Botrytis grey mould, ascochyta blight, chocolate spot	Botrytis grey mould, ascochyta blight, chocolate spot	Botrytis grey mould
				160 mL	11.80	–	–	–	*Cercospora*, rust	–	–

❶ Health warnings are in place for potential effects on male fertility.
❷ Health warnings are in place for women of child-bearing age.
❸ Do not feed to livestock producing milk for human consumption.
❹ Rate when combined with use of a seed treatment or in-furrow fungicide treatment.
❺ Price includes the prescribed tank-mix partner herbicide
❻ The grazing withholding period for lupin is 35 days, as per the other pulses
❼ Prices quoted are GST Inclusive at 31 January 2023 and approximate only. Prices will vary depending on pack size purchased.

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