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2024
Western Australian Crop Sowing Guide

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2024 Western Australian Crop Sowing Guide

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Photo: Georgia Trainor, InterGrain

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Remember to update it each October.

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The majority of the varieties mentioned in this guide are protected by Plant Breeder's Rights where the variety name is followed by the symbol ⓑ, however this symbol has been omitted in this bulletin.

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Interpreting resistance classifications

Below is an explanation of the resistance ratings used in this guide for foliar diseases, nematodes and crown rot and how they should be interpreted. These classifications are only a guide and yield losses will depend on environmental and seasonal conditions. Regional and national differences in disease resistance may also occur for different pathotypes.

Cereal resistance classifications (foliar diseases)

R **Resistant:** the disease will not multiply or cause any damage.

MR **Moderately resistant:** the disease may be visible and will multiply slightly but will not cause significant yield loss.

MS **Moderately susceptible:** the disease may cause yield losses up to 15% or more in very severe cases.

S **Susceptible:** the disease can be severe and yield losses of 15 to 50% can occur.

VS **Very susceptible:** the variety should not be grown in areas where a disease is likely to be a problem. Yield losses higher than 50% are possible and the build-up of inoculum will create problems for other growers.

Pulse resistance classifications (foliar diseases)

No pulse varieties are immune to disease and fungicide application may therefore be required under severe disease pressure.

R **Resistant:** no symptoms visible, no fungicides are required.

MR **Moderately resistant:** the disease may be visible but will not cause significant plant damage or loss. However, under high disease pressure or highly favourable environmental conditions fungicide applications may be required e.g. to prevent seed staining.

MS **Moderately susceptible:** disease symptoms are moderate to severe and will cause significant yield and seed quality loss (but not complete crop loss) in conducive seasons in the absence of fungicides.

S **Susceptible**: the disease is severe and in conducive conditions will cause significant yield and seed quality loss, including complete crop loss in the absence of fungicides.

VS **Very susceptible:** growing very susceptible varieties in areas where a disease is likely to be present is very high risk. Without control significant yield and seed quality losses, including complete crop loss, can be expected and the increase in inoculum may create problems for other growers.

Nematode resistance classifications

PLEASE NOTE: *Pratylenchus neglectus* resistance ratings for all pulses and varieties of wheat released since 2018 have not been tested in Western Australia and should be used as a guide only. Resistance ratings for *P. quasitereoides* are from trials conducted in WA.

R **Resistant:** nematode numbers will decrease when resistant varieties are grown.

MR **Moderately resistant:** nematode numbers are expected to decrease slightly in most seasons when moderately resistant varieties are grown.

MS **Moderately susceptible:** nematode numbers are expected to increase slightly in most seasons when moderately susceptible varieties are grown.

S **Susceptible:** nematode numbers will increase when susceptible varieties are grown.

VS **Very susceptible:** a large increase in nematode numbers can occur when very susceptible varieties are grown.

Colour range

Introduction

Welcome to the 2024 edition of the Western Australian Crop Sowing Guide, which introduces 19 new variety releases: six wheat, one barley (seven in total are currently under malt evaluation), 10 canola and two lupin varieties.

The 2024 Western Australian Crop Sowing Guide has been compiled by officers in the Department of Primary Industries and Regional Development. It provides information to support variety decisions for each of the major crops for the upcoming season.

The canola NVT series are now identified by GRDC/NVT as 'Low-Med Rainfall' and 'Med–High Rainfall' to reflect the environments where the trials are located. Previously these were the 'Early' and 'Mid' trial series, respectively. In 2021, the lupin agzones were reduced from eight agzones to six so that each of the major crops grown in WA are evaluated using the same environmental regions. Refer to page 100 for canola NVT trial locations or the back cover page for details of agzones for all other crop types.

Herbicide mode-of-action classifications have been updated internationally to capture new active constituents and to ensure the system is globally relevant. While the science has not changed – the classification codes on product labels and literature currently used in Australia have changed from a letter to a number. The pulse section includes an 'agronomy guide' that covers herbicide options for these crops (with both the new numerical codes and old letter codes provided). Please consult your agronomist for more specific pulse information for your local area.

It is good news for all Australian barley growers that China has removed anti-dumping and countervailing duty measures that have been imposed on Australian barley since 2020. However as Australian barley grain can now start flowing into China, there will be disruptions again to international trade flows. There is also a demand steadily rising for Australian feed barley. To help with barley decisions, market feedback from GIWA can be found on pages 61–63 of this guide. Before making a barley variety choice, it is important to consider market demand, pricing signals, location of segregation sites and the risk associated with delivering malt-grade barley.

Frost can have a devastating effect on crop yield, and matching variety maturity with sowing time remains the most reliable way of reducing yield losses. The relative maturities of wheat, barley and oat varieties are provided in their respective sections of this guide to help match sowing opportunities with the best variety.

Flower power is also a useful tool to match the predicted flowering times of wheat, barley and oats with sowing date in your area (https://fp.dpird.app). No wheat or barley variety is tolerant to frost, and other crops vary in their susceptibility. Strategies for managing frost are available on the GRDC and DPIRD websites.

Additional information to support crop variety decisions are listed in each section. Advisers can provide locally relevant information and growers are encouraged to use this publication as a guide to support discussions with consultants, agronomists and marketing agents.

It is important for growers and consultants to review disease resistance ratings in autumn 2024 to confirm variety resistance ratings for new varieties and any changes to existing varieties. The latest NVT data will be available early in 2024 via the NVT website and the Long Term MET Yield Reporter tool.

Wheat

Introduction

Brenda Shackley and Dion Nicol (DPIRD)

Following a well above-average wheat crop of 12.9 million tonnes in 2021, Western Australian growers produced the State's largest ever wheat crop of 13.9 million tonnes in 2022 (Source: GIWA crop estimates). Growers responded to the favourable season by sowing early, increasing sowing area and using best practice to manage for nitrogen and disease despite the constraints and input costs of 2022.

The WA wheat industry is supported by significant private and public R&D that underpins decisions on variety selection and management. This guide summarises the yield performance, disease ratings and best practice agronomy of varieties in the GRDC National Variety Trials (NVT) and DPIRD agronomy research trials. Variety snapshots for twenty of the most common and recently released wheat varieties can be found at the back of the guide.

Scepter accounted for 50% of the area sown to wheat in 2023, making it the most popular variety grown in WA. As such, it is used as the comparison variety for yield (in the variety snapshots) and days-to-flowering data (Table 13). Diversifying from Scepter will be driven by yield advantages, which are typically driven by phenology or maturity. Other driving factors to make a variety change include disease resistance, weed control options (primarily tolerance to imidazolinone) and the potential for premium prices, such as noodle wheats.

Environmental conditions are a major driver of crop performance, making it important to review variety performance over multiple years to better understand how a variety in a specific environment might perform across variable seasons. For example, the wetter season and soft/late finish experienced in 2022 improved the relative performance of the mid-slow maturing varieties. Varietal differences can also be used to mitigate the risk of frost or terminal drought by matching the maturity rating of a variety with its optimum sowing time (and likely germination). Finally, it is important to be aware of whether a variety can access specific quality segregations and the value of the segregation for the season.

A new variety should therefore provide:

- an improvement in yield, grain quality and/or disease traits
- diversity or risk mitigation within a farming system
- suitable characteristics for current markets.

New in 2024

Mowhawk (LPB19-14343) was released by LongReach at the start of 2023. It is a quick winter AH variety that fits between Longsword and Illabo in maturity and is the first winter type to be bred in WA with a Scepter background. Mowhawk was included in the early season NVT for the first time in 2022 where it yielded 10% higher than the current benchmark winter variety Illabo. Mowhawk has an excellent disease package with an improved leaf rust rating of MR*p* compared to Illabo rated as S.

Tomahawk CL Plus (RAC3261) is an APW variety released by AGT in 2023. It is closely related to Scepter with similar maturity and other characteristics, but also provides the option to apply Intervix® in-crop or to manage imidazolinone herbicide soil residues from previous crops. Tomahawk CL Plus was included in the WA NVT for the first time in 2022 where it yielded slightly higher than Scepter and significantly higher than other Clearfield® varieties currently grown in WA. AGT suggest that in the longer term yields will be similar to Scepter. At this stage Tomahawk CL Plus is rated S*p* for leaf rust compared to Scepter at MSS.

Note: There are no grower-to-grower sales permitted for any CL Plus varieties.

Thumper (IGW6884) is an APW (potential AH) wheat variety released by InterGrain in 2023. Thumper has only been included in the WA NVT for the first time in 2023 so information is restricted to InterGrain data at the time of publication. Thumper is thought to have a quick-mid maturity, similar to Devil, with a higher yield than Devil, Scepter and Calibre. Disease rating of Thumper will be confirmed by GRDC and DPIRD in 2024.

Dozer (IGW6783) was released by InterGrain in 2023 as a quick to mid maturing APW wheat with tolerance to imidazolinone herbicide. It was included in selected WA NVT in 2021 and later in the 2023 WA NVT. InterGrain data suggests Dozer yielded 5% higher than Hammer CL Plus. Provisional disease ratings for Dozer are MS*p* for stem rust, MRMS*p* for stripe rust, S*p* for leaf rust and MS*p* for yellow spot.

Note: There are no grower-to-grower sales permitted for any imidazolinone tolerant varieties.

Firefly (IGW8192) is a next generation noodle wheat (ANW) from InterGrain. Firefly was included in the 2021 and 2023 WA NVT, with InterGrain data indicating yield was 11% higher than Zen. Firefly maturity is mid-slow, similar to Zen. Provisional disease ratings are S*p* for stem rust, MSS*p* for stripe rust, MSS*p* for leaf rust and MRMS*p* for yellow spot.

Genie (IGW6754) was released by InterGrain in 2023 primarily for the high yielding environments of WA such as the medium to high rainfall regions and the South Coast. Genie is an AH, mid to slow maturity, similar to RockStar. Genie has only been included in the WA NVT since 2023 so information is restricted to InterGrain data at the time of publication. InterGrain data indicates that Genie yields are similar to RockStar in environments yielding above 3t/ha. Disease ratings are to be confirmed by GRDC and DPIRD in 2024.

Variety classification

Source: Wheat Quality Australia

Removal of varieties: Wheat Quality Australia (WQA) rationalise the *Wheat Variety Master List* with annual reviews of varieties that are more than ten years old and which have accounted for less than 0.1% of deliveries over the previous four seasons. In 2024, several old favourites will be removed including Carnamah, Stiletto, Spear and Halberd. The soft-wheat varieties EGA2248 and Bullaring will also be removed from the list in 2024 and 2025 respectively, due to inadequate plantings.

In attempts to improve wheat quality exports of udon noodle to Japan, Calingiri is now only received as a feed grade wheat in WA.

Australian Premium White Noodle (APWN) is a quality class created to allow varietal control of the hard wheat component of export blends with Australian Standard Noodle Wheat (ANW) and to optimise end-use quality for the premium Japanese udon noodle market. APWN classification has been determined for the following AH and APW varieties: Chief CL Plus, Cutlass, Devil, EGA Bonnie Rock, Hammer CL Plus, King Rock, LRPB Avenger, LRPB Havoc, LRPB Trojan, LRPB Scout, Mace, RockStar, Sheriff CL Plus, Vixen, Westonia and Wyalkatchem.

New classifications:

Australian White Wheat (AWW) is a new general-purpose milling wheat class suitable for the instant noodle and general-purpose flour markets. AWW meets the increasing market demand for general-purpose wheat with less complex qualities than existing classes. The AWW class will allow breeders to focus more on yield traits and less on quality attributes, which will enable faster breeding cycles within breeding programs. AWW was included in the 2021 classification guidelines and Longsword (a quick winter) is the first variety to be classified for this class in 2022. However, it is uncertain when segregations/delivery locations will be offered.

CBH has created a new wheat grade in WA called **AWW2** as a trial for the 2023–24 harvest. This new grade will replace:

- ASW1 (the milling grade that previously took protein below 9.0% – note that ASW9 takes protein >9%, see below)
- AGP1
- Fed1 (if falling number is an issue this may be open for the season)
- AUN1 (if falling number is an issue this may be open for the season).

The trial AWW2 wheat grade has been introduced to simplify the CBH wheat segregation process, which should in turn deliver supply chain efficiencies and better meet market demand for feed-specification grain.

Australian Standard White Wheat 9 (ASW9) was introduced in a statewide trial by CBH in 2022. Hard-grained wheats such as ASW with a protein concentration below 9% typically have very limited functional value and are typically sold to feed wheat markets. To ensure milling quality, ASW >9% protein was segregated from ASW <9% protein. From the 2024–25 season onwards, ASW9 (protein >9.0%) will become a national grade.

What variety should I grow?

Scepter dominates the WA wheat planting area, accounting for half of all hectares sown and superseding Mace, which continues to decline in acreage (Table 1). The area planned for sowing in 2023 was not available at the time of publication, but it is anticipated that Vixen and Calibre will increase at the expense of Scepter. The total area sown to IMI tolerant wheat is expected to remain static at about 10% in 2023. About 300,000 hectares of wheat are still being sown to varieties that have been superseded for yield, disease and quality attributes. These varieties include Mace, Yitpi and Magenta several other less popular varieties that together account for 10% of WA's wheat area. In some cases, these long-retained varieties are slower maturity types that are being retained to take advantage of earlier sowing opportunities. In recent years, there has been a significant yield improvement in varieties within the mid-slow maturity class and growers are encouraged to compare the performance of these varieties and consider their uptake.

Table 1. Proportion (%) of total area sown to individual wheat varieties in WA (2018–2022)

Variety	2018	2019	2020	2021	2022
Scepter	37.8	52.4	53.2	51.3	50.1
Vixen	-	0.0	0.2	3.4	9.1
Chief CL Plus	1.0	4.9	6.3	9.0	6.5
Devil	-	0.3	2.6	4.5	5.0
RockStar	-	-	-	1.7	4.4
Ninja	3.0	5.1	5.2	4.5	4.4
Zen	6.0	4.0	5.0	4.6	4.0
Mace	31.0	17.0	12.0	7.1	3.8
LRPB Havoc	0.0	1.0	3.0	5.0	3.4
Hammer CL Plus	-	-	-	0.1	2.2
Kinsei	-	0.0	0.3	0.7	1.0
Yitpi	1.5	1.1	1.2	0.9	0.6
Catapult	-	-	-	0.3	0.6
Illabo	-	0.1	0.3	0.8	0.6
Magenta	3.0	2.0	1.4	0.8	0.6
Cutlass	0.4	0.8	0.9	0.5	0.5
Corack	1.8	1.7	1.1	0.9	0.4
Sting	-	-	-	0.1	0.4
Denison	-	-	-	0.0	0.3
Machete	0.1	0.5	0.4	0.4	0.3
Calingiri	6.0	3.0	3.0	1.0	0.3
Calibre	-	-	-	-	0.3

Source: Grower estimates provided to CBH for 2018–2022. Varieties with less than 0.2% of total crop area in 2022 season are not included.

While many farming operations seek to limit the number of varieties on-farm, it is important to consider the opportunities that a diverse range of varieties can provide, particularly when matched with appropriate management. Several traits differ between well-adapted varieties and when these are used correctly, they can increase production and/or reduce risk. For example:

- selecting varieties of slower or quicker maturity to optimise yield potential across a range of sowing time opportunities and frost risk profiles.
- selecting varieties with improved or diverse disease resistance ratings to reduce disease risk.
- growing varieties of multiple quality grades to respond to different pricing signals.

In addition to diversification within the wheat program, diversification of crop types can also reduce risk and improve overall productivity.

When selecting wheat varieties, it is important to consider:

- yield performance in a specific environment over multiple seasons
- matching variety maturity to a targeted sowing time
- varietal herbicide tolerance and weed control options
- varietal disease resistance ratings, particularly for prevalent diseases. **Please note** that due to the incursion of new strains and mutations of pathogens already present in WA, it is essential to review disease ratings of existing varieties each year as these can change.
- susceptibility to pre-harvest sprouting (presented as falling number index ratings) and blackpoint, particularly if sowing into April or early May where the risk is higher.

Tables 2 to 5 compare current and new wheat varieties with WA's most popular variety Scepter. Agronomic characteristics and disease traits will vary in priority depending on the pressures present in the target environment and farming system. In Tables 2 to 5, the statewide MET yield (presented as a percentage of site mean) is combined across the six Agzones and a five-year weighted average has been calculated from the MET data. Caution should be exercised when examining the weighted average as it can mask important variety-by-environment interactions (i.e. how variety performance changes under different environmental conditions). Refer to Tables 6 to 11 for a more precise estimate of variety performance in specific regions for NVT main season sowings.

Early season or late April sowing performances are provided in the section 'Early season NVT' and in Tables 14 to 16.

AH and APW quick-mid season varieties

In 2023, there are three quick-mid maturity releases, Thumper (IGW6884) and the two imidazolinone (IMI) herbicide tolerant varieties Tomahawk CL Plus (RAC3261) and Dozer (IGW6783). More detail for the two CL Plus varieties is provided in the 'CL Plus' section, pages 11 and 12.

Growers continue to have a wide range of wheat varieties to choose from for May and June sowing times. It is important to take advantage of varietal tolerances to herbicide and disease and to adopt varieties with a range of maturity lengths to allow for a diversity of sowing and germination opportunities.

Scepter remains a strong overall package for sowing in May, achieving consistently high yields and having relatively good disease and pre-harvest sprouting resistance (see Tables 2, 18 and 20). However as indicated in Table 2, Vixen, Calibre and Devil may have a slight yield advantage over Scepter, depending on the environment. The yield advantage of Vixen and Calibre is more evident in Agzones 4 and 5 (Tables 9 and 10) and to a lesser extent in Agzones 1 and 2 (Tables 6 and 7). Devil has a yield advantage over Scepter in Agzones 3 and 6, but is more susceptible to preharvest sprouting which is likely to be a higher risk factor in these Agzones.

Table 2. Relative performance of top-yielding quick and quick-mid maturity wheat varieties compared to Scepter

	Scepter	Vixen	Calibre	Devil	Tomahawk CL Plus	Sting	Thumper	LRPB Havoc
Statewide MET yield (% site mean)[1]	109%	111%	111%	110%	110%^	109%	2023 1st year in NVT	106%
Maturity	Quick-mid	Quick	Quick-mid	Quick-mid	Quick-mid	Quick	Quick-mid	Quick-mid
Classification	AH	AH (N)	AH	AH(N)	APW	AH	APW	AH(N)
Falling no. index	5	3	6*p*	3	-	4*p*	-	3
Stem rust	MRMS	MRMS	MR	S	MR*p*	MRMS	-	S
Stripe rust	RMR	MRMS	RMR	MR	RMR*p*	MR	-	MR
Leaf rust	MSS	SVS	S	SVS	S*p*	SVS	-	S
Powdery mildew	S	SVS	MSS	S	-	S	-	MSS
Yellow spot	MRMS	MRMS	MRMS	MRMS	MRMS*p*	MRMS	-	MRMS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2018–2022). Readers are directed to Tables 6 to 11 for a more precise estimate of variety performance in their region. (N) = supplementary classification of APWN. *Refer to page 4 for interpreting resistance classification. p* = provisional rating. ^ = single year of NVT data in 2022. Falling no. index please refer to page 35.

Thumper has been in the NVT since 2023, with InterGrain data indicating it is higher yielding than Devil, Scepter and Calibre. However, it will be important to revise yield data on this variety when the 2023 NVT becomes available in early 2024.

Calibre and Tomahawk CL Plus offer an improved stem rust rating in the quick- to mid-season maturity group. All varieties competing in this maturity class are MRMS for yellow spot and most are SVS or S to powdery mildew and the new strain of leaf rust. The exceptions are Scepter with MSS for leaf rust and Calibre and LRBP Havoc with MSS for powdery mildew (Table 2). Brumby, the quickest of the mid-slow maturity group, has a disease rating of R, making it the highest of all main season varieties (Tables 4 and 18).

Quick maturity wheats have often been seen as a way to avoid drought stress, particularly when sowing late. However, they make up only a small component of the WA crop primarily because quick-mid maturity varieties like Scepter yield similarly in seasons with later emergence and the quick maturity wheats have not performed well in seasons with an early germination or later rainfall distribution.

Vixen has quick maturity and offers an alternative variety in this group. In 2022, Vixen sown in mid to late May flowered, on average, eight days before Scepter (ranging from -4 to -12 days, Table 13). Vixen is currently one of the highest yielding varieties, as mentioned above, and is likely to be the preferred option when choosing a quick season wheat. Although Vixen is very competitive, the variety should be targeted to later sowing and scenarios with higher risk of terminal drought (e.g. shallow soils and/or low rainfall environments).

CL Plus wheats

Wheat varieties denoted with ‘CL Plus’ are varieties with two resistance genes for imidazolinone (IMI) herbicides and are registered for spraying with label rates of Intervix®. Unlike traits such as Triazine Tolerance in canola, IMI-herbicide resistance genes in wheat are not known to reduce growth or cost yield. However, until now, IMI-tolerant wheats have lagged behind the highest yielding wheat varieties.

Tomahawk CL Plus and Dozer are two new APW quick-mid releases in 2023 and are leading the way in IMI-wheats becoming competitive with the current yield benchmark Scepter. Tomahawk CL Plus is closely related to Scepter and was included in the 2022 WA NVT where it yielded 2–3% higher. While AGT suggest that the yield difference will be less in the long-term, Tomahawk CL Plus will provide an important option to use Intervix® in-crop for certain weed control or in managing the imidazolinone herbicide soil residues from previous crops.

Dozer has been present in NVT since 2023, however InterGrain data indicate it is higher yielding than Hammer CL Plus. It will be important to revise the performance on this variety when the 2023 NVT becomes available in early 2024.

LRPB Anvil CL Plus is an AH quick IMI-tolerant variety, which has a clear advantage in the quicker season environments of Agzones 2, 4 and 5 (Tables 6–11).

In 2021, InterGrain released the mid-slow maturing AH Valiant CL Plus, which provides growers with a more appropriate maturity for use with the Clearfield system in earlier sowing opportunities. Valiant has been tested in the ‘main’ and ‘early season’ WA NVT over the past three seasons. It yielded similarly to Cutlass and Denison when sown in May or mid-to-late April (Tables 4 and 14) but was lower yielding than the quicker CL Plus varieties (Table 3).

The yields of LRPB Anvil CL Plus, Razor CL Plus, Hammer CL Plus, Chief CL Plus and Sheriff CL Plus were competitive with Mace in the NVT, however, yields were inferior to other non-imidazolinone resistant varieties. Hammer CL Plus is AH and APWN, which may be prone to lodging. Chief CL Plus and Sheriff CL Plus are both classified as APW and APWN. Razor CL Plus is classified as ASW. Disease packages vary significantly within Clearfield varieties, as does their susceptibility to preharvest sprouting, which may influence their adoption.

Note: there are no grower-to-grower sales permitted for any CL Plus varieties.

Mid-slow maturity varieties in main season NVT

Mid-slow maturity wheats, as their name suggests, show a delayed rate of development compared to the widely grown quick-mid types. When sown early, the mid-slow varieties are slower to flower than faster wheats, which enables a greater biomass accumulation and therefore yield potential. When sown on mainstream sowing dates mid-slow maturity wheats exhibit delayed development, which can help to avoid frost.

Table 3. Relative performance of CL Plus wheat varieties compared to Scepter

	Scepter	Tomahawk CL Plus	LRPB Anvil CL Plus	Razor CL Plus	Hammer CL Plus	Chief CL Plus	Dozer	Valiant CL Plus
Statewide MET yield (% site mean)[1]	109%	110%^	104%	103%	102%	101%	2023 1st year in NVT	99%
Maturity	Quick-mid	Quick-mid	Quick	Quick-mid	Quick-mid	Mid	Quick-mid	Mid-slow
Classification	AH	APW	AH	ASW	AH (N)	APW(N)	APW	AH
Falling no. index	5	-	2/3*p*	4	4	*4*	-	2/3*p*
Stem rust	MRMS	MR*p*	MR	MRMS	MR	MR	MS*p*	MR
Stripe rust	RMR	RMR*p*	RMR	RMR	RMR	S	MRMS*p*	RMR
Leaf rust	MSS	S*p*	SVS	S	S	MR*	S*p*	S
Powdery mildew	S	-	S*p*	MSS	SVS	S	-	S
Yellow spot	MRMS	MRMS*p*	MSS	MSS	MRMS	MRMS	MS*p*	MRMS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2018–2022). Readers are directed to Tables 6 to 11 for a more precise estimate of variety performance in their region. (N) = supplementary classification of APWN. *Refer to page 4 for interpreting resistance classification.* * Some other races can attack these varieties. *p* = provisional rating. ^ = single year of NVT data in 2022. Falling no. index please refer to page 35.

Within this mid-slow maturity category are faster and slower types and this impacts their performance in main-season NVT yield data. For example, Cutlass, Denison and Valiant CL Plus are much slower than the other varieties in this category. The spread of phenology responses show RockStar flowering, on average, seven days after Scepter and Cutlass thirteen days after Scepter when sown in mid-May (Table 13). When sown in April, maturity of mid-slow varieties will be delayed more than those in the quick-mid maturing category (Figure 2, page 24).

Genie (IGW6754) is a new entry into this maturity group and was tested in WA NVT for the first time in 2023. InterGrain data indicates that Genie yields similarly to RockStar in southern WA. It will be important to review the performance of this variety when the 2023 NVT becomes available in early 2024.

RockStar and Brumby performed well in the main season NVT (Table 4), with RockStar yielding similar to Scepter despite its slightly later maturity (average of six days in 2021 and seven days in 2022, see Table 13). Brumby is slightly quicker than RockStar (average of two days in 2022, Table 13). Catapult and Kinsei yielded more than other mid–slow varieties such as Denison, Valiant CL Plus and Cutlass.

In earlier sowing opportunities (late April to early May) the yield advantage of mid-slow varieties can be significant over quicker maturity counterparts. However, this yield advantage is not always picked up in the main season NVT, which are commonly sown at a date best suited to quick-mid maturity varieties (see – Sowing time response page 25, and Early season NVT page 26–28). In addition, when sowing/emergence is delayed the newer mid-slow varieties have a much lower risk of poor yields than superseded mid-slow maturity varieties such as Magenta and Yitpi (see NVT results in Tables 6–11).

Catapult, RockStar, Valiant CL Plus and Brumby have superior stem (MR) and stripe (RMR) rust resistance than Kinsei (MSS for stem and MRMS for stripe) and Denison (MS for stem and MR for stripe). Apart from Cutlass (RMR) and Kinsei (MSS), other recent mid-slow releases are all S or SVS to the new pathotype of leaf rust. However, Cutlass has an inferior rating for yellow spot compared to other mid-slow varieties, which are all MRMS. Brumby has the highest powdery mildew rating (R*) of all varieties currently grown in WA. Catapult can look worst for disease due to its leaf speckling, but this is a physiological response, which typically has no effect on yield.

Falling number index ratings suggest RockStar is at high risk of low falling number. The difference in ratings is very evident when RockStar is sown in April or early May. Valiant CL Plus is now provisionally rated as 2/3*p* while Brumby is higher than Scepter at 6*p*.

Winter or long season spring wheats in Early season NVT

Please refer to ‘Early season NVT’ on page 26.

ANW

ANW is WA’s premium wheat product. Recent changes in the blend of noodle wheat for the Japanese market have resulted in an increase in the ratio of ANW to APW from the long-term, stable ratio of 60:40, to a ratio of 80:20. This has

Table 4. Relative performance of mid–slow maturity wheat varieties compared to Scepter in main season NVT (refer to Tables 15 and 16 for early season NVT)

	Scepter	RockStar	Brumby	Catapult	Kinsei	Denison	Genie	Valiant CL Plus
Statewide MET yield (% site mean)[1]	109%	109%	108%	104%	103%	101%	2023 1st year in NVT	99%
Maturity	Quick-mid	Mid-slow	Mid-slow	Mid-slow	Mid-slow	Mid-slow	Mid-slow	Mid-slow
Classification	AH	AH(N)	APW	AH	ANW	APW	AH	AH
Falling no. index	5	2	6*p*	6	4	5	-	2/3*p*
Stem rust	MRMS	MRMS	MR	MR	MSS	MS	-	MR
Stripe rust	RMR	RMR	RMR	RMR	MRMS	MR	-	RMR
Leaf rust	MSS	S	SVS	S	MSS	S	-	S
Powdery mildew	S	MS	R*	S	S	S	-	S
Yellow spot	MRMS	MRMS	MRMS	MRMS	MS	MRMS	-	MRMS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2018–2022). Readers are directed to Tables 6 to 11 for a more precise estimate of variety performance in their region. (N) = supplementary classification of APWN. *Refer to page 4 for interpreting resistance classification.* * Some other races can attack these varieties. *p* = provisional rating. ^ = single year of NVT data in 2022. Falling no. index please refer to page 35.

increased the volume/proportion of ANW to the premium Japanese market. In this ratio, the APW component has also become only the varieties with the APWN classification. In recent years, APW1 prices have increased at harvest due to limited higher protein wheat in the State, with ANW failing to maintain a premium over APW1. As a result, plantings of ANW have declined and this may see a premium price return in the future.

Since the 2022 harvest Calingiri is now classified as FEED, with its yield and quality superseded by Kinsei, Ninja, Zen and now the new release, Firefly (IGW8192).

Firefly is InterGrain's first ANW release since the release of Kinsei in 2018. InterGrain data indicates that Firefly is higher yielding than the current ANW varieties in WA and possibly slightly higher yielding than Scepter. Firefly is similar in maturity to Zen. However, it will be important to review the performance of Firefly when the 2023 NVT results become available in early 2024.

Ninja is currently the highest yielding ANW in the main season NVT and has yielded below Scepter over the past five years (Table 5). The slower maturing Kinsei has performed relatively well, with Ninja and Kinsei yielding slightly higher than Zen. Ninja is marginally quicker in maturity than Firefly and Zen, while Kinsei is slightly slower in maturity. As Ninja is 'S' to leaf and stem rust, disease should be actively monitored and managed. Firefly is provisionally marginally better than Ninja and Zen for leaf rust, which is similar to Kinsei. Of the four ANW varieties, Kinsei's disease ratings are marginally better for stem rust, similar to Zen for stripe rust and currently a MS for yellow spot compared to MRMS for Firefly, Ninja and Zen.

When sown in late April in the early NVT, yields of Kinsei were slightly below RockStar and similar to Cutlass, Valiant CL Plus and Catapult (Table 14). However, with a rating of S for black point, there is a higher risk of Kinsei grain being downgraded when sown early.

Table 5. Relative performance of noodle wheat varieties compared to Scepter

	Scepter	Firefly	Ninja	Kinsei	Zen
Statewide MET yield (% site mean)[1]	110%	Data to be released in 2024	105%	103%	102%
Maturity	Quick-mid	Mid-slow	Mid	Mid-slow	Mid-slow
Classification	AH	ANW	ANW	ANW	ANW
Falling no. index	5	-	4	4	3
Stem rust	MRMS	S*p*	S	MSS	S
Stripe rust	RMR	MSS*p*	MS	MRMS	MRMS
Leaf rust	MSS	MSS*p*	S	MSS	S
Powdery mildew	S	-	MSS	S	S
Yellow spot	MRMS	MRMS*p*	MRMS	MS	MRMS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2018–2022). Readers are directed to Tables 6 to 11 for a more precise estimate of variety performance in their region. *Refer to page 4 for interpreting resistance classification.* *p* = provisional rating. Falling no. index please refer to page 35.

Grain yield

Brenda Shackley and Dion Nicol (DPIRD)

The GRDC National Variety Trials (NVT) provide an independent assessment of crop variety performance in WA. NVT results can be viewed as individual site reports or as multi-environment (MET) long-term summaries that provide insight into variety yield performance across environments and seasons. Tables 6 to 11 are outputs extracted from nvtonline.com.au and provide the MET data for the six Agzones in WA between 2018 and 2022. Where there is more than one year of data, or four or more observations, a five-year weighted average has been calculated from the MET data, including the predicted yields for varieties that were absent at a site or in a season. Caution should be exercised when examining the weighted average as it can mask important variety-by-environment interactions (i.e. how a variety performance changes under different environmental conditions).

The overall performance of a variety within an Agzone does not necessarily capture the variation in relative yield performance of varieties in response to those environments. Major drivers in the relative performance of a variety include its maturity and germination timing, the amount and timing of rainfall and occurrence of abiotic stressors such as drought, heat shock and frost damage. Growers are encouraged to consider the predominant environmental conditions experienced in any given season in their region when interpreting relative varietal performance in local NVTs.

Visit app.nvtonline.com.au to access the NVT Online Long-Term Yield Reporter.

Table 6. Grain yield of wheat varieties in AGZONE 1 expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)			3.58	1.13	3.64	3.98	4.64	
Variety	Maturity	(No. trials)	(6)	(5)	(4)	(5)	(4)	(24)
Australian Hard								
Emu Rock	Quick	(24)	99	96	95	99	88	**96**
LRPB Anvil CL Plus	Quick	(9)	-	-	-	104	90	**103**
Sting	Quick	(18)	-	114	106	107	101	**108**
Vixen (N)	Quick	(24)	114	117	106	112	101	**111**
Calibre	Quick-mid	(13)	-	-	107	104	106	**109**
Devil (N)	Quick-mid	(24)	109	113	106	107	109	**109**
Hammer CL Plus (N)	Quick-mid	(13)	-	-	101	100	97	**101**
LRPB Havoc (N)	Quick-mid	(24)	110	108	101	111	98	**106**
Mace (N)	Quick-mid	(24)	104	104	98	102	97	**101**
Scepter	Quick-mid	(24)	109	112	106	108	107	**109**
Genie	Mid-slow	(-)	-	-	-	-	-	**-**
Catapult	Mid-slow	(24)	101	105	101	98	107	**102**
RockStar (N)	Mid-slow	(24)	106	111	107	107	113	**109**
Yitpi	Mid-slow	(24)	91	90	92	86	96	**91**
Valiant CL Plus	Mid-slow	(9)	-	-	-	98	108	**99**
Australian Premium White								
LRPB Avenger (N)	Quick	(13)	-	112	98	-	95	**105**
Tomahawk CL Plus	Quick-mid	(4)	-	-	-	-	110	**-**
Dozer	Quick-mid	(-)	-	-	-	n/a	-	**-**
Thumper	Quick-mid	(-)	-	-	-	-	-	**-**
Chief CL Plus (N)	Mid	(24)	103	101	96	105	99	**101**
Sheriff CL Plus (N)	Mid	(18)	-	99	100	103	101	**101**
Brumby	Mid-slow	(9)	-	-	-	108	111	**108**
Cutlass (N)	Mid-slow	(24)	96	98	97	93	106	**98**
Denison	Mid-slow	(13)	-	-	102	102	111	**102**
LRPB Trojan (N)	Mid-slow	(24)	92	92	105	95	101	**96**
Magenta	Mid-slow	(24)	90	90	95	88	99	**92**
Australian Noodle Wheat								
Firefly	Mid-slow	(5)	-	-	-	104	-	**-**
Ninja	Mid	(24)	103	105	106	104	108	**105**
Kinsei	Mid-slow	(24)	101	103	105	103	110	**104**
Zen	Mid-slow	(24)	104	102	100	107	102	**103**
Australian Standard White								
Razor CL Plus	Quick–mid	(24)	105	105	102	105	96	**103**

(N) = supplementary classification of APWN. = new releases for 2024 season. n/a = data to be released in 2024.
Source: NVT Online, nvtonline.com.au

Table 7. Grain yield of wheat varieties in AGZONE 2 expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)			4.04	2.22	2.74	4.45	4.96	
Variety	Maturity	(No. trials)	(14)	(16)	(14)	(15)	(16)	(75)
Australian Hard								
Emu Rock	Quick	(75)	94	101	99	96	90	**96**
LRPB Anvil CL Plus	Quick	(45)	-	-	106	104	93	**104**
Sting	Quick	(61)	-	114	111	108	104	**109**
Vixen (N)	Quick	(75)	109	118	114	112	103	**111**
Calibre	Quick-mid	(45)	-	-	111	108	109	**110**
Devil (N)	Quick-mid	(75)	109	110	109	110	109	**109**
Hammer CL Plus (N)	Quick-mid	(45)	-	-	104	101	99	**102**
LRPB Havoc (N)	Quick-mid	(75)	105	109	107	108	98	**105**
Mace (N)	Quick-mid	(75)	101	106	103	102	98	**102**
Scepter	Quick-mid	(75)	108	110	109	109	107	**109**
Genie	Mid-slow	(-)	-	-	-	-	-	**-**
Catapult	Mid-slow	(75)	104	103	101	102	106	**103**
RockStar (N)	Mid-slow	(75)	110	106	107	110	112	**109**
Yitpi	Mid-slow	(75)	92	92	90	89	96	**92**
Valiant CL Plus	Mid-slow	(45)	-	-	95	101	104	**99**
Australian Premium White								
LRPB Avenger (N)	Quick	(46)	-	114	108	-	97	**106**
Tomahawk CL Plus	Quick-mid	(4)	-	-	-	-	109	**-**
Dozer	Quick-mid	(-)	-	-	-	n/a	-	**-**
Thumper	Quick-mid	(-)	-	-	-	-	-	**-**
Chief CL Plus (N)	Mid	(75)	102	101	99	103	97	**100**
Sheriff CL Plus (N)	Mid	(61)	-	98	100	102	100	**100**
Brumby	Mid-slow	(31)	-	-	-	109	110	**108**
Cutlass (N)	Mid-slow	(75)	100	95	95	97	104	**98**
Denison	Mid-slow	(61)	-	96	98	104	108	**102**
LRPB Trojan (N)	Mid-slow	(75)	96	91	97	94	102	**96**
Magenta	Mid-slow	(75)	94	90	91	91	99	**93**
Australian Noodle Wheat								
Firefly	Mid-slow	(15)	-	-	-	106	-	**-**
Ninja	Mid	(75)	105	102	105	105	107	**105**
Kinsei	Mid-slow	(75)	105	99	101	105	108	**104**
Zen	Mid-slow	(75)	103	101	101	105	100	**102**
Australian Standard White								
Razor CL Plus	Quick–mid	(75)	102	107	106	103	98	**103**

(N) = supplementary classification of APWN. = new releases for 2024 season. n/a = data to be released in 2024.
Source: NVT Online, nvtonline.com.au

Table 8. Grain yield of wheat varieties in AGZONE 3 expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)			3.00	3.33	3.73	5.02	5.34	
Variety	Maturity	(No. trials)	(3)	(4)	(5)	(4)	(5)	(21)
Australian Hard								
Emu Rock	Quick	(21)	97	98	92	93	87	**93**
LRPB Anvil CL Plus	Quick	(9)	-	-	-	95	93	**101**
Sting	Quick	(18)	-	110	106	106	102	**106**
Vixen (N)	Quick	(21)	112	115	108	106	103	**108**
Calibre	Quick-mid	(14)	-	-	109	109	108	**109**
Devil (N)	Quick-mid	(21)	109	110	110	109	111	**110**
Hammer CL Plus (N)	Quick-mid	(14)	-	-	100	100	97	**100**
LRPB Havoc (N)	Quick-mid	(21)	109	109	103	101	99	**104**
Mace (N)	Quick-mid	(21)	103	105	100	99	98	**101**
Scepter	Quick-mid	(21)	109	109	108	108	108	**108**
Genie	Mid-slow	(-)	-	-	-	-	-	**-**
Catapult	Mid-slow	(21)	102	103	105	104	108	**105**
RockStar (N)	Mid-slow	(21)	108	108	111	110	114	**110**
Yitpi	Mid-slow	(21)	91	92	93	93	96	**93**
Valiant CL Plus	Mid-slow	(14)	-	-	103	101	109	**103**
Australian Premium White								
LRPB Avenger (N)	Quick	(14)	-	112	102	-	98	**103**
Tomahawk CL Plus	Quick-mid	(4)	-	-	-	-	110	**-**
Dozer	Quick-mid	(-)	-	-	-	-	-	**-**
Thumper	Quick-mid	(-)	-	-	-	-	-	**-**
Chief CL Plus (N)	Mid	(21)	104	104	100	98	101	**101**
Sheriff CL Plus (N)	Mid	(18)	-	100	101	100	101	**101**
Brumby	Mid-slow	(9)	-	-	-	109	111	**108**
Cutlass (N)	Mid-slow	(21)	97	98	101	100	107	**101**
Denison	Mid-slow	(18)	-	100	106	105	112	**106**
LRPB Trojan (N)	Mid-slow	(21)	92	89	98	102	98	**96**
Magenta	Mid-slow	(12)	91	91	95	-	-	**95**
Australian Noodle Wheat								
Firefly	Mid-slow	(4)	-	-	-	109	-	**-**
Ninja	Mid	(21)	103	102	106	107	107	**105**
Kinsei	Mid-slow	(21)	103	101	107	106	110	**106**
Zen	Mid-slow	(21)	105	104	102	101	103	**103**
Australian Standard White								
Razor CL Plus	Quick-mid	(21)	104	105	100	101	96	**101**

(N) = supplementary classification of APWN. = new releases for 2024 season.
Source: NVT Online, **nvtonline.com.au**

Table 9. Grain yield of wheat varieties in AGZONE 4 expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)			3.28	1.18	2.31	3.99	4.33	
Variety	Maturity	(No. trials)	(9)	(9)	(11)	(6)	(11)	(46)
Australian Hard								
Emu Rock	Quick	(46)	97	102	103	99	92	**98**
LRPB Anvil CL Plus	Quick	(28)	-	-	111	108	94	**107**
Sting	Quick	(37)	-	120	113	110	105	**111**
Vixen (N)	Quick	(46)	111	122	118	115	105	**114**
Calibre	Quick-mid	(28)	-	-	110	108	108	**112**
Devil (N)	Quick-mid	(46)	109	113	108	109	108	**109**
Hammer CL Plus (N)	Quick-mid	(28)	-	-	105	102	100	**104**
LRPB Havoc (N)	Quick-mid	(46)	106	108	112	111	100	**107**
Mace (N)	Quick-mid	(46)	103	107	105	104	98	**103**
Scepter	Quick-mid	(46)	108	112	110	110	107	**109**
Genie	Mid-slow	(-)	-	-	-	-	-	**-**
Catapult	Mid-slow	(46)	103	105	99	100	104	**102**
RockStar (N)	Mid-slow	(46)	108	106	105	107	110	**107**
Yitpi	Mid-slow	(46)	93	93	87	87	93	**91**
Valiant CL Plus	Mid-slow	(17)	-	-	-	96	101	**96**
Australian Premium White								
LRPB Avenger (N)	Quick	(31)	-	119	112	-	98	**109**
Tomahawk CL Plus	Quick-mid	(4)	-	-	-	-	111	**-**
Dozer	Quick-mid	(-)	-	-	-	n/a	-	**-**
Thumper	Quick-mid	(-)	-	-	-	-	-	**-**
Chief CL Plus (N)	Mid	(46)	102	97	102	104	98	**100**
Sheriff CL Plus (N)	Mid	(37)	-	95	100	102	101	**100**
Brumby	Mid-slow	(17)	-	-	-	108	109	**106**
Cutlass (N)	Mid-slow	(46)	98	95	90	93	101	**96**
Denison	Mid-slow	(28)	-	-	95	100	105	**98**
LRPB Trojan (N)	Mid-slow	(46)	94	91	94	94	102	**95**
Magenta	Mid-slow	(46)	93	90	86	88	97	**91**
Australian Noodle Wheat								
Firefly	Mid-slow	(6)	-	-	-	103	-	**-**
Ninja	Mid	(46)	104	102	103	104	107	**104**
Kinsei	Mid-slow	(46)	102	96	99	102	107	**101**
Zen	Mid-slow	(46)	102	97	104	105	101	**102**
Australian Standard White								
Razor CL Plus	Quick-mid	(46)	103	109	109	106	100	**105**

(N) = supplementary classification of APWN. = new releases for 2024 season. n/a = data to be released in 2024.
Source: NVT Online, nvtonline.com.au

Table 10. Grain yield of wheat varieties in AGZONE 5 expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)			2.43	2.06	2.09	4.02	3.82	
Variety	Maturity	(No. trials)	(4)	(4)	(6)	(5)	(6)	(25)
Australian Hard								
Emu Rock	Quick	(25)	97	100	101	93	93	**97**
LRPB Anvil CL Plus	Quick	(17)	-	-	116	101	105	**110**
Sting	Quick	(21)	-	116	117	110	108	**113**
Vixen (N)	Quick	(25)	118	119	122	112	111	**116**
Calibre	Quick-mid	(17)	-	-	117	113	111	**116**
Devil (N)	Quick-mid	(25)	113	112	112	112	112	**112**
Hammer CL Plus (N)	Quick-mid	(17)	-	-	106	102	100	**104**
LRPB Havoc (N)	Quick-mid	(25)	105	108	113	105	107	**108**
Mace (N)	Quick-mid	(25)	106	106	107	101	102	**104**
Scepter	Quick-mid	(25)	111	111	113	111	110	**111**
Genie	Mid-slow	(-)	-	-	-	-	-	**-**
Catapult	Mid-slow	(25)	108	105	101	104	105	**104**
RockStar (N)	Mid-slow	(25)	109	108	108	112	112	**110**
Yitpi	Mid-slow	(25)	97	93	87	90	92	**91**
Valiant CL Plus	Mid-slow	(17)	-	-	92	99	104	**97**
Australian Premium White								
LRPB Avenger (N)	Quick	(16)	-	116	117	-	107	**112**
Tomahawk CL Plus	Quick-mid	(4)	-	-	-	-	115	**-**
Dozer	Quick-mid	(-)	-	-	-	-	-	**-**
Thumper	Quick-mid	(-)	-	-	-	-	-	**-**
Chief CL Plus (N)	Mid	(25)	99	100	102	100	104	**101**
Sheriff CL Plus (N)	Mid	(21)	-	96	99	100	101	**99**
Brumby	Mid-slow	(11)	-	-	-	110	109	**107**
Cutlass (N)	Mid-slow	(25)	101	97	92	98	101	**98**
Denison	Mid-slow	(21)	-	95	95	103	106	**100**
LRPB Trojan (N)	Mid-slow	(25)	90	90	90	97	92	**92**
Magenta	Mid-slow	(14)	94	91	85	-	-	**91**
Australian Noodle Wheat								
Firefly	Mid-slow	(5)	-	-	-	108	-	**-**
Ninja	Mid	(25)	103	103	103	107	105	**104**
Kinsei	Mid-slow	(25)	99	98	99	106	106	**102**
Zen	Mid-slow	(25)	97	99	103	102	105	**102**
Australian Standard White								
Razor CL Plus	Quick-mid	(25)	105	107	110	103	101	**105**

(N) = supplementary classification of APWN. = new releases for 2024 season.
Source: NVT Online, **nvtonline.com.au**

Table 11. Grain yield of wheat varieties in AGZONE 6 expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)			3.78	4.3	3.65	4.24	4.53	
Variety	Maturity	(No. trials)	(2)	(1)	(3)	(2)	(3)	(11)
Australian Hard								
Emu Rock	Quick	(11)	93	90	90	93	90	**91**
LRPB Anvil CL Plus	Quick	(5)	-	-	-	98	97	**98**
Sting	Quick	(9)	-	105	106	106	103	**105**
Vixen (N)	Quick	(11)	107	107	109	109	104	**107**
Calibre	Quick-mid	(8)	-	-	109	106	108	**108**
Devil (N)	Quick-mid	(11)	109	112	112	110	110	**111**
Hammer CL Plus (N)	Quick-mid	(8)	-	-	98	99	98	**99**
LRPB Havoc (N)	Quick-mid	(11)	103	105	105	108	101	**104**
Mace (N)	Quick-mid	(11)	100	100	100	100	99	**100**
Scepter	Quick-mid	(11)	107	110	110	109	107	**108**
Genie	Mid-slow	(-)	-	-	-	-	-	**-**
Catapult	Mid-slow	(11)	105	106	105	102	106	**105**
RockStar (N)	Mid-slow	(11)	110	114	114	112	112	**112**
Yitpi	Mid-slow	(11)	95	92	90	87	95	**92**
Valiant CL Plus	Mid-slow	(8)	-	-	105	103	108	**105**
Australian Premium White								
LRPB Avenger (N)	Quick	(7)	-	102	102	-	100	**102**
Tomahawk CL Plus	Quick-mid	(4)	-	-	-	-	110	**-**
Dozer	Quick-mid	(-)	-	-	-	-	-	**-**
Thumper	Quick-mid	(-)	-	-	-	-	-	**-**
Chief CL Plus (N)	Mid	(11)	101	104	103	104	102	**103**
Sheriff CL Plus (N)	Mid	(9)	-	102	102	103	101	**102**
Brumby	Mid-slow	(5)	-	-	-	112	109	**110**
Cutlass (N)	Mid-slow	(11)	102	103	101	98	105	**102**
Denison	Mid-slow	(9)	-	110	109	107	109	**108**
LRPB Trojan (N)	Mid-slow	(11)	96	94	96	97	96	**96**
Magenta	Mid-slow	(6)	96	94	93	-	-	**94**
Australian Noodle Wheat								
Firefly	Mid-slow	(-)	-	-	-	-	-	**-**
Ninja	Mid	(11)	105	107	108	107	106	**107**
Kinsei	Mid-slow	(11)	106	109	109	108	108	**108**
Zen	Mid-slow	(11)	102	106	105	107	103	**104**
Australian Standard White								
Razor CL Plus	Quick-mid	(11)	100	99	100	102	98	**100**

(N) = supplementary classification of APWN. = new releases for 2024 season.
Source: NVT Online, **nvtonline.com.au**

Relative grain yield comparison

To help assess relative varietal performance at different site yields, NVT Online (through the Long-Term MET Yield Reporter) presents data in 'yield groups', based on trials that match the yield range. This guide presents an alternative method of viewing yield performance at different site yields and uses data extracted from the 'Statewide tables of yield and grain quality' available at nvtonline.com.au. For several years, the barley section has examined barley varieties based on yield potential or the site mean yield, highlighting differences between the barley varieties at sites with different yield potentials (pages 70–72). This edition of the Crop Sowing Guide includes a similar comparison for wheat varieties for the first time. Differences in comparative grain yield performance between varieties can depend on the yield potential of the site. For example, yield potential can reflect when the site was sown, soil type, total rainfall and its distribution during the season.

Figure 1 was developed by calculating differences between the grain yield of a variety relative to the site mean yield (the 'deviation'), with the deviation assessed for quadratic or linear trends. If the quadratic trend was significant ($p<0.05$), a quadratic polynomial was fitted to the data. If the linear trend (but not the quadratic trend) was significant, a linear polynomial was fitted to the data. If neither the quadratic nor the linear trend was significant, the grain yield response of a variety was deemed to run parallel to the site mean yield at the average deviation for that variety. From observations in the barley section, it is worth noting that depending on which years and locations are analysed, the relative performance of varieties may differ. This has highlighted the importance of examining more than one dataset and comparing the performance of new varieties over at least three seasons.

With wheat varieties now having high yield performance across a broader range of maturities, some interesting trends have emerged with different site mean yields have become more apparent in WA. With three seasons of data for Calibre now available, linear regressions were used to compare the response of Calibre, Scepter, Devil, RockStar and Devil at different yield potentials to clarify trends identified when comparing between the Agzones (Tables 6 to 13). Figure 1 shows that Calibre and Scepter had no significant quadratic or linear trends, indicating yields of these varieties are stable across a range of yield potentials. Vixen has a negative linear trend and does relatively better in low yielding environments (<4t/ha) which is likely due to its quicker maturity, while RockStar and Devil have a positive linear slope indicating they do better in high yielding environments (>4t/ha). It is likely that RockStar can also respond to a longer growing season than the other varieties due to its slower maturity. However, it is important to note that higher yielding environments (generally Agzones 3 and 6) may result in higher pre-harvest sprouting and that RockStar and Devil have a higher risk of pre-harvest sprouting.

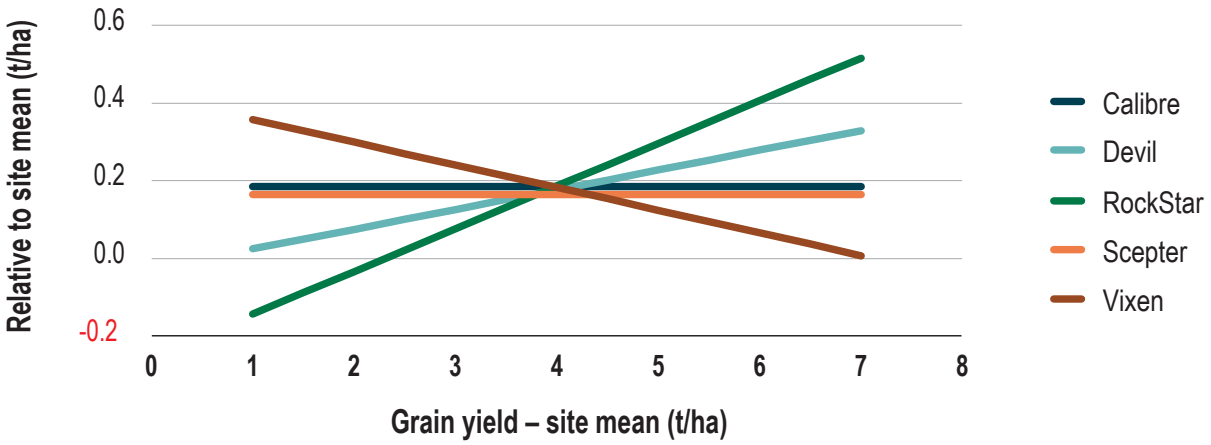


Figure 1. Fitted grain yield of Calibre, Devil, RockStar, Scepter and Vixen at different site means

Source: is based on NVT statewide tables of yield and grain quality (2020–2022). Each variety sown in all 125 trial-years of data, NVT Online, nvtonline.com.au

Suggested sowing times

Suggested sowing times for varieties (Table 12) have been developed to support decisions around sowing time preferences and opportunities. The suggestions are based on knowledge of the varieties and their performance in NVT and DPIRD agronomy trials (see *Sowing time response of wheat varieties in WA* on page 25). The suggested sowing times were developed in consultation with breeding companies and researchers. For varieties not listed in the table, refer to the maturity class of the variety.

Note: spring wheats generally have a lower yield potential if sown before late April in WA.

The number of days to flowering relative to Scepter is provided in the variety snapshots at the end of this guide. Knowing the maturity length of a variety helps with planting order planning and enables variety development to be aligned with typical seasonal conditions.

Table 12 does not suggest sowing time of wheat varieties where frost may be an issue. Frost risk is extremely variable within the landscape and across environments. Delaying sowing time and choice of variety or crop are still the most reliable ways of reducing yield losses in frost-prone areas. Frost management strategies are available on the GRDC and DPIRD websites.

Maturity

In WA, the flowering time of spring wheat varieties are broadly classified into maturity categories of quick, quick-mid, mid and mid-slow. While there are later maturing spring wheats and winter wheats, these are not commonly grown in WA. Most spring wheat varieties grown in WA have a minor vernalisation requirement (responding to an accumulation of cold temperatures) and photoperiod sensitivity (response to daylength), which means their development is mainly driven by temperature (warmer temperatures increase development rate).

The quick-mid spring maturity type is the predominant maturity type in WA. Spring wheat varieties with a higher, albeit still limited, response to vernalisation (such as Magenta) or photoperiod (such as Cutlass) can be sown from late April as their maturity is delayed, and many of these varieties fall into the mid-slow maturity class. In recent years, very slow spring (such as LRPB Nighthawk) and winter wheats (such as Mowhawk and Illabo) with greater adaptation to the WA environment have been released, offering unique maturity characteristics for very early sowing.

Sowing spring wheats into April can result in an advanced rate of development (due to warmer temperatures and longer daylengths) and a faster time to flowering. For this reason, winter wheats are seen as having more appropriate development times for an early April (or even March) sowing in WA, primarily due to their vernalisation requirement which negates much of the warmer temperatures in April and May.

Scepter is classified as quick-mid maturity and Table 13 outlines how other varieties compared to Scepter when sown in mid to late May at the Gnowangerup and Kojonup NVT sites and in DPIRD trials in 2022. A more detailed flowering comparison between Scepter and other varieties can be found in the variety snapshots (pages 37–46).

Table 12. Suggested sowing times of wheat varieties in WA (assumes low frost risk)

AGZONES 1–6	April				May				June			
	wk 1	wk 2	wk 3	wk 4	wk 1	wk 2	wk 3	wk 4	wk 1	wk 2	wk 3	wk 4
# Winter wheat (quick): Illabo, Mowhawk												
Mid-slow: Brumby, Catapult, Cutlass, Denison, Kinsei, Magenta, RockStar, Yitpi, Valiant CL Plus, Zen												
Quick-mid to mid: Calibre, Chief CL Plus, Devil, Hammer CL Plus, LRPB Havoc, Mace, Ninja, Scepter, Tomahawk CL Plus												
Quick: Emu Rock, LRPB Anvil CL Plus, LRPB Avenger, Sting, Vixen												

= earlier than ideal = optimum sowing time = later than ideal but acceptable

Suggested sowing times for quick winter wheats such as Illabo or Mowhawk, however these are only applicable to southern WA where the winter types are more adapted to the longer environments (refer to Figures 3 and 4).

Table 13. Days from sowing to flowering (relative to Scepter) at selected NVT and DPIRD trials in 2022

Variety	Maturity	Southern NVTs*	Mullewa	Merredin	Katanning	Grass Patch	Average
Sowing date		**Av of 13-May**	**13-May**	**18-May**	**10-May**	**16-May**	
Emu Rock	Quick	-5	-	-	-	-	**-**
LRPB Anvil CL Plus	Quick	-5	-13	-10	-9	-10	**-9**
Vixen	Quick	-4	-12	-10	-8	-8	**-8**
LRPB Avenger	Quick	-5	-8	-9	-	-7	**-7**
Sting	Quick	-3	-4	-6	-5	-3	**-4**
Razor CL Plus	Quick-mid	-3	-	-	-	-	**-**
LRPB Havoc	Quick-mid	-2	-	-	-	-	**-**
Dozer	Quick-mid	-	-2	-2	-1	-3	**-2**
Mace	Quick-mid	0	-	-	-	-	**-**
Devil	Quick-mid	1	-	-	-	-	**-**
Hammer CL Plus	Quick-mid	2	2	-3	-2	1	**0**
Calibre	Quick-mid	-2	1	1	-4	-1	**-1**
Scepter	**Quick-mid**	**0**	**0**	**0**	**0**	**0**	**0**
Tomahawk CL Plus	Quick-mid	2	-	-	-	-	**-**
Chief CL Plus	Mid	4	5	3	4	5	**4**
Ninja	Mid	4	7	3	5	1	**4**
Sheriff CL Plus	Mid	5	-	-	-	-	**-**
Zen	Mid-slow	6	-	-	-	-	**-**
Brumby	Mid-slow	6	6	3	5	4	**5**
RockStar	Mid-slow	6	10	7	6	5	**7**
Kinsei	Mid-slow	10	11	9	7	6	**9**
Catapult	Mid-slow	9	17	10	9	8	**10**
Denison	Mid-slow	13	18	11	9	10	**12**
Valiant CL Plus	Mid-slow	13	14	8	9	8	**10**
Yitpi	Mid-slow	13	-	-	-	-	**-**
Cutlass	Mid-slow	13	19	13	10	11	**13**
Scepter's flowering date		**Av 17 Sept**	**11-Aug**	**12-Sep**	**20-Sep**	**9-Sep**	

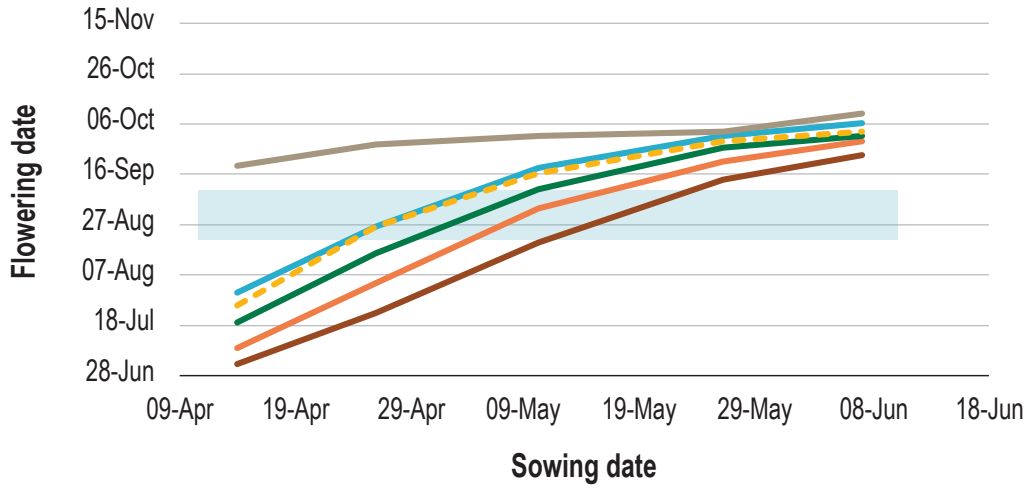
*NVT sites include Gnowangerup and Kojonup. = new releases for 2024 season.

Flowering dates change with sowing date, location (Figures 2a and b) and from season to season (Figures 2b and c) predominantly due to differences in temperature, although stress can also have an impact (not shown). Figure 2 shows the large difference in flowering date measured in mid-slow spring and winter wheats at two locations (differences are greatest with an April and early May sowing). Given the genetic control of flowering is complex and is driven by environmental conditions that differ from season to season, it is important to consider data from multiple sites and seasons to better understand the maturity type of a variety.

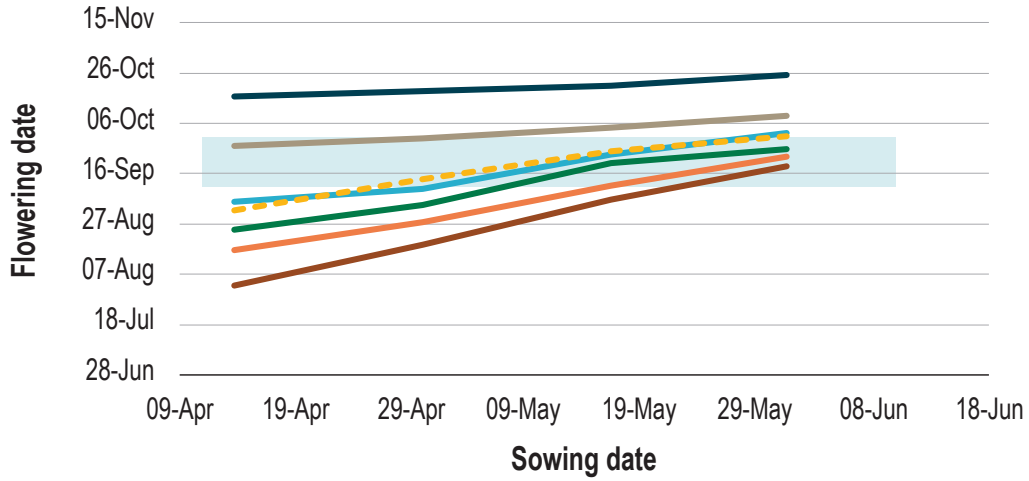
Earlier sowing of mid-slow maturity types still results in an earlier flowering time than mid-May sowing of quick-mid maturity wheats. Therefore, risk factors associated with early flowering wheat such as frost damage, low falling numbers or pre-harvest sprouting and blackpoint should be considered with greater scrutiny if early sowing is planned with these maturity types

FlowerPower: is an online tool used to predict cereal flowering dates (or hay cutting dates for oats) across the WA grainbelt. FlowerPower enables the user to compare flowering date predictions over a range of sowing dates. Refer to DPIRD website or https://www.agric.wa.gov.au/frost/flowerpower.

(a) Merredin in 2021



(b) Katanning in 2022



(c) Katanning in 2021

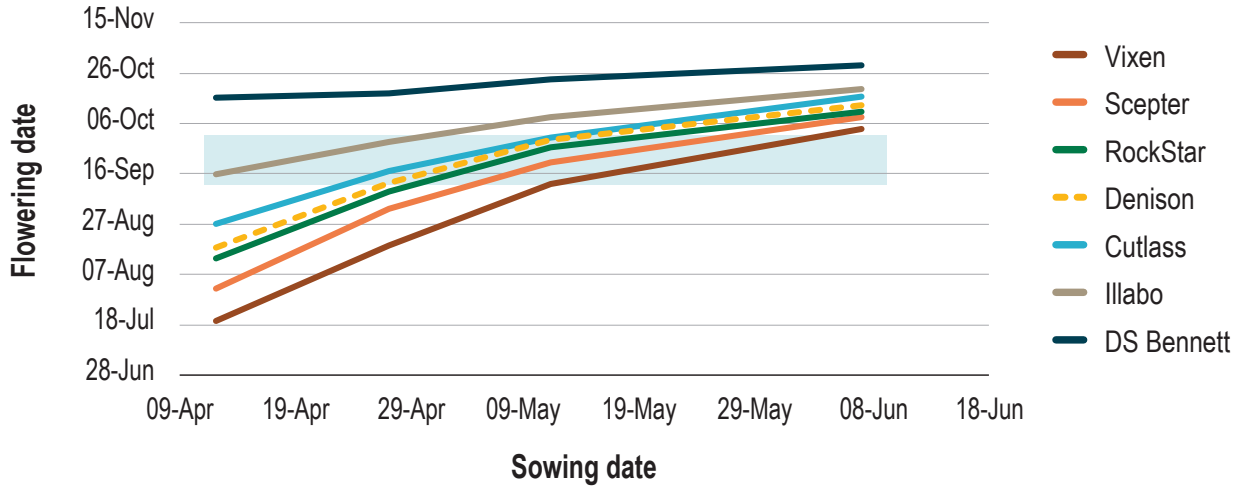


Figure 2. Flowering date of varieties sown on a range of sowing dates (mid-April to early June) at a) Merredin in 2021, b) Katanning in 2022 and c) Katanning in 2021.

Shaded area is the estimated optimum flowering window.

Sowing time response of wheat varieties in WA

Matching varieties to their optimum sowing date is key to maximising wheat yield potential in WA. However, as the environmental constraints of each season differ in significance, prevalence and timing, the perfect match of sowing date and variety development is difficult to achieve. For example, many wheat growing areas in WA have had both tight, dry finishes and cool, long finishes over the past few years. These differing conditions alter the developmental timings of wheat crops and result in one maturity type being favoured over another for any given sowing date. Despite this, there are some consistencies that occur over several seasons which can guide appropriate variety choice for any sowing opportunity.

Most of the main season wheat NVTs germinate from mid-May onwards, a time best suited to the quicker maturity varieties that currently dominate WA's wheat area. DPIRD research in 2020, 2021 and 2022 assessed the best variety choices for any given sowing date and the best match of variety maturity types to sowing opportunities in specific environments.

Even at the vastly different locations of Katanning, Mullewa and Merredin peak yields generally occurred from a late April to early May sowing (Figure 3). However, the variety combinations to maximise yield from each sowing date at each site varied and there are opportunities to maintain high yields across the sowing window by matching varieties to a given sowing date. Table 12 provides the suggested sowing times of main season wheat varieties in WA.

Late rain in 2022: The later rains and soft finish in 2022 resulted in the latest sowings achieving the highest yields at Mullewa (data not shown) and Katanning (Figure 3d) and a fairly flat yield response at Merredin with delayed sowing (data not shown). The atypical finish to the 2022 season delivered an improved performance of the mid-slow and even the quick winter varieties at later sowing dates at Katanning and Mullewa where the quick winter varieties are rarely competitive with the mainstream varieties, even when sown in early April.

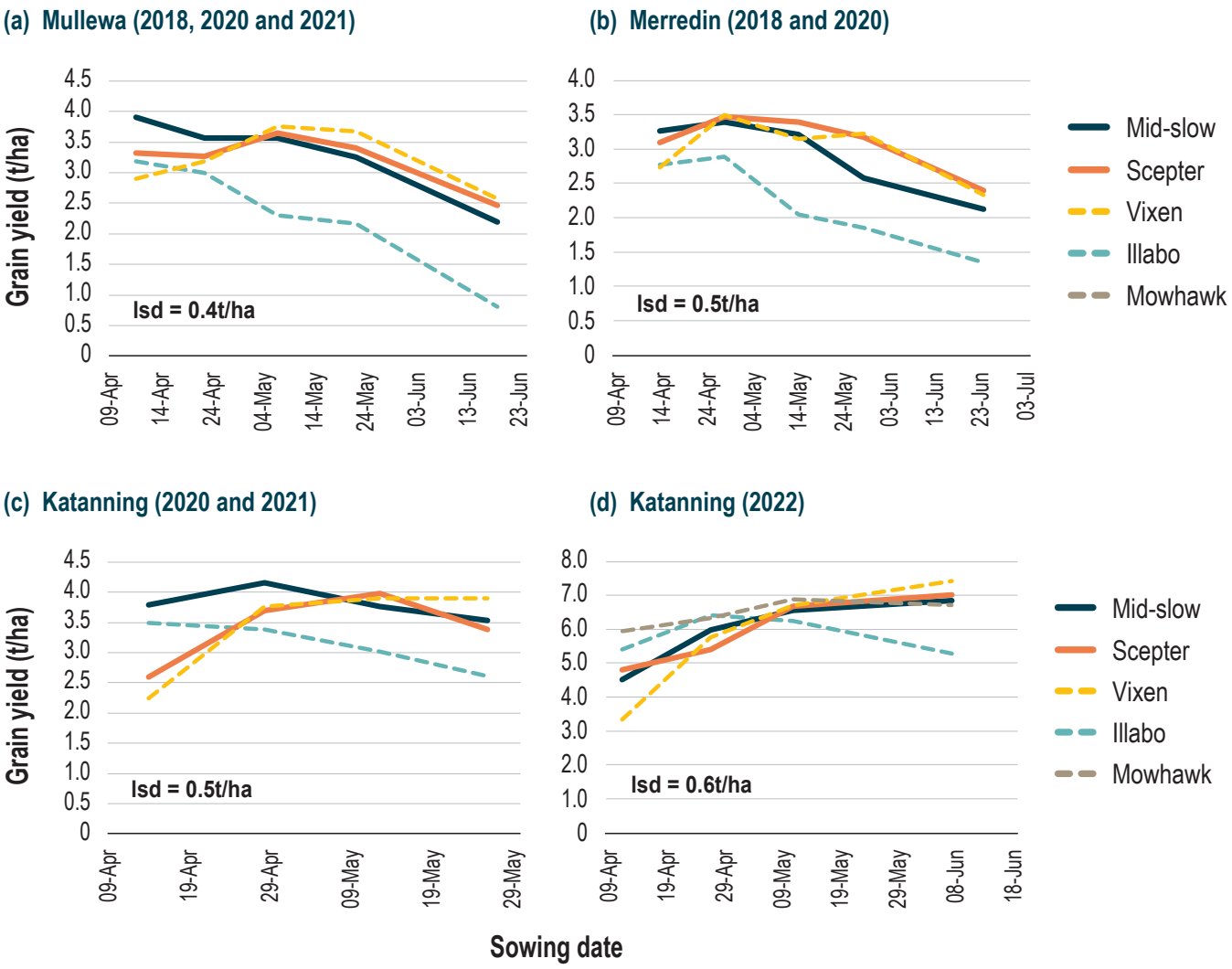


Figure 3. Grain yield (t/ha) response of varieties sown on four to five sowing dates (early April to mid-June) at a) Mullewa (2018, 2020 and 2021), b) Merredin (2018 and 2020), c) Katanning (2020 and 2021) and d) Katanning (2022).

Irrigation was used at the early sowing dates to ensure timely germination. Source: DPIRD wheat agronomy research.

Early season NVT

Since 2017, an 'early-season' wheat NVT series in WA has evaluated the performance of slower maturing varieties when sown at an earlier sowing date (Table 14).

Between 2018 and 2022 the 'early-season' series was generally sown in late April, a timing favourable to varieties with a mid-long maturity but potentially not early enough for the long spring or winter varieties (see Figure 4).

RockStar has to date yielded highest in the early season NVT, however the late/soft finish of 2022 favoured the quick winter wheats such as Mowhawk, Longsword and Illabo. The results of Mowhawk should be treated with caution as this variety has only been in the early season NVT in 2022. Over the past five years, Denison, Cutlass, Valiant CL Plus, Kinsei and Catapult have achieved an average yield slightly lower than RockStar. Catapult has tended to be more yield competitive with the other mid-slow maturing varieties in Agzones 2,3,5 and 6 than in Agzones 1 and 4 (Tables 15 and 16).

RockStar is the quickest to flowering in the mid-slow maturity group so be aware of a higher frost risk. RockStar is also more susceptible to pre-harvest sprouting, which is expressed more with earlier sowing.

Kinsei is susceptible to black point, which is also expressed more with April sowings in susceptible environments.

Table 14. Relative performance of slower maturity wheat varieties in EARLY SEASON NVT

	RockStar	Mowhawk^	Denison	Cutlass	Valiant CL Plus	Kinsei	Catapult	Longsword	Illabo
Statewide MET yield (% site mean)[1]	112%	112%^	110%	109%	109%	108%	107%	104%	101%
Maturity	Mid-slow	Quick winter	Mid-slow	Mid-slow	Mid-slow	Mid-slow	Mid-slow	Quick winter	Quick winter
Classification	AH(N)	AH	APW	APW(N)	AH	ANW	AH	AWW	AH
Falling no. index	2	-	5	4	2/3*p*	4	6	-	5
Stem rust	MRMS	RMR*p*	MS	R	MR	MSS	MR	MR	MRMS
Stripe rust	RMR	RMR*p*	MR	RMR*	RMR	MRMS	RMR	RMR	RMR
Leaf rust	S	MR*p*	S	RMR*	S	MSS	S	MR*	S
Powdery mildew	MS	RMR*p*	S	S	S	S	S	MRMS	RMR
Yellow spot	MRMS	MRMS*p*	MRMS	MSS	MRMS	MS	MRMS	MRMS	MS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat EARLY SEASON NVT MET data (2018–2022). Readers are directed to Tables 15 and 16 for a more precise estimate of variety performance in their region. *Refer to page 4 for interpreting resistance classification.* (N) = Denotes supplementary classification of APWN. *p* = provisional rating. ^ = single year of NVT data in 2022.
* = Some races in eastern Australia can attack these varieties. Falling no. index please refer to page 35.

Table 15. Relative performance of varieties in the early season NVT for AGZONES 1 and 4 combined (2018–2022), expressed as a percentage of site mean yield and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year				2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)				3.55	2.02	2.45	4.14	4.21	
Variety (order of maturity)	Classification	Maturity	(No. trials)	(2)	(2)	(2)	(1)	(3)	(10)
RockStar	AH (N)	Mid-slow	(8)	-	118	114	99	83	**104**
Catapult	AH	Mid-slow	(10)	107	107	106	101	88	**101**
Kinsei	ANW	Mid-slow	(10)	108	109	106	100	88	**101**
Denison	APW	Mid-slow	(6)	-	-	113	110	105	**109**
Valiant CL Plus	AH	Mid-slow	(4)	-	-	-	106	104	**106**
Yitpi	AH	Mid-slow	(10)	100	96	96	99	91	**96**
Cutlass	APW (N)	Mid-slow	(10)	106	105	109	108	109	**108**
LRPB Nighthawk	APW	Very slow	(10)	93	96	95	97	107	**99**
Longsword	AWW	Quick winter	(10)	89	92	92	105	116	**100**
Mowhawk	AH	Quick winter	(3)	-	-	-	-	118	**-**
Illabo	AH	Quick winter	(10)	92	99	95	98	109	**100**
Sowing dates				20 and 30 April	11 and 17 April	21-Apr	21-Apr	14 and 20 April	

Agzone 1 site is Ogilvie and Agzone 4 sites were Bencubbin, Moorine Rock (2019) and Kalannie (2020, 2021 and 2022)
(N) = Denotes supplementary classification of APWN.

Table 16. Relative performance of varieties in the Early season NVT for AGZONES 2, 3, 5 and 6 combined (2018–2022), expressed as a percentage of site mean yield and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year				2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)				2.16	3.07	3.43	4.79	4.51	
Variety (order of maturity)	Classification	Maturity	(No. trials)	(2)	(4)	(3)	(6)	(7)	(22)
RockStar	AH (N)	Mid-slow	(13)	-	115	124	121	104	**115**
LRPB Trojan	APW (N)	Mid-slow	(22)	104	106	107	108	91	**102**
Magenta	APW	Mid-slow	(22)	96	100	100	101	93	**98**
Catapult	AH	Mid-slow	(22)	110	114	116	113	103	**110**
Kinsei	ANW	Mid-slow	(22)	114	115	118	115	104	**112**
Denison	APW	Mid-slow	(16)	-	-	116	110	108	**111**
Valiant CL Plus	AH	Mid-slow	(13)	-	-	-	109	108	**110**
Yitpi	AH	Mid-slow	(22)	92	102	98	98	93	**97**
Cutlass	APW (N)	Mid-slow	(22)	110	110	112	108	110	**110**
LRPB Nighthawk	APW	Very slow	(20)	-	90	90	92	100	**94**
Longsword	AWW	Quick winter	(22)	112	105	101	100	114	**107**
Mowhawk	AH	Quick winter	(7)	-	-	-	-	118	**-**
Illabo	AH	Quick winter	(22)	109	95	97	99	107	**101**
DS Bennett	Feed	Mid-slow winter	(17)	-	77	82	81	108	**89**
Average sowing date				20 and 30 April	11 and 17 April	21-Apr	21-Apr	14 and 20 April	

Sites are: Agzone 2 is Eneabba or Tincurrin-N (2019), Agzone 3 is York or Narrogin, Agzone 5 is Hyden and Jerramungup and Agzone 6 is Gibson or South Stirlings (2021). (N) = Denotes supplementary classification of APWN.

The suitability of winter wheats and slower spring varieties continue to be assessed however, in general, they are more competitive when sown in early to mid-April in southern, longer season environments and/or at frost-prone locations (Figure 4).

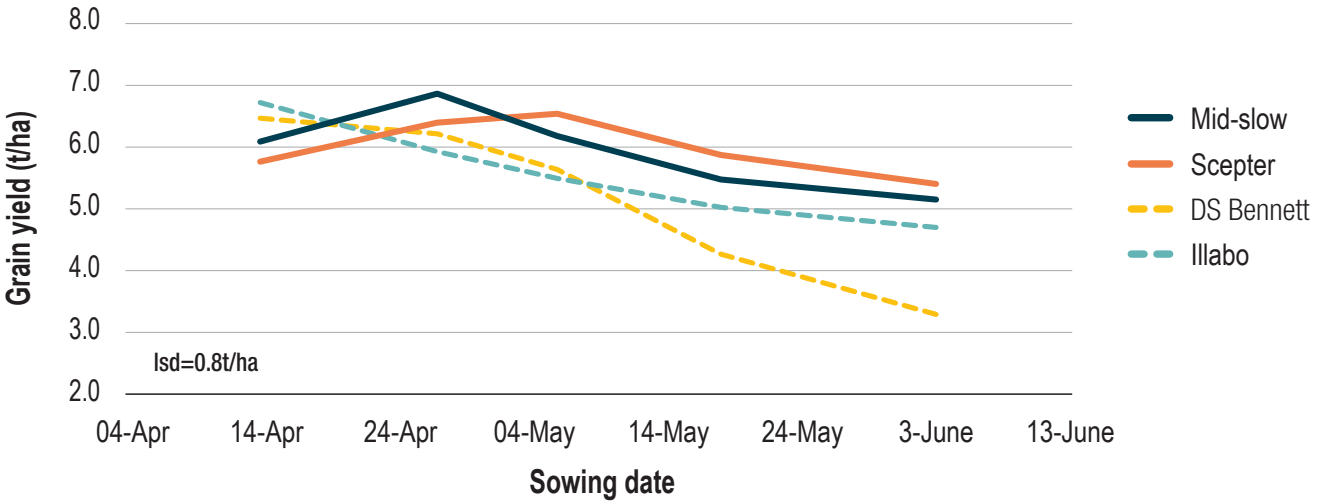


Figure 4. Grain yield (t/ha) response of mid–slow spring and winter wheat varieties compared to Scepter when sown on five sowing dates at Dale in 2021.

Source: DPIRD wheat agronomy project

Disease and pest resistance

Manisha Shankar, Geoff Thomas, Carla Wilkinson, Sarah Collins and Daniel Huberli (DPIRD)

Key points

- Be aware of a variety's disease package so that pre- and in-season disease management can be planned
- Do not plant a susceptible variety into a paddock with high disease risk
- Use a diversity of wheat varieties and crop types.

When selecting a wheat variety, it is important to consider yield and potential quality grade along with disease resistance (Table 18). Higher resistance ratings reduce disease severity and subsequent yield loss. Avoiding susceptible or very susceptible varieties significantly reduces the chance of disease outbreaks and the need for in-season management.

For a disease to become damaging in-season, there needs to be:

- the presence of inoculum, which is usually carried over from the previous season
- favourable weather conditions for disease proliferation
- a susceptible host crop to become infected.

Depending on the disease in question, inoculum can be carried on infested stubble or trash, a green bridge, in seed or in the soil (Table 17).

Table 17. Examples of wheat diseases carried over from different inoculum sources

Inoculum carryover source	Disease
Infested stubble or trash	Yellow spot, septoria nodorum blotch, powdery mildew and crown rot.
Green bridge	Rusts, powdery mildew and viruses.
Seed	Loose smut.
Soilborne	Root lesion nematode, CCN, rhizoctonia root rot, take-all, flag smut and common bunt.

Choose varieties for each paddock based on disease resistance/susceptibility and disease risk of the paddock. Disease risk is related to the potential presence of disease inoculum and the favourability of the environment for the disease. For example, it is not advisable to sow Yitpi, which is rated SVS for yellow spot, onto wheat stubble.

Knowing the disease strengths and weaknesses of a variety enables more effective disease management during the season. Varieties that are very susceptible (VS) to susceptible (S) to powdery mildew are more likely to get the disease and the rate of epidemic development will be faster and the impact will be greater in these types. When susceptible varieties such as Scepter make up a high proportion of the crop grown, the disease will be more common and damaging across the grainbelt. Therefore, the need to respond with in-crop fungicide can be greater and the time to respond shorter with these varieties. Use of proactive protection such as fertiliser applied fungicides may be more useful for these varieties to delay or slow disease onset in favourable environments.

Using a diverse range of varieties with different disease resistance traits reduces the risk that the whole farm will require disease management at the same time. Diversification also reduces the risk of new pathotypes emerging, which could render a significant proportion of a farm or region susceptible and require region-wide management responses.

Disease ratings provided in this guide reflect the expected response to the most common or dominant pathotype or strain of a disease in WA. For most diseases, very little variability in response is evident between seasons or regions, but occasionally mutations or incursions of rusts can significantly change variety ratings. For example, leaf rust ratings in Table 18 are for pathotypes that entered WA in 2015 (104-1,3,4,6,7,8,10,12 +Lr37) and 2017 (104-1,3,4,5,7,9,10,12 +Lr37).

Ratings for powdery mildew reflect expected resistance to the general mildew population, however varietal response can differ on rare occasions when a more virulent isolate occurs.

Nodorum blotch causes characteristic necrotic lesions on leaves and can also cause glume blotch, dark brown to black lesions or staining on the heads associated with infection. Varieties can differ in disease expression on foliage and heads so in this guide variety rankings have been included for both these plant parts (Table 18). Susceptible varieties are more likely to suffer glume blotch in seasons where disease is present in the foliage and when weather favourable to disease occurs after head emergence.

Soilborne diseases and pests

Soilborne pathogens and nematode pests infect plant roots and impact their ability to take up water and nutrients. Environmental factors such as soil moisture, temperature and nutrient availability will determine the severity of disease development. The most prevalent root diseases of wheat in WA are rhizoctonia bare patch, root lesion nematodes (RLN), fusarium crown rot and take-all. Less widespread are cereal cyst nematodes (CCN), common root rot and pythium root rot.

Soilborne diseases and nematode pests are best managed by (i) identifying the pathogens or pests causing plant decline, (ii) use of crop and variety rotation and (iii) chemical management if available.

DPIRD Plant Pathology group.

Rhizoctonia bare patch is probably the most prevalent and damaging soilborne disease in WA wheat, and there is no varietal resistance. For fusarium crown rot, there is currently limited resistance in varieties grown in WA. Reducing build up of infected cereal stubble and weeds are the best approach through inclusion of broadleaf crops in the rotation and controlling grasses and cereal volunteers.

Root lesion nematodes (RLN) cause damage when they enter the root and extract nutrients and water from the plant. *Pratylenchus neglectus* is the dominant RLN species in broadacre growing areas of WA, followed by *P. quasitereoides* (formerly *P. teres*). *P. thornei* and *P. penetrans* are less commonly detected but may also impact yields. The key to managing RLN is identifying paddocks with yield-limiting numbers and incorporating more resistant crops and varieties to reduce RLN populations. Wheat, barley and canola are all susceptible crops. These crops can suffer significant yield loss and can increase *P. neglectus* and *P. quasitereoides* levels in a paddock over a growing season.

In this guide, *P. quasitereoides* nematode resistance scores are from WA glasshouse and field trials. *P. neglectus* ratings should be used as a guide only as not all varieties have been tested in WA. Varieties with fewer than five observations, or where there has been no field trial verification of the glasshouse rating, receive provisional ratings.

Cereal cyst nematodes (*Heterodera avenae*; CCN) are one of the most damaging pests found in WA soils and can cause significant yield losses in wheat, oats and barley. Canola and other broadleaf crops are not hosts so yields of these crops are not affected by CCN. When the season breaks, CCN eggs hatch and juveniles enter plant roots where they set up a fixed feeding site. They damage root tissues as they grow and reduce plant functions because they extract nutrients and water from the plant. The nematodes form into hardened cysts which protect hundreds of eggs over the summer period. CCN is mostly found around Geraldton, Esperance and the Avon Valley but can occur elsewhere in the WA grainbelt. CCN can be easily managed by including resistant cereal varieties and weed free non-cereal crops in the rotation. If levels of CCN are high, then two consecutive years of a non-host may be required. There are no registered chemical treatments to control CCN.

In-crop diagnosis of the disease or pest affecting plant roots is best achieved by sending affected plants to DPIRD Diagnostic and Laboratory Services (DDLS) in South Perth. For more information on sample submission contact (08) 9368 3351 or DDLS@dpird.wa.gov.au. Alternatively, a DNA-based soil-testing service (PREDICTA®B) is also available, and growers can contact their agronomist or SARDI for advice on how to submit samples for molecular testing.

Fungicides

Fungicides can help control disease and limit yield impacts but fungicide resistance in a range of wheat and barley pathogens is a rapidly developing issue for the Australian grains industry. Using integrated disease management (IDM), including varietal disease resistance, can help reduce reliance on fungicides for disease management. More information on fungicide resistance is available from The Australian Fungicide Resistance Extension Network (https://afren.com.au/)

For more information:

- Crop diseases – forecasts and management at https://agric.wa.gov.au/n/2319
- Wheat disease ratings at https://agric.wa.gov.au/n/3353
- Registered seed dressing and in-furrow fungicides for cereals in WA at https://agric.wa.gov.au/n/1794
- Download the ‘Australian Field Crop Disease Guide App’ which is available for both Apple and Android.
- Download the ‘MyCrop App’ which is available for both Apple and Android.

Table 18. Disease resistance ratings for wheat varieties grown in Western Australia

Variety	Grade	Yellow spot	Nodorum blotch (leaf)	Nodorum blotch (glume)	Rust			Powdery mildew
					Stem	Stripe	Leaf	
Brumby	APW	MRMS	MRMS	MS	MR	RMR	SVS	R*
Calibre	AH	MRMS	MSS	MSS	MR	RMR	S	MSS
Calingiri	Feed	MS	MSS	MSS	SVS	SVS	S	SVS
Catapult	AH	MRMS	MRMS	MRMS	MR	RMR	S	S
Chief CL Plus	APW (N)	MRMS	MS	MRMS	MR	S	MR*	S
Corack	APW	MRMS	MS	MRMS	MR	MS	SVS	SVS
Cutlass	APW (N)	MSS	MRMS	MRMS	R	RMR*	RMR*	S
Devil	AH (N)	MRMS	MS	MRMS	S	MR	SVS	S
Denison	APW	MRMS	MR	MRMS	MS	MR	S	S
Dozer	APW	MS*p*	–	–	MS*p*	MRMS*p*	S*p*	S*p*
DS Bennett	Feed	MRMS	MR	MR	MS	RMR	SVS	R*
DS Pascal	APW	MS	MRMS	MRMS	MSS	RMR	MS	RMR
EGA Bonnie Rock	AH (N)	MS	MS	MSS	MSS	SVS	SVS	SVS
Firefly	ANW	MRMS*p*	–	–	S*p*	MSS*p*	MSS*p*	–
Hammer CL Plus	AH (N)	MRMS	MRMS	MRMS	MR	RMR	S	SVS
Illabo	AH	MS	MR	MR	MRMS	RMR	S	RMR
Kinsei	ANW	MS	MRMS	MRMS	MSS	MRMS	MSS	S
Longsword	AWW	MRMS	MRMS	MRMS	MR	RMR	MR*	MRMS
LRPB Anvil CL Plus	AH	MSS	MSS	MSS	MR	RMR	SVS	S*p*
LRPB Avenger	APW (N)	MS	S	MS	MS	MRMS	S	S*p*
LRPB Cobra	AH	MRMS	MRMS	MS	MR	MSS	MR*	MSS
LRPB Havoc	AH (N)	MRMS	MS	MRMS	S	MR	S	MSS
LRPB Nighthawk	APW	MS	MRMS	MR	RMR	RMR	MSS	MSS
LRPB Trojan	APW (N)	MSS	MS	MS	MRMS	MR	MR*	S
Mace	AH (N)	MRMS	MS	MS	MRMS	RMR*	S	MSS
Magenta	APW	MRMS	MRMS	MS	MR	MSS	RMR*	MRMS
Mowhawk	AH	MRMS*p*	–	–	RMR*p*	RMR*p*	MR*p*	RMR*p*
Ninja	ANW	MRMS	MS	MS	S	MS	S	MSS
Razor CL Plus	ASW	MSS	MS	MS	MRMS	RMR	S	MSS
RockStar	AH (N)	MRMS	MRMS	MRMS	MRMS	RMR	S	MS
Scepter	AH	MRMS	MRMS	MSS	MRMS	RMR	MSS	S
Sheriff CL Plus	APW (N)	MRMS	MRMS	MRMS	MS	MS	SVS	SVS
Sting	AH	MRMS	MS	MS	MRMS	MR	SVS	S
Tomahawk CL Plus	APW	MRMS*p*	–	–	MR*p*	RMR*p*	S*p*	–
Valiant CL Plus	AH	MRMS	MR	MRMS	MR	RMR	S	S
Vixen	AH (N)	MRMS	MSS	MSS	MRMS	MRMS	SVS	SVS
Westonia	APW (N)	MSS	S	MSS	SVS	VS	S	SVS
Wyalkatchem	APW (N)	MRMS	MS	MS	SVS	S	S	SVS
Yitpi	AH	SVS	MS	MRMS	S	MRMS	S	MS
Zen	ANW	MRMS	MS	MRMS	S	MRMS	S	S

(N) = Denotes supplementary classification of APWN. = new releases for 2024 season.

VS = Very susceptible, SVS = Susceptible to very susceptible, S = Susceptible, MSS = Moderately susceptible to susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, RMR = Resistant to moderately resistant, R = Resistant. *Refer to page 4 for interpreting resistance classification.*

No score '–' = no rating is currently available. *p* = provisional rating.

* Some races in eastern Australia can attack these varieties, including races with Yr17 virulence for stripe rust and races with Lr24 virulence for leaf rust and a virulent pathotypes for powdery mildew at Bute, SA affecting Brumby and Shenton Park affecting DS Bennett.

[Table 18. continued following page...]

Table 18. Disease resistance ratings for wheat varieties grown in Western Australia (cont'd)

Variety	Grade	Septoria tritici blotch	Flag smut	Common bunt	Root lesion nematode#		Cereal cyst nematode	Crown rot
					P. neglectus	*P. quasitereoides*		
Brumby	APW	MSS*p*	–	–	MRMS*p*	–	MRMS*p*	S
Calibre	AH	SVS	–	–	S	MR*p*	MRMS	S
Calingiri	Feed	MSS	RMR	MRMS	SVS	S	–	S
Catapult	AH	S	RMR	MRMS	S	MRMS	R	MSS
Chief CL Plus	APW (N)	MSS	SVS	MR	MRMS	MRMS	MS	MSS
Corack	APW	S	S	MSS	MSS	MSS	RMR	S
Cutlass	APW (N)	MSS	MSS	S	MSS	MS*p*	MR	S
Devil	AH (N)	SVS	SVS	MR	MSS	MRMS	MSS	MSS
Denison	APW	MS	R*p*	MR*p*	S	MR*p*	MS	MSS
Dozer	APW	–	–	–	–	–	MS*p*	–
DS Bennett	Feed	MR	SVS	RMR	S	–	S	VS
DS Pascal	APW	MS	S	SVS	S	–	S	S
EGA Bonnie Rock	AH (N)	S	S	MS	VS	S	S	–
Firefly	ANW	–	–	–	–	–	MSS*p*	–
Hammer CL Plus	AH (N)	MSS	RMR	RMR	MSS	MR*p*	MRMS	MSS
Illabo	AH	MR	R	MS	MSS	MR*p*	MRMS	S
Kinsei	ANW	MSS	RMR	MR	S	S	MSS	MSS
Longsword	AWW	MRMS	MRMS	RMR	MRMS	–	MRMS	MSS
LRPB Anvil CL Plus	AH	S	–	–	MSS	–	MRMS	MSS
LRPB Avenger	APW (N)	MSS	S	S	MSS	–	MRMS	SVS
LRPB Cobra	AH	S	MS	VS	MSS	MSS	MS	S
LRPB Havoc	AH (N)	MRMS	MS	R	S	MRMS	S	MSS
LRPB Nighthawk	APW	MRMS	MSS	RMR	MSS	MRMS*p*	MS	MSS
LRPB Trojan	APW (N)	S	SVS	SVS	MSS	MS*p*	MS	MS
Mace	AH (N)	S	S	MRMS	MSS	MRMS	MRMS	S
Magenta	APW	MS	MSS	SVS	MSS	MSS	S	MSS
Mowhawk	AH	–	–	–	–	–	–	–
Ninja	ANW	MSS	MR	RMR	S	S	MS	S
Razor CL Plus	ASW	SVS	RMR	RMR	S	–	MR	S
RockStar	AH (N)	S	VS	MR	MRMS	MS	MSS	S
Scepter	AH	S	MSS	MSS	S	MS	MRMS	MSS
Sheriff CL Plus	APW (N)	S	S	RMR	MRMS	MRMS*p*	MS	S
Sting	AH	S	SVS	S	MRMS	MS*p*	MS	MSS
Tomahawk CL Plus	APW	–	–	–	–	–	–	–
Valiant CL Plus	AH	MRMS	–	–	S	MS*p*	MSS*p*	S
Vixen	AH (N)	MSS	SVS	RMR	MRMS	MSS	MSS	S
Westonia	APW (N)	S	SVS	S	SVS	S	S	S
Wyalkatchem	APW (N)	S	S	MR	MRMS	MSS	S	S
Yitpi	AH	MS	MR	S	MSS	MS	MR	S
Zen	ANW	S	MS	MR	MRMS	MRMS*p*	S	S

(N) = Denotes supplementary classification of APWN. = new releases for 2024 season.

VS = Very susceptible, SVS = Susceptible to very susceptible, S = Susceptible, MSS = Moderately susceptible to susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, RMR = Resistant to moderately resistant, R = Resistant. *Refer to page 4 for interpreting resistance classification.*

No score '-' = no rating is currently available. *p* = provisional rating.

* Some races in eastern Australia can attack these varieties, including races with Yr17 virulence for stripe rust and races with Lr24 virulence for leaf rust and a virulent pathotype at Bute in SA for powdery mildew.

Use *P. neglectus* ratings as a guide only as not all varieties have been tested in WA. *P. quasitereoides* ratings are from DPIRD WA glasshouse and field trials.

Cereal Cyst Nematode data from **nvtonline.com.au**

Crown rot ratings from SARDI, USQ and DPI NSW data.

Variety traits

Jeremy Curry, Brenda Shackley and Dion Nicol (DPIRD)

Coleoptile length and seeding depth

Seeding into moisture at a seeding depth of 2–4cm is the preferred option in WA to ensure quick establishment and maintain yield potential. However, with expanding seeding programs and increased variability in the timing and amount of autumn rainfall, dry seeding has dramatically increased in WA.

Avoid sowing deeper than 5cm as this has the potential to delay and reduce emergence, causing weaker seedlings and an overall reduction in yield (Table 19).

Longer coleoptiles can maintain establishment rate if seeding depth increases (Table 19). The ability to establish wheat crops from seed placed deeper in the soil can be useful in situations where the soil surface is dry, but the subsoil is moist. Coleoptile length is influenced by factors other than variety, including seed size and source, temperature, soil water, certain seed dressings and the type of coleoptile length assessment (as shown in Table 19). Generally, there is more scope to adjust seeding equipment for deep sowing and impact establishment to a greater degree than the often minor differences in mainstream varieties.

Varieties vary inherently in coleoptile lengths. Table 20 replaces previous reporting of coleoptile index and provides a guide to coleoptile group. Coleoptile groups are collectively identified as short (S), medium (M), long (L) or very long (VL).

- Halberd is currently the only variety in the 'very long' coleoptile group, with potential replacements in the breeding pipeline.
- Varieties with 'long' coleoptile lengths include Calibre, Cutlass, Magenta and Yitpi. Denison and Sting have a slightly shorter coleoptile and hence are rated as M/L.
- The impact of deep sowing on grain yield depends on growing season conditions and whether lower plant density and vigour can be compensated for through increases in other yield components such as tiller number, grains per ear and grain weight.
- Increasing seeding rates can help partially reduce the yield penalty caused by reduced establishment with deeper sowing.
- Not all seeding systems are equal for deep sowing, so ensure depth is monitored as conditions change.

Grain quality

While hectolitre weights and small grain screenings for individual varieties can vary from site to site and year to year, they are generally well below industry limits in WA and are therefore not presented in this guide.

Details can be found at nvt.online.com.au.

Table 19. Coleoptile length (cm) and plant establishment of a range of varieties germinated on filter paper 'cigars' or sown at 10cm at Katanning in 2021

Variety (Coleoptile group)	Coleoptile length (cm)		Establishment (m²) at 10cm deep	Grain yield (t/ha)	
	Filter paper	Sown at 10cm		at 10cm deep	at 4cm deep
DS Pascal (S)	6.3	4.9	27	2.3	4.4
Scepter (S/M)	7.5	5.5	31	2.5	5.0
Calibre (L)	8.5	6.7	48	3.0	4.9
Yitpi (L)	9.4	6.8	58	2.7	4.6
Halberd (VL)	12.3	7.8	100	3.3	4.2
lsd			30 (m²)	0.5 (t/ha)	0.5 (t/ha)

Germination cabinet set at 15°C and average soil temp = 14.7°C for the 15 days from 'seeding' to measurement. Plant establishment determined at 21 days after sowing, sown 5th May. Average establishment at 4cm was 175 plants/m². Variable seed sources and grain weights. Coleoptile groups are collectively identified as short (S), medium (M), long (L) or very long (VL).

Falling Number Index

The falling number index (FNI) is a rating system that reflects the risk of a wheat variety exhibiting a low falling number at harvest (Table 20). Low falling number in wheat has several causes and these are controlled by complex interactions between genotype and the environment. An example is pre-harvest sprouting, a common cause of low falling number where mature grain begins to germinate in the paddock in response to rainfall. The falling number of a variety upon receival will be influenced by the wheat variety grown, stage of maturity, timing and intensity of seasonal rainfall and temperature/humidity during the growing season.

DPIRD has carried out research since 2013 to better understand the susceptibility of wheat varieties to low falling number, both in response to growing conditions and rainfall in the pre- and post-maturation period.

The FNI determines the risk of a variety exhibiting low falling number. On a 1–9 scale, the higher the rating the more likely a variety is to maintain falling number and the lower the risk of downgrade at grain delivery.

The pre-harvest sprouting (PHS) tolerance of Mace and Scepter (FNI of 5) has underpinned their widespread adoption across WA, even into areas of high PHS risk. With a FNI of 7, DS Pascal is considered the variety of lowest risk of PHS. New varieties with updated ratings include Calibre and Brumby (both rated 6*p*), Mowhawk (5), Sting (4*p*), and LRPB Anvil and Valiant CL Plus (both 2/3*p*).

DPIRD research has found crops that mature earlier (such as spring wheats sown in April) have a higher risk of low falling number and blackpoint.

Further research is being carried out to understand the drivers of this risk and how it varies across WA wheat growing regions.

Table 20. Black point ratings, falling number index and coleoptile group of wheat varieties in 2023

Variety	Black point#	Falling number index	Coleoptile group
Brumby	MS*p*	6*p*	M
Calibre	MS*p*	6*p*	L
Catapult	S	6	M
Chief CL Plus	MS	4	M
Cutlass	MS	4	L
Denison	MS	5	M/L
Devil	MSS	3	M
DS Bennett	MSS	-	M
DS Pascal	MS	7	S
Hammer CL Plus	MRMS	4	M
Illabo	MRMS	5	M
Kinsei	S	4	M
LRPB Anvil CL Plus	S*p*	2/3*p*	M
LRPB Avenger	MS	5*p*	-
LRPB Havoc	MS	3	-
LRBP Nighthawk	MS	-	-
LRPB Trojan	MS	5	-
Mace	MRMS	5	M
Magenta	MSS	3	L
Mowhawk	-	5	M*p*
Ninja	MRMS*	4	S/M
Razor CL Plus	MS	4	M
Rockstar	MSS	2	M
Scepter	MS	5	S/M
Sheriff CL Plus	MS	4	-
Sting	S	4*p*	M/L
Valiant CL Plus	MS*p*	2/3*p*	M
Vixen	MSS	3	M
Westonia	MS*	2	M
Wyalkatchem	MS*	3	S
Yitpi	MS	5	L
Zen	MRMS	3	S

Black point ratings are sourced from NVT disease ratings from NVT Online, nvtonline.com.au

* = Black point ratings not updated. Coleoptile groups are collectively identified as short (S), medium (M), long (L) or very long (VL). Coleoptile groups are based filter paper 'cigars' germinated at 15°C for 15 days. Groups combine information previously supplied as part of an NVT project and DPIRD research in 2023.

p = provisional rating based upon a single year of data and limited data hence results to be treated with caution.

Variety snapshots

Brenda Shackley, Jeremy Curry and Dion Nicol (DPIRD)

Variety snapshots are presented for 20 varieties in order of quality classification.

Each snapshot includes a summary of essential characteristics for each variety and its key strengths and weaknesses. Grain yields relative to Scepter for each year between 2018 and 2022 for each Agzone are presented (extracted from nvtonline.com.au. Disease ratings are as per Table 18.

Flowering information is sourced from DPIRD experiments in 2019, 2020, 2021 and 2022 and from NVT sites when other data is not available.

All information is presented relative to Scepter.

Variety information including pedigree, seed licensee, seed trading restrictions and end point royalty (EPR) payable is sourced from breeding companies and Variety Central (varietycentral.com.au).

If seeking information for any varieties not included in the snapshots, please consult varietycentral.com.au, nvtonline.com.au or the respective breeding company.

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- **GRDC:** NVT trials (grain yield data) and their service providers.

Calibre(Þ)

AH

Comments

Calibre is the first Scepter cross released by AGT in 2021. It is a quick-mid maturing AH variety with a longer coleoptile than its parent Scepter (similar to Cutlass). Calibre has been included in the NVT since 2020, yielding similar to or slightly higher than Scepter, and competitive with Vixen, Rockstar and Devil across the various agzones. Calibre is MSS to powdery mildew, similar to LRPB Havoc, which is the highest rating amongst the quick-mid maturity group. Preliminary data indicates Calibre has a slightly higher rating than Scepter for pre-harvest sprouting.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	-	-	101	96	99
Agzone 2	-	-	102	99	102
Agzone 3	-	-	101	101	100
Agzone 4	-	-	100	98	101
Agzone 5	-	-	104	102	101
Agzone 6	-	-	99	97	101
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MSS				
Nodorum blotch (glume)	MSS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	MSS				
Septoria tritici blotch	SVS				
Flag smut	–				
Common bunt	–				
RLN (*P. quasitereoides*)	MR*p*				
RLN (*P. neglectus*)	S				
CCN	MRMS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+2	+2	+0	-
Merredin	-	-1	+1	2	-
Katanning	-1	-3	-2	-1	-
Grass Patch	2	-1	+0	-	+1
Agronomic traits					
Coleoptile group	Long				
Black point	MS*p*				
Falling number index	6*p*				
Maturity	Quick-mid				
Variety information					
Pedigree	Derived from a Scepter cross				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.50				

Refer to page 4 for interpreting resistance classification.
p = provisional rating

Catapult(Þ)

AH

Comments

Catapult is a mid-slow maturity AH variety released by AGT in 2019. Catapult was included in the NVT for the first time in 2018, yielding higher than alternatives such as Denison, Cutlass and Valiant CL Plus, but lower than Scepter, RockStar and Brumby in the main season trials. In the early season NVT trials, Catapult has yielded similar to Kinsei with a more robust performance in Agzones 2, 3, 5 and 6 compared to Agzones 1 and 4. However in the early season NVT, Catapult is slightly lower than Denison, Cutlass and Valiant CL Plus. Catapult is S to leaf rust, powdery mildew and black point. With a falling number rating of 6, Catapult has a lower risk of pre-harvest sprouting. In good growing conditions, Catapult can exhibit a speckling on the leaves or what has previously been known as 'Mace yellows'. This is not a disease but a physiological response, which typically has no effect on yield.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	93	94	95	91	100
Agzone 2	96	94	93	94	99
Agzone 3	94	94	97	96	100
Agzone 4	95	94	90	91	97
Agzone 5	97	95	89	94	95
Agzone 6	98	96	95	94	99
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MRMS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	S				
Flag smut	RMR				
Common bunt	MRMS				
RLN (*P. quasitereoides*)	MRMS				
RLN (*P. neglectus*)	S				
CCN	R				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+19	+13	+12	-
Merredin	+19	+13	+8	+5	-
Katanning	+20	+11	+9	+5	-
Grass Patch	+18	+13	+6	-	+5
Agronomic traits					
Coleoptile group	Medium				
Black point	S				
Falling number index	6				
Maturity	Mid-slow				
Variety information					
Pedigree	Mace/Corack				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.25				

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Devil(b)

AH (N)

Comments

Devil is a quick-mid maturity AH (N) variety which was released in 2018. Devil has been in the NVT since 2017 and has yielded similarly to Scepter in all years and agzones. Devil has been recently downgraded to S for stem rust and remained SVS to the latest leaf rust pathotype and powdery mildew. DPIRD trials suggest that Devil has different maturity triggers to Scepter resulting in earlier flowering when sown in April or in the northern regions. A falling number rating of 3, so not recommended for areas prone to pre-harvest sprouting. Devil is best suited to the Northern zone of WA for this reason.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	100	101	100	99	102
Agzone 2	101	100	100	101	102
Agzone 3	100	101	102	101	103
Agzone 4	101	101	98	99	101
Agzone 5	102	101	99	101	102
Agzone 6	102	102	102	101	103
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	S				
Stripe rust	MR				
Leaf rust	SVS				
Powdery mildew	S				
Septoria tritici blotch	SVS				
Flag smut	SVS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MRMS				
RLN (*P. neglectus*)	MSS				
CCN	MSS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2020 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-3	-3	-3	-1	-1
Merredin	+1	-2	-2	+0	–
Katanning	-4	-1	-1	+0	–
South East	-4	-2	-1	–	-1
Agronomic traits					
Coleoptile group	Medium				
Black point	MSS				
Falling number index	3				
Maturity	Quick-mid				
Variety information					
Pedigree	IGW3110/Mace				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$3.50				

(N) denotes the supplementary classification of APWN.
Refer to page 4 for interpreting resistance classification.

Hammer CL Plus(b)

AH (N)

Comments

Hammer CL Plus is an AH (N) imidazolinone tolerant variety released in 2020 by AGT. Hammer CL Plus has been included in the WA NVT since 2020, where it yielded 5 to 9% lower than Scepter depending on the agzone. Overall, it is slightly higher yielding than Chief CL Plus and Sheriff CL Plus and slightly lower yielding than Razor CL Plus. Hammer CL Plus is closely related to Mace with a similar maturity. A disadvantage with Hammer is that it may be prone to lodging compared to other IMI varieties. Hammer CL Plus is RMR for stripe rust, MR for stem rust, S for leaf rust and SVS for powdery mildew. Registered for label rate applications of Intervix® herbicide.

Note: There are no grower-to-grower sales permitted for any CL Plus varieties.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	-	-	95	93	91
Agzone 2	-	-	95	93	93
Agzone 3	-	-	93	93	90
Agzone 4	-	-	95	93	93
Agzone 5	-	-	94	92	91
Agzone 6	-	-	89	91	92
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MRMS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	SVS				
Septoria tritici blotch	MSS				
Flag smut	RMR				
Common bunt	RMR				
RLN (*P. quasitereoides*)	MR*p*				
RLN (*P. neglectus*)	MSS				
CCN	MRMS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	-1	+2	+1	–
Merredin	+5	+1	-2	+0	–
Katanning	-3	-2	+1	+0	-
Grass Patch	+0	-1	+1	-	-2
Agronomic traits					
Coleoptile group	Medium				
Black point	MRMS				
Falling number index	4				
Maturity	Quick-mid				
Variety information					
Pedigree	Clearfield donor backcrossed to Mace derivative				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates or retailers. **No grower-to-grower trading permitted**				
EPR ($/t, excl GST)	$4.25				

(N) denotes the supplementary classification of APWN
Refer to page 4 for interpreting resistance classification.
p = provisional rating.

LRPB Anvil$^{\phi}$ CL Plus

AH

Comments

LPRB Anvil was released by LongReach in 2022, as a quick AH imidazoline tolerant variety. It has been included in the WA NVT since 2020, previously achieving the highest yields of the IMI tolerant varieties until the latest release of Tomahawk CL Plus and Dozer. It is lower yielding than Scepter, particularly in the soft finish of 2022. LongReach suggests that LRPB Anvil is well suited to the terminal drought conditions in the low to medium rainfall areas of WA. LRPB Anvil has a similar stem and stripe rust profile to Hammer CL Plus, but is weaker for leaf rust and yellow spot. Registered for label rate applications of Intervix® herbicide.

Note: There are no grower-to-grower sales permitted for any CL Plus varieties.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	96	84
Agzone 2	-	-	97	95	87
Agzone 3	-	-	-	88	86
Agzone 4	-	-	101	98	88
Agzone 5	-	-	103	91	95
Agzone 6	-	-	-	90	91
Disease resistance	**Adult rating**				
Yellow spot	MSS				
Nodorum blotch (leaf)	MSS				
Nodorum blotch (glume)	MSS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	SVS				
Powdery mildew	S*p*				
Septoria tritici blotch	S				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	MSS				
CCN	MRMS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	-18	-13	-9	-
Merredin	-	-12	-11	-4	-
Katanning	-17	-12	-9	-5	-
Grass Patch	-	-11	-9	-	-4
Agronomic traits					
Coleoptile group	Medium				
Black point	S*p*				
Falling number index	2/3*p*				
Maturity	Quick				
Variety information					
Pedigree	Mace cross				
Breeder/Seed licensee	LongReach Plant Breeders				
Access to seed	Seed associate network. **No grower-to-grower trading permitted**				
EPR ($/t, excl GST)	$4.25				

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

LRPB Havoc$^{\phi}$

AH (N)

Comments

LPRB Havoc was released by LongReach in 2017, as an AH and now an APWN. Over the last five years the variety has yielded slightly less than Scepter in Agzones 1, 2 and 4. Havoc is slightly quicker in maturity than Scepter. Havoc has a low falling number index rating. Please note: Havoc is S to both rust types but MR to stripe rust. Havoc is now MSS to powdery mildew, similar to Calibre, which is the highest rating amongst the quick-mid maturity group.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	101	96	95	103	92
Agzone 2	97	99	98	99	92
Agzone 3	100	100	95	94	92
Agzone 4	98	96	102	101	93
Agzone 5	95	97	100	95	97
Agzone 6	96	95	95	99	94
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	S				
Stripe rust	MR				
Leaf rust	S				
Powdery mildew	MSS				
Septoria tritici blotch	MRMS				
Flag smut	MS				
Common bunt	R				
RLN (*P. quasitereoides*)	MRMS				
RLN (*P. neglectus*)	S				
CCN	S				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	-9	-7	-9	-4	-5
Eastern	-5	-6	-3	-4	-4
Katanning	-	-4	-3	-4	-3
Gibson	-	-12	-6	-6	-6
Agronomic traits					
Coleoptile group	-				
Black point	MS				
Falling number index	3				
Maturity	Quick-mid				
Variety information					
Pedigree	Mace/LPB07-0980				
Breeder/Seed licensee	LongReach Plant Breeders				
Access to seed	Seed associate and farmer to farmer (WA)				
EPR ($/t, excl GST)	$4.00				

(N) denotes the supplementary classification of APWN.
Refer to page 4 for interpreting resistance classification.
p = provisional rating.

RockStar(b)

AH (N)

Comments

RockStar is a mid-slow AH (N) variety released in 2019 by InterGrain. It has been included in the NVT since 2018, yielding similar to Scepter and higher than other mid-slow alternatives such as Catapult, Cutlass, Denison, Kinsei and Valiant CL Plus. RockStar is MRMS to *P. neglectus* but S to leaf rust and VS to flag smut. RockStar was amongst the highest yielding varieties in the early season NVTs. RockStar has different maturity triggers than other mid-slow varieties such as Cutlass, caution is recommended if sown in April. It has a falling number rating of 2, so a higher risk to pre-harvest sprouting.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	97	99	101	99	106
Agzone 2	102	96	98	101	105
Agzone 3	99	99	103	102	106
Agzone 4	100	95	95	97	103
Agzone 5	98	97	96	101	102
Agzone 6	103	104	104	103	105
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MRMS				
Stem rust	MRMS				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	MS				
Septoria tritici blotch	S				
Flag smut	VS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MS				
RLN (*P. neglectus*)	MRMS				
CCN	MSS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+12	+9	+7	-
Merredin	+12	+9	+7	+5	-
Katanning	+10	+7	+5	+3	-
Grass Patch	+9	+6	+5	-	+3
Agronomic traits					
Coleoptile group	Medium				
Black point	MSS				
Falling number index	2				
Maturity	Mid-slow				
Variety information					
Pedigree	IGW3119/Mace/IGW3176				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$3.50				

(N) denotes the supplementary classification of APWN.
Refer to page 4 for interpreting resistance classification.

Scepter(b)

AH

Comments

Scepter, released in 2015, remains the yield benchmark in WA NVT, although it is similar in yield to Calibre and Devil, and slightly lower in yield than Vixen in Agzones 4 and 5. Scepter is MSS to the latest strain of leaf rust, which is an advantage over Calibre, Devil, Vixen, LRPB Havoc and Sting, which are more susceptible. Scepter appears to have a similar pre-harvest sprouting resistance to Mace, but its powdery mildew and black point ratings are poorer than Mace (which is one of its parents). Due to a consistent increase in yield, grain protein is on average lower for this variety and additional nitrogen may benefit yield and protein performance.

Yield (% of Mace)	2018	2019	2020	2021	2022
Agzone 1	**105**	**104**	**107**	**108**	**106**
Agzone 2	**105**	**107**	**104**	**107**	**107**
Agzone 3	**110**	**106**	**104**	**108**	**108**
Agzone 4	**105**	**106**	**105**	**105**	**106**
Agzone 5	**108**	**107**	**105**	**106**	**110**
Agzone 6	**107**	**108**	**110**	**111**	**110**
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MSS				
Stem rust	MRMS				
Stripe rust	RMR				
Leaf rust	MSS				
Powdery mildew	S				
Septoria tritici blotch	S				
Flag smut	MSS				
Common bunt	MSS				
RLN (*P. quasitereoides*)	MS				
RLN (*P. neglectus*)	S				
CCN	MRMS				
Crown rot	MSS				
Flowering	**Days after/before Mace**				
2020 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	**+2**	**+1**	**+4**	**+1**	**+6**
Merredin	**+4**	**+4**	**+4**	**+4**	**+2**
Katanning	**+3**	**+3**	**+3**	**+2**	**-**
Gibson	**+6**	**+5**	**+6**	**+3**	**+4**
Agronomic traits					
Coleoptile group	Short				
Black point	MS				
Falling number index	5				
Maturity	Quick-mid				
Variety information					
Pedigree	RAC1480/2*Mace				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.25				

Refer to page 4 for interpreting resistance classification.

Sting(ᵇ)

AH

Comments

Sting is a quick maturity AH variety released in 2020 by AGT. It was present in the NVT for the first time in 2019, and although its average yield is similar to Scepter, its performance is variable depending on the season and agzone. Sting is usually superior to Scepter in scenarios with late sowing or earlier onset of terminal drought. Maturity is similar to Corack but not as quick as Vixen. Sting is SVS to leaf rust.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	-	102	100	99	94
Agzone 2	-	104	102	99	97
Agzone 3	-	101	98	98	94
Agzone 4	-	107	103	100	98
Agzone 5	-	105	104	99	98
Agzone 6	-	95	96	97	96
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MS				
Stem rust	MRMS				
Stripe rust	MR				
Leaf rust	SVS				
Powdery mildew	S				
Septoria tritici blotch	S				
Flag smut	SVS				
Common bunt	S				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	MRMS				
CCN	MS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	-10	-6	-5	-
Merredin	-	-7	-7	-1	-
Katanning	-12	-7	-5	-2	-
Grass Patch	-	-5	-2	-	-3
Agronomic traits					
Coleoptile group	Medium/Long				
Black point	S				
Falling number index	4*p*				
Maturity	Quick				
Variety information					
Pedigree	Mace backcross				
Breeder/Seed licensee	AGT*				
Access to seed	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.50				

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Valiant CL Plus(ᵇ)

AH

Comments

Valiant CL Plus is an AH imidazolinone tolerant variety released in 2021 by InterGrain. Valiant CL Plus has been included in WA NVT since 2020 where it yields between 3 to 12% lower than Scepter depending on the agzone. Valiant CL Plus has a mid-slow maturity, offering the unique trait of IMI tolerance for an April sowing. However, it should be noted that Valiant CL Plus has a provisional rating of 2/3*p* for falling number index, a risk that is increased with earlier sowing. Valiant CL Plus is MRMS for yellow spot, RMR for stripe rust, MR for stem rust and S for leaf rust and powdery mildew. Registered for label rate applications of Intervix® herbicide.

Note: There are no grower-to-grower sales permitted for any CL Plus varieties.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	91	101
Agzone 2	-	-	87	93	97
Agzone 3	-	-	95	94	101
Agzone 4	-	-	-	87	94
Agzone 5	-	-	81	89	95
Agzone 6	-	-	95	94	101
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MR				
Nodorum blotch (glume)	MRMS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	MRMS				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	S				
CCN	MSS*p*				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2022 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+25	+16	+13	-
Merredin	+16	+19	+11	+6	+4
Katanning	+16	+11	+9	+5	-
Grass Patch	+23	+9	+8	+7	-
Agronomic traits					
Coleoptile group	Medium				
Black point	MS*p*				
Falling number index	2/3*p*				
Maturity	Mid-slow				
Variety information					
Pedigree	Complex cross				
Breeder/Seed licensee	InterGrain				
Access to seed	Intergrain Seed Club Members or Seed Retailers. **No grower-to-grower trading permitted**				
EPR ($/t, excl GST)	$4.35				

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Vixen(Þ)

AH (N)

Comments

Vixen is a quick maturity AH (N) variety released in 2018 by InterGrain. Yields are higher than Scepter in Agzones 4 and 5 and slightly lower in Agzone 6. Despite it's quick maturity,Vixen is a very competitive variety, however, it responds better with later sowing and terminal drought to the season compared to the softer finish in 2022. Vixen is MRMS to stem and stripe rust but SVS to the latest strain of leaf rust and powdery mildew. A falling number rating of 3, so not recommended for areas prone to pre-harvest sprouting.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	105	104	100	104	94
Agzone 2	101	107	105	103	96
Agzone 3	103	106	100	98	95
Agzone 4	103	109	107	105	98
Agzone 5	106	107	108	101	101
Agzone 6	100	97	99	100	97
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MSS				
Nodorum blotch (glume)	MSS				
Stem rust	MRMS				
Stripe rust	MRMS				
Leaf rust	SVS				
Powdery mildew	SVS				
Septoria tritici blotch	MSS				
Flag smut	SVS				
Common bunt	RMR				
RLN (*P. quasitereoides*)	MSS				
RLN (*P. neglectus*)	MRMS				
CCN	MSS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	-13	-11	-9	-
Merredin	-	-12	-10	-3	-
Katanning	-14	-12	-7	-4	-
Grass Patch	-	-10	-6	-	-5
Agronomic traits					
Coleoptile group	Medium				
Black point	MSS				
Falling number index	3				
Maturity	Quick				
Variety information					
Pedigree	Mace/IGW3119				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$3.50				

(N) denotes the supplementary classification of APWN.
Refer to page 4 for interpreting resistance classification.

Brumby(Þ)

APW

Comments

Brumby is an APW variety released by InterGrain in 2022. Brumby was included in the WA NVT for the first time in 2021 where it yielded similar to RockStar and Scepter. Brumby has a similar maturity to RockStar in the southern areas of WA, but slightly quicker in the warmer northern regions. A key attribute of Brumby is its powdery mildew resistance of R*, with ratings of RMR for stripe rust, MR for stem rust but SVS for leaf rust. Brumby currently has a provisional rating of 6p for pre-harvest sprouting, similar to Catapult, which has the highest rating for the more recently released wheat varieties grown in WA.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	100	104
Agzone 2	-	-	-	100	103
Agzone 3	-	-	-	101	103
Agzone 4	-	-	-	98	102
Agzone 5	-	-	-	99	99
Agzone 6	-	-	-	103	102
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	SVS				
Powdery mildew	R*				
Septoria tritici blotch	MSS				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	MRMS*p*				
CCN	MRMS*p*				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+7	+6	+4	-
Merredin	+11	+5	+4	+2	-
Katanning	+10	+8	+7	+3	-
Grass Patch	+11	+5	+4	-	+3
Agronomic traits					
Coleoptile group	Medium				
Black point	MS*p*				
Falling number index	6*p*				
Maturity	Mid-slow				
Variety information					
Pedigree	–				
Breeder/Seed licensee	InterGrain				
Access to seed	Intergrain Seed Club Members or Seed Retailers. Free to trade				
EPR ($/t, excl GST)	$3.50				

Refer to page 4 for interpreting resistance classification.
p = provisional rating.
* = some races in eastern Australia can attack these varieties.

Chief CL Plus(Þ)

APW (N)

Comments

Chief CL Plus is an APW imidazolinone tolerant variety which was released in 2016. At release it was the highest yielding APW imidazolinone tolerant variety but is now slightly lower yielding than the recently released Tomahawk CL Plus, LRPB Anvil CL Plus, Hammer CL Plus and Razor CL Plus. Chief CL Plus is resistant to both pathotypes of leaf rust, but S to the Lr24 virulent pathotype which is not present in WA (*). Registered for label rate applications of Intervix® herbicide.

Note: There are no grower-to-grower sales permitted for any CL Plus varieties.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	94	90	91	97	93
Agzone 2	94	92	91	94	91
Agzone 3	95	95	93	91	94
Agzone 4	94	87	93	95	92
Agzone 5	89	90	90	90	95
Agzone 6	94	95	94	95	95
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	MR				
Stripe rust	S				
Leaf rust	MR*				
Powdery mildew	S				
Septoria tritici blotch	MSS				
Flag smut	SVS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MRMS				
RLN (*P. neglectus*)	MRMS				
CCN	MS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+7	+5	+3	-
Merredin	+8	+4	+1	+4	-
Katanning	+3	+4	+4	+1	-
Grass Patch	+4	+3	+3	-	+2
Agronomic traits					
Coleoptile group	Medium				
Black point	MS				
Falling number index	4				
Maturity	Mid				
Variety information					
Pedigree	Wyalkatchem derivative				
Breeder/Seed licensee	InterGrain				
Access to seed	Intergrain Seed Club Members or Seed Retailers. **No grower-to-grower trading permitted**				
EPR ($/t, excl GST)	$4.25				

(N) denotes the supplementary classification of APWN.
Refer to page 4 for interpreting resistance classification.
* = some races in eastern Australia can attack these varieties.

Cutlass(Þ)

APW (N)

Comments

Cutlass provides growers with a later season APW option. In the main season NVT, Cutlass averages 90% of Scepter yield. However, DPIRD and early season NVT show that Cutlass is best suited to sowing from late April to early May and is competitive with other mid-slow types in this window. Cutlass is resistant to all three rusts, is MSS to yellow spot and S to powdery mildew. Appears to have a higher risk of pre-harvest sprouting than Catapult and Denison.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	88	88	92	86	99
Agzone 2	93	86	87	89	97
Agzone 3	89	90	94	93	99
Agzone 4	91	85	82	85	94
Agzone 5	91	87	81	88	92
Agzone 6	95	94	92	90	98
Disease resistance	**Adult rating**				
Yellow spot	MSS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MRMS				
Stem rust	R				
Stripe rust	RMR*				
Leaf rust	RMR*				
Powdery mildew	S				
Septoria tritici blotch	MSS				
Flag smut	MSS				
Common bunt	S				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	MSS				
CCN	MR				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+24	+16	+14	-
Merredin	+26	+16	+12	+11	-
Katanning	+23	+14	+11	+9	-
Grass Patch	+30	+20	+11	-	+11
Agronomic traits					
Coleoptile group	Long				
Black point	MS				
Falling number index	4				
Maturity	Mid-slow				
Variety information					
Pedigree	RAC1316//Fang				
Breeder/Seed licensee	AGT				
Access to seed	Seed Sharing				
EPR ($/t, excl GST)	$3.00				

(N) denotes the supplementary classification of APWN.
Refer to page 4 for interpreting resistance classification.
p = provisional rating.
* = some races in eastern Australia can attack these varieties.

Denison(Þ)

APW

Comments

Denison is a mid-slow maturing APW variety released by AGT in 2020. Denison yields slightly higher than Cutlass in Agzones 4 and 5 and about 4–6% higher than Cutlass in Agzones 1, 2, 3 & 6. In Agzone 6, Denison yields similar to Scepter in the main season NVT. Denison is one of the highest yielding varieties in the early season NVT, slightly behind RockStar, but slightly higher than Cutlass, Valiant CL Plus, Kinsei and Catapult. Denison's maturity is similar to Cutlass when sown in May, but it can be quicker than Cutlass when sown early to mid April, particularly in the northern areas. Denison is rated S to leaf rust and powdery mildew. Denison has a good pre-harvest sprouting rating compared to Cutlass.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	-	-	96	94	104
Agzone 2	-	87	90	95	101
Agzone 3	-	92	98	97	104
Agzone 4	-	-	86	91	98
Agzone 5	-	86	84	93	96
Agzone 6	-	100	99	98	102
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MR				
Nodorum blotch (glume)	MRMS				
Stem rust	MS				
Stripe rust	MR				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	MS				
Flag smut	R*p*				
Common bunt	MR*p*				
RLN (*P. quasitereoides*)	MR*p*				
RLN (*P. neglectus*)	S				
CCN	MS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+12	+16	+15	-
Merredin	+21	+17	+11	+7	-
Katanning	+16	+14	+12	+7	-
Grass Patch	+26	+17	+10	-	+7
Agronomic traits					
Coleoptile group	Medium/Long				
Black point	MS				
Falling number index	5				
Maturity	Mid-slow				
Variety information					
Pedigree	–				
Breeder/Seed licensee	InterGrain				
Access to seed	Intergrain Seed Club Members or Seed Retailers. Free to trade				
EPR ($/t, excl GST)	$3.50				

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Tomahawk CL Plus(Þ)

APW

Comments

Tomahawk CL Plus is an APW variety released by AGT in 2023. It is closely related to Scepter with a similar maturity but with the additional benefit of the option to use Clearfield® Intervix® technology in-crop or to manage the Clearfield® Intervix® soil residues from previous crops. Tomahawk CL Plus was included in the WA NVT for the first time in 2022 where it yielded slightly higher than Scepter and significantly higher than other Clearfield® varieties currently grown in WA. At this stage Tomahawk CL Plus is rated S*p* for leaf rust compared to Scepter at MSS.

Note: There are no grower-to-grower sales permitted for any CL Plus varieties.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	105
Agzone 2	-	-	-	-	104
Agzone 3	-	-	-	-	104
Agzone 4	-	-	-	-	104
Agzone 5	-	-	-	-	104
Agzone 6	-	-	-	-	105
Disease resistance	**Adult rating**				
Yellow spot	MRMS*p*				
Nodorum blotch (leaf)	-				
Nodorum blotch (glume)	-				
Stem rust	MR*p*				
Stripe rust	RMR*p*				
Leaf rust	S*p*				
Powdery mildew	-				
Septoria tritici blotch	-				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	-				
CCN	-				
Crown rot	-				
Flowering	**Days after/before Scepter**				
2022 NVT					
Great Southern	+2				
Agronomic traits					
Coleoptile group	-				
Black point	-				
Falling number index	-				
Maturity	Quick-mid				
Variety information					
Pedigree	Scepter type with Clearfield donor				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates or retailers. **No grower to grower trading permitted**				
EPR ($/t, excl GST)	$4.15				

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Firefly(Þ)

ANW

Comments

Firefly was released in 2023, InterGrain's first ANW release since Kinsei in 2018. Firefly was included in the 2021 and 2023 WA NVT. InterGrain data indicates Firefly's yields to be 11% higher than Zen. Firefly has mid-slow maturity, similar to Zen, although 2021 NVT data indicates it may be quicker in northern areas.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	96	-
Agzone 2	-	-	-	97	-
Agzone 3	-	-	-	101	-
Agzone 4	-	-	-	94	-
Agzone 5	-	-	-	97	-
Agzone 6	-	-	-	-	-
Disease resistance	**Adult rating**				
Yellow spot	MRMS*p*				
Nodorum blotch (leaf)	-				
Nodorum blotch (glume)	-				
Stem rust	S*p*				
Stripe rust	MSS*p*				
Leaf rust	MSS*p*				
Powdery mildew	-				
Septoria tritici blotch	-				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	-				
CCN	MSS*p*				
Crown rot	-				
Flowering	**Days after/before Scepter**				
2022 NVT					
Northern	+3				
Great Southern	+4				
Agronomic traits					
Coleoptile group	-				
Black point	-				
Falling number index	-				
Maturity	Mid-slow				
Variety information					
Pedigree	Complex cross of coded breeding lines				
Breeder/Seed licensee	InterGrain				
Access to seed	Intergrain Seed Club Members or Seed Retailers.				
EPR ($/t, excl GST)	$4.00				

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Kinsei(Þ)

ANW

Comments

Kinsei is a mid-slow maturity noodle wheat released by InterGrain in 2018. It is well suited to early sowing opportunities and has also performed well in the NVT main season plantings. Kinsei yields slightly less than Ninja, similar to Zen, and out-yields Calingiri (which is now classified as Feed). Kinsei is among the highest yielding varieties in the early season NVT, only out-yielded by RockStar. Kinsei is S to leaf rust, powdery mildew and black point. Kinsei's disease ratings are marginally better than Ninja and Zen.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	93	92	99	95	103
Agzone 2	97	90	93	96	101
Agzone 3	94	93	99	98	102
Agzone 4	94	86	90	93	100
Agzone 5	89	88	88	95	96
Agzone 6	99	99	99	99	101
Disease resistance	**Adult rating**				
Yellow spot	MS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MRMS				
Stem rust	MSS				
Stripe rust	MRMS				
Leaf rust	MSS				
Powdery mildew	S				
Septoria tritici blotch	MSS				
Flag smut	RMR				
Common bunt	MR				
RLN (*P. quasitereoides*)	S				
RLN (*P. neglectus*)	S				
CCN	MSS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+12	+11	+9	-
Merredin	+15	+10	+10	+6	-
Katanning	+10	+10	+9	+6	-
Grass Patch	+11	+10	+7	-	+5
Agronomic traits					
Coleoptile group	Medium				
Black point	S				
Falling number index	4				
Maturity	Mid-slow				
Variety information					
Pedigree	Complex cross				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$4.00				

Refer to page 4 for interpreting resistance classification.

Ninja(b)

ANW

Comments

Ninja is a noodle wheat variety released by InterGrain in 2016 with a Calingiri and Wyalkatchem background. To date; Ninja has been the highest yielding ANW variety, but will likely be replaced in the future as InterGrain release Firefly and a new generation of noodle wheats. Ninja is S to stem rust, powdery mildew and the new incursion of leaf rust. Rated MRMS to black point.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	93	92	99	95	103
Agzone 2	97	90	93	96	101
Agzone 3	94	93	99	98	102
Agzone 4	94	86	90	93	100
Agzone 5	89	88	88	95	96
Agzone 6	99	99	99	99	101
Disease resistance	**Adult rating**				
Yellow spot	MS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MRMS				
Stem rust	MSS				
Stripe rust	MRMS				
Leaf rust	MSS				
Powdery mildew	S				
Septoria tritici blotch	MSS				
Flag smut	RMR				
Common bunt	MR				
RLN (*P. quasitereoides*)	S				
RLN (*P. neglectus*)	S				
CCN	MSS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2022 & 2021 DPIRD trials	**Early/ mid April**	**Late April**	**Early/ mid May**	**Late May**	**Early June**
Mullewa	-	+12	+11	+9	-
Merredin	+15	+10	+10	+6	-
Katanning	+10	+10	+9	+6	-
Grass Patch	+11	+10	+7	-	+5
Agronomic traits					
Coleoptile group	Medium				
Black point	S				
Falling number index	4				
Maturity	Mid-slow				
Variety information					
Pedigree	Complex cross				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$4.00				

Refer to page 4 for interpreting resistance classification.

ZEN(b)

ANW

Comments

Zen is a noodle variety with a Calingiri and Wyalkatchem background. On average Zen's yields are similar to Kinsei, however Kinsei does outyield Zen in Agzones 3 and 6 and with earlier May sowings. Zen is S to leaf rust, stem rust and powdery mildew. It has a good black point and RLN (*P. neglectus*) rating but has a weaker falling number index rating than Ninja and Kinsei.

Yield (% of Scepter)	2018	2019	2020	2021	2022
Agzone 1	95	91	94	99	95
Agzone 2	95	92	93	96	93
Agzone 3	96	95	94	94	95
Agzone 4	94	87	95	95	94
Agzone 5	87	89	91	92	95
Agzone 6	95	96	95	98	96
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	S				
Stripe rust	MRMS				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	S				
Flag smut	MS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MRMS*p*				
RLN (*P. neglectus*)	MRMS				
CCN	S				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	+9	+4	+5	+6	+4
Eastern	+7	+8	+5	+2	+0
Katanning	+6	+4	+0	+0	+0
Gibson	-	-	-	-	-
Agronomic traits					
Coleoptile group	Short				
Black point	MRMS				
Falling number index	3				
Maturity	Mid-slow				
Variety information					
Pedigree	Calingiri/Wyalkatchem				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$3.85				

Refer to page 4 for interpreting resistance classification.

p = provisional rating.

Barley

Introduction

Blakely Paynter and Hammad Khan (DPIRD)

This variety guide is designed as a reference to help determine which barley variety to grow in your region. It provides market feedback, relative grain yield and grain quality comparisons, disease ratings and agronomic information for malt barley varieties segregated in Western Australia (WA), those in Stage Two of malt accreditation with Grains Australia and selected varieties deliverable as feed to the WA bulk handling system (Tables 1–15; Figures 1–7).

The removal by China on 05 August 2023 of the 80.5% anti-dumping and countervailing duty measures imposed on Australian barley in 2020 is good news for all Australian barley growers. The re-opening of trade with China is expected to benefit WA malt barley growers significantly, given the strong history of our relationship with China and the excellent fit that our varieties have in their malting and brewing systems. However, Chinese maltsters and brewers will need to adjust to the change in the malt variety mix since they implemented tariffs in 2020. For example, varieties such as La Trobe and Scope CL are no longer segregated, and WA growers have switched from Spartacus CL (relatively new in 2019) to Maximus CL. In 2024, six varieties could be accredited by Grains Australia.

With China out of the market over the past three harvests, diversification (and acceptance) of Australian barley grain and malt to Africa, Mexico, and South America has occurred, along with continued sales to long-standing customers in South-East Asia and Japan. As Australian barley grain can now start flowing into China, there will be disruptions to international trade flows.

Over time, if China offers a market price superior to other options, China can be expected to again become a significant trading partner for Australian barley. Chinese demand is significantly higher than other markets we have serviced over the past three seasons. The relationships developed with maltsters and brewers in Africa, Mexico, and South America will, however, continue and provide a broader market opportunity for our barley.

High-quality malt barley that can be malted without processing aids is in strong demand from export customers of our malt barley grain and domestic processors of export malt. Demand for Bass, Flinders and RGT Planet has influenced premiums for malt over feed, especially in the Kwinana port zone, with significant premiums offered over the past two years. The low supply of Bass, Flinders, and RGT Planet will exclude WA malt barley in several premium markets in Asia until production ramps up of new varieties suited to malting without processing aids. Unfortunately, Spartacus CL and Maximus CL are less suited to malting without processing aids.

With the Australian Export Grains Innovation Centre (AEGIC) building technical capability and production knowledge in South-East Asia (focusing on Vietnam, Thailand, Philippines and Indonesia), there is a growing awareness of the value proposition afforded from including barley in animal feed rations. Such diversification opportunities enable feed barley sales to a broader range of international animal feed markets. While Saudi Arabia is the largest feed market for Australian feed barley, Iran, Jordan, Kuwait, and Qatar are also crucial, with demand from the Philippines and Vietnam rising steadily.

Deciding whether to grow barley for malt or feed classification still depends on five main factors:

1. Premium paid for different varieties when segregated.
2. Relative grain yield of malt and feed grade barley varieties.
3. Differences in input costs due to their agronomic and disease characteristics.
4. Likelihood of meeting malt barley receival specifications with a malt variety.
5. Location of receival segregations for malt barley varieties.

The decision to sow wheat instead of barley depends on:

1. The price spread between wheat and barley.
2. Relative grain yield of malt barley, feed barley and wheat.
3. Availability of premiums for malt grade barley.

WA's receival standards for BFED1 (feed barley) focus primarily on hectolitre weight (minimum of 56kg/hL) as the critical quality trait. This differs from growers in eastern Australia who deliver against Grain Trade Australia (GTA) Barley1 (feed barley) receival standards and are required to meet both hectolitre weight (minimum of 62.5kg/hL) and screenings targets (maximum of 15% through a 2.2mm slotted sieve). Therefore, feed barley production systems in WA can focus on targeting yield (with minimal consideration of quality), which enables the sowing of the highest-yielding variety (regardless of its malt accreditation or segregation opportunity). Production systems that maximise grain yield potential include a mid-April to mid-May sowing, targeting a density of 180–220 plants/m^2 with nutrition, herbicide and fungicide strategies in line with the yield potential, deficiencies and risks of the site and the variety sown.

When sowing a malt variety targeting MALT1, it will be necessary to hold discussions with domestic processors and the trade before planting to understand better which malt segregations are likely to be available and the potential premium for MALT1 barley. Growers are encouraged to deliver malt barley grain between 10.3–10.8% protein for domestic sales and 10.5–11.0% for export sales (even though the receival window is 9.5–12.8%) with a minimum of 80% retention on a 2.5mm sieve, a hectolitre weight above 64kg/hL with ryegrass ergot less than 3cm, no whole snails and no glyphosate use near harvest.

Barley varieties differ in their agronomic fit across WA, and market demand for malt barley varieties varies by port zone due to the various domestic and international markets serviced by each port zone. Therefore, choosing a variety that suits your farming business and meets the needs of different customers can be complicated.

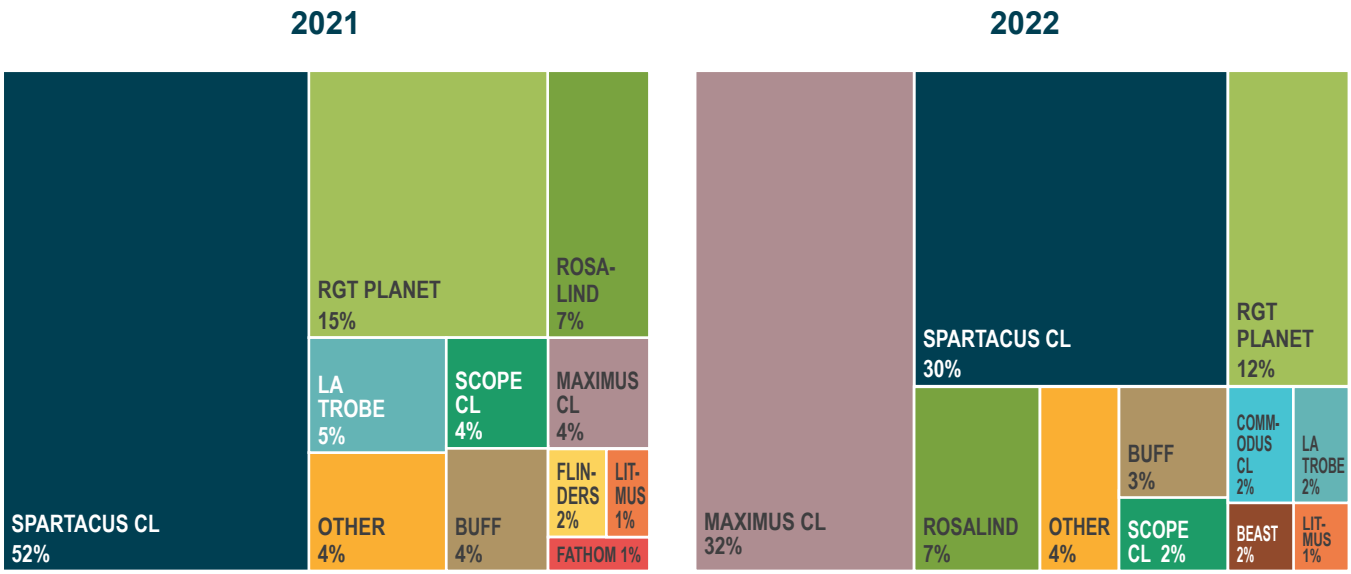


Figure 1. Relative popularity (percentage of barley area) of the top ten barley varieties plus the combined area sown to the other 20 varieties delivered in WA in 2021 and 2022. The top ten varieties occupied 96% of the area planted to barley in both seasons.

Source: grower estimates provided to CBH for 2021 and 2022

Table 1. Comparison of barley variety traits across seven of the more popular varieties grown in WA

Trait	Beast	Buff	Commodus CL	RGT Planet	Rosalind	Spartacus CL	Maximus CL
First year in variety trials in WA	**2019**	**2016**	**2020**	**2016**	**2014**	**2014**	**2018**
Statewide MET yield (% site mean)[1]	107%	103%	100%	102%	108%	102%	106%
Maturity (sown in late May)	Early spring	Early spring	Early spring	Medium spring	Early spring	Early spring	Early spring
Deliverable as / accreditation stage[2]	Stage 2	Malt	Stage 2	Malt	Feed	Malt	Malt
Brewing demand (barley and malt)[3]	-	-	-	Preferred	-	Acceptable	Acceptable
Straw strength (excl. head loss)	Fair	Moderately good	Fair	Good	Good	Good	Good
Sc[4]	S	MS	MSS	MR	MSS	MR	MR
NFNB – Beecher virulent	MRMS	MS	MRMS	S	MS	MS	MRMS
NFNB – Beecher avirulent	MS	MRMS	MRMS	MS	MR	MS	MRMS
NFNB – Oxford virulent	MSS	MS	MSS	SVS	MSS	S	S
SFNB	MSS	S	MSS	S	S	SVS	MSS
PM	MR	S	MR	R	MSS	MS	RMR
BLR	MSS	S	MSS	MRMS (late APR)	MR	MSS	MSS

Source: Blakely Paynter, Sanjiv Gupta, GIWA, Grains Australia and NVT Online **nvtonline.com.au**

[1]Regional differences in grain yield are masked when using a statewide average of the WA barley NVT MET data (2018–2022). Growers are directed to Tables 4 to 10 for a more precise estimate of variety performance in their region and Figures 2 and 3 for an indication of relative variety performance at different site yields.

[2]Varieties classed as malt have been accredited by Grains Australia. Varieties classed as Stage 0, 1 or 2 are under evaluation for their malting and brewing end-use in the Grains Australia Malt Accreditation Program

[3]For more information on malting and brewing demand, go to the 'Market feedback' section.

[4] Adult plant foliar disease abbreviations: Sc = Scald, NFNB = net-form net blotch, SFNB = spot-form net blotch, PM = powdery mildew, BLR = barley leaf rust and APR = adult plant resistance. Resistant varieties (non-*mlo*) may show a variable reaction to strains of PM present in the southern regions of WA.

Barley variety choice in 2024 – what should I grow?

The change in variety popularity from 2019 to 2021 saw an increase in the area sown to Spartacus CL and a plateauing of RGT Planet. Growers began switching from Spartacus CL to Maximus CL in 2022, resulting in both varieties having similar popularity at seeding (Figure 1). Growers have continued to reduce the area sown to Bass, Flinders, La Trobe, RGT Planet and Scope CL while increasing the area to Beast and Commodus CL. The proportion of the area sown to Buff and Rosalind stabilised in 2022.

The removal of tariffs on Australian barley exports to China provides greater market opportunities for WA, especially for growers in the Albany and Esperance port zones. There will be increased demand for varieties that meet MALT1 specifications, requiring a sharpened focus on varieties with a high yield potential and good grain quality while managing their susceptibility to leaf diseases. Sowing date, location, yield potential, disease pressure, soil type, herbicide system and segregation options will drive individual choices.

Since its release, Rosalind has been the yield benchmark in WA and remains an attractive option when targeting yield across a range of yield potentials. Combat and Cyclops have now superseded Rosalind for grain yield potential in the medium to high rainfall areas. Beast and Titan AX are benchmarks in lower rainfall areas, and Buff is a benchmark on acidic and non-acidic soils in low rainfall areas north of the Great Eastern Highway.

RGT Planet has remained a good option, particularly in higher rainfall areas where it performs increasingly well as yield potential increases. However, as disease pressure starts to bite, alternatives such as Cyclops, Laperouse and Minotaur are being considered. Zena CL is another option, but its only advantage over RGT Planet is its tolerance to imidazolinone (IMI) herbicides, as it has the same disease risk.

Growers targeting barley for sowing in an IMI herbicide management system have many plant types available, including Commodus CL

Table 2. Comparison of barley variety traits across six of the newer varieties and the most widely sown variety, Maximus CL

Trait	Combat	Cyclops	Laperouse	Minotaur	Titan AX	Zena CL	Maximus CL
First year in variety trials in WA	**2021**	**2020**	**2016**	**2020**	**2021**	**2021**	**2018**
Statewide MET yield (% site mean)[1]	111%	109%	106%	106%	105%	101%	106%
Maturity (sown in late May)	-	Early spring	Medium spring	Medium spring	-	Medium spring	Early spring
Deliverable as / accreditation stage[2]	Feed	Stage 2	Stage 2	Stage 2	Stage 1	Stage 2	Malt
Brewing demand (barley and malt)[3]	-	-	-	-	-	-	Acceptable
Straw strength (excl. head loss)	-	Good	Good	Good	Fair	Good	Good
Sc[4]	S	MRMS	S	VS	S	MR	MR
NFNB – Beecher virulent	MSS	MRMS	MRMS	MRMS	MRMS	MS	MRMS
NFNB – Beecher avirulent	MSS	MRMS	MRMS	MRMS	MRMS	MRMS	MRMS
NFNB – Oxford virulent	MS	MSS	MSS	MS	MS	SVS	S
SFNB	MRMS	MSS	MSS	S	MSS	SVS	MSS
PM	R	MR	MR	S	RMR	R	RMR
BLR	MRMS*p* (late APR)	S	MSS	S	S	MRMS (late APR)	MSS

Source: Blakely Paynter, Sanjiv Gupta, GIWA, Grains Australia and NVT Online **nvtonline.com.au**

[1] Regional differences in grain yield are masked when using a statewide average of the WA barley NVT MET data (2018–2022). Growers are directed to Tables 4 to 10 for a more precise estimate of variety performance in their region and Figures 2 and 3 for an indication of relative variety performance at different site yields.

[2] Varieties classed as malt have been accredited by Grains Australia. Varieties classed as Stage 0, 1 or 2 are under evaluation for their malting and brewing end-use in the Grains Australia Malt Accreditation Program

[3] For more information on malting and brewing demand, go to the 'Market feedback' section.

[4] Adult plant foliar disease abbreviations: Sc = Scald, NFNB = net-form net blotch, SFNB = spot-form net blotch, PM = powdery mildew, BLR = barley leaf rust and APR = adult plant resistance. Resistant varieties (non-*mlo*) may show a variable reaction to strains of PM present in the southern regions of WA.

(semi-erect and tall), Maximus CL (erect and medium height), Scope CL (semi-erect and tall), Spartacus CL (erect and medium height) and Zena CL (prostrate and medium height). Varieties with tolerance to IMI herbicides occupied two in every three barley hectares in 2022. Commodus CL offers greater early vigour at a similar yield potential but with increased lodging risk. Even if accredited by Grains Australia, the industry does not expect Commodus CL to be segregated in WA due to its malt quality profile (low fermentability). Maximus CL has a similar plant type to Spartacus CL, and growers consider this plant type to be less competitive with weeds. Maximus CL has replaced Spartacus CL as the dominant variety being grown in the state. Scope CL is still a popular variety well suited to early sowing opportunities. Zena CL is modelled on RGT Planet, offering the same plant type and similar agronomic performance but tolerant of IMI-herbicides. The industry expects Zena CL to have a similar market fit to RGT Planet if accredited by Grains Australia, subject to market sensitivities around herbicide residues in this well-known malt background.

There is strong demand for Bass, Flinders and RGT Planet from malting and brewing customers in South-East Asia and Japan as the varieties can be malted without processing aids and are well-known by the market. All three varieties are in production decline. Growers should expect price premiums over and above other malt barley options (i.e. Buff, Maximus CL and Spartacus CL). Segregations of Flinders will cease after the 2023–24 harvest, while the 2024–25 harvest will be the last harvest for Bass segregations. Production volumes of Buff are sufficient to support segregations in the Kwinana port zone. Feedback from domestic maltsters suggests Buff could be suitable for malting without processing aids and, therefore, might be an alternative to Bass, Flinders and RGT Planet. There is the opportunity for contract production of Bottler and LG Alestar for domestic processing, as their production volumes are too low to support segregation in WA. Bottler and LG Alestar are suitable for malting without processing aids and could fill a gap in the market due to the reduced supply of Bass, Flinders and RGT Planet, which require a sustainable production level in WA to warrant domestic demand.

Barley varieties with specific traits have a functional agronomic fit in certain areas, such as Buff on soils with a subsoil pH_{Ca} below 4.8; Scope CL for early sowing and grazing systems where an IMI herbicide might be needed; Banks for early sowing; Beast, Combat and Laperouse where a more weed-competitive growth habit might be helpful; and Combat where the risk of SFNB is high.

Titan AX is a new herbicide-tolerant barley option that allows growers to apply Aggressor® (quizalofop-P-ethyl), a Group 1 herbicide, to control in-crop brome grass, barley grass, wild oats, susceptible ryegrass and ALS (Group 2) resistant weeds. The advantage of this system over the IMI system is that there are no soil and grain residues when applied according to the label. Titan AX has a similar plant type to Compass and, therefore, has the advantage of being competitive against weeds.

Barley varieties suited to low rainfall environments include Beast (weed competitive and taller plant type), Buff (acid soil tolerance and for delivery into MALT1 segregations), Commodus CL (IMI herbicide system and weed competitive plant type), Maximus CL (if MALT1 is the target or an IMI system is practised), Rosalind (reliable yield performance) and Titan AX (alternative to IMI system).

For medium rainfall environments, Combat (where SFNB is an issue and a new yield benchmark), Cyclops (Rosalind replacement and a future malt option if accredited), Maximus CL (if MALT1 is the target or an IMI system is practised) and Titan AX (alternative to IMI system) are excellent options. Neo CL (IMI herbicide system) could also be a good fit for medium rainfall areas.

For higher rainfall areas, Bass (for use by domestic maltsters), Combat (where SFNB is an issue and a new yield benchmark), Cyclops (Rosalind replacement and a future malt option if accredited), Maximus CL (if MALT1 is the target or an IMI system is practised), Laperouse (disease resistance and taller straw), Neo CL (yield or an IMI system is practised), RGT Planet (yield and competitive plant type), and Zena CL (yield and competitive plant type in an IMI background) are worth growing after considering their relative strengths and weaknesses.

This bulletin outlines the characteristics of current malt varieties, newer options and selected older barley varieties. More information about each suggested barley variety for WA can be found in the variety snapshot section, with additional commentary on the newer barley varieties in the ‘New in 2024’ section below. The ‘Market feedback’ section provides specific market information published by the Grain Industry Association of Western Australia (GIWA) for varieties received as malt.

New in 2024

A suite of new barley varieties has become available to growers. AGT has released Cyclops (tested as AGTB0200), Minotaur (tested as AGTB0213) and Titan AX (tested as AGTB0325). InterGrain has released Combat (IGB1944), Commodus CL (tested as IGB1908T), Neo CL (tested as IGB22102T) and Zena CL (tested as IGB20125T). SECOBRA Recherches, through Seednet partners, are progressing Laperouse (tested as WI4592).

When deciding which barley variety to sow, grain yield potential needs to be balanced against trade-offs with agronomy, disease resistance, grain quality, segregation opportunities and market demand. Commonly-grown varieties differ in their agronomic traits and the pathways to building yield (i.e. trade-offs between tiller number, grains per ear and grain weight). These phenotypic differences may favour one variety over another in some seasons but not in others. Therefore, looking across seasons and sites is vital when assessing which variety best suits each farming business.

The following are notes on these newer barley varieties: Combat, Commodus CL, Cyclops, Laperouse, Minotaur, Neo CL, Titan AX, and Zena CL.

Combat

Key points:

- Released as a feed-only variety and not being evaluated for brewing potential.
- Targeted for sowing across various environments from low to high rainfall zones.
- Combat has been tested in WA barley NVT since 2021.
- New yield benchmark above 5t/ha.
- Comparable resistance to Fathom for SFNB, PM and BLR but with higher yield potential.
- Scald management is required in adult plants.

Combat (tested as IGB1944) is a medium-height, medium-spring, two-row feed variety bred by InterGrain and registered as a variety in August 2022.

Combat has the highest multi-year weighted NVT yield in WA at 111% of the site mean compared to Beast at 107%, Cyclops at 109% and Rosalind at 108%. In a linear regression analysis (2021–2022), Combat had a yield advantage over other varieties when the site yielded more than 5t/ha (Figure 3). Across 52 WA barley NVT (2021–2022), Combat yielded less than Rosalind in 4% of trials, the same in 21% and higher in 75% (Table 12). Relative to Cyclops, Combat yielded less in 10% of trials, the same in 46% of trials and higher in 44% (data not shown).

Combat is an allrounder suited to various growing environments, with good early canopy size and ground coverage for weed suppression. It has moderate straw strength and a medium risk of head loss.

Combat has valuable resistance to SFNB, powdery mildew (PM) and BLR (with late adult plant resistance, APR) but may need management for scald (Tables 13 and 14). As a seedling, it is rated as S to the Beecher and SVS to the Oxford virulent strains of NTNB, with slightly better resistance as an adult (MSS and MS, respectively). It has better tolerance to the Beecher avirulent strain of NTNB, being MRMS as a seedling and MSS as an adult.

Seed is available for planting in 2024 from Seedclub members and resellers.

Commodus CL

Key points:

- In Stage Two assessment for malt accreditation in 2023, with the earliest accreditation date March 2024.
- Targeted for sowing in low to medium rainfall zones and lighter soil types.
- Commodus CL has been tested in WA barley NVT since 2020.
- The statewide MET yield for Commodus CL is 3% below Compass, the variety it is modelled on. Its yield disadvantage relative to Compass was more evident at lower-yielding sites than higher-yielding sites.
- Commodus CL, like Spartacus CL, Maximus CL and Zena CL, has the gene conferring tolerance to label application rates of registered IMI products.
- Susceptible to PM in the presence of *MlLa* virulence.

Commodus CL (tested as IGB1908T) is an IMI-tolerant, tall-height, early spring, two-row variety bred by InterGrain and registered as a variety in October 2020. Commodus CL has a similar genetic background to Compass. Feedback from the breeder suggests that even if accredited by Grains Australia, WA has no interest in processing Commodus CL into malt. Likewise, the trade has expressed little interest in segregating it for export as grain for brewing end-use. Commodus CL is a variety with a low fermentability profile.

Across 79 WA barley NVT (2020–2022), Commodus CL yielded less than Compass in 29% of trials, the same in 71% and higher in 0% (data not shown). Relative to Maximus CL, Commodus CL yielded less in 53% of 79 WA barley NVT (2020–2022), the same in 34% and higher in 11% (Table 11).

Commodus CL is best suited to low and medium rainfall environments, has good early canopy size and ground coverage for weed suppression, high grain plumpness and is of a similar plant height to Compass but is tolerant to IMI herbicides. Straw strength may be an issue in longer-growing environments and sites with higher yield potential. Head loss risk is expected to be like Compass.

Commodus CL has useful resistance to NFNB (Beecher avirulent and virulent) and PM (except in the presence of *MlLa* virulence) with a lower level of resistance to scald, NFNB (Oxford virulent) and BLR (Tables 13 and 14). It is rated as MRMS as a seedling and MSS as an adult plant to SFNB, limiting disease expression.

Seed is available for planting in 2024 from Seedclub members and resellers. It is not legal to acquire Commodus CL via farmer-to-farmer trading.

Cyclops

Key points:

- In Stage Two assessment for malt accreditation in 2023, with the earliest accreditation date March 2024.
- Targeted for sowing in all rainfall zones, but better suited to medium and higher rainfall areas.
- Cyclops has been tested in WA barley NVT since 2020.
- Has shown a yield advantage over Rosalind, primarily in environments that yielded less than 2t/ha or more than 4t/ha.
- Requires management of NFNB (Oxford avirulent) and BLR.

Cyclops (tested as AGTB0200) is a medium-height, early spring, two-row variety bred by AGT and registered as a variety in August 2021. Cyclops has the same erect-growing habit as La Trobe (due to similar dwarfing genetics), with short coleoptile and short rachilla hairs, making it a low itch variety. The breeder has engaged with grain marketers and malt companies operating in WA, and there is positive interest in Cyclops subject to Grains Australia accreditation and sufficient scale of production.

Across 59 WA barley NVT (2020–2022), Cyclops yielded more than RGT Planet in three of every four WA barley NVT (Table 11), with an advantage below 6t/ha (Figure 4). Relative to Rosalind, Cyclops was lower yielding in 22% of 79 WA barley NVT (2020–2022), the same in 42% of trials and higher yielding in 40% of trials (Table 12), with the yield advantage most apparent in environments yielding below 2t/ha or above 4t/ha (Figure 3).

According to the breeder, Cyclops is adapted to a wide range of environments and has a competitive grain quality package. Growers should expect its agronomic attributes (i.e. lodging and head loss risk) to be similar to those displayed in varieties with similar dwarfing genes, like La Trobe and Spartacus CL.

The grain quality of Cyclops is an improvement on Spartacus CL for grain plumpness with a lower hectolitre weight and a similar grain protein concentration at the same grain yield (data not shown). Cyclops grain has a lower hectolitre weight and retention (Figures 5 and 6) at the same grain protein concentration for a given grain yield (data not shown) relative to Maximus CL. A slightly lower probability of receival as MALT1 is likely. There is insufficient evidence to determine if Cyclops has the same germ-end staining risk as Maximus CL and Spartacus CL.

Cyclops has useful resistance to scald, NFNB (Beecher virulent), and PM but may need management for NFNB (Oxford avirulent) and BLR (Tables 13 and 14). It is rated MSS to SFNB (seedling and adult plant), limiting disease expression relative to susceptible varieties like RGT Planet, Rosalind and Spartacus CL. Given its genetic background, it is unknown if it carries the same risk of smut as Maximus CL and Spartacus CL.

Seed is available for planting in 2024 from AGT Affiliates and resellers. Seed is also free to trade from farmer to farmer by complying with the AGT Seed Sharing Licence Agreement (agtbreeding.com.au/sourcing-seed/seed-sharing).

Laperouse

Key points:

- In Stage Two assessment for malt accreditation in 2023, with the earliest accreditation date March 2024.
- Targeted for sowing in medium to higher rainfall areas.
- Laperouse has been tested in WA barley NVT since 2016.
- Statewide grain yields of Laperouse have been competitive with Rosalind.
- Needs management for scald and NFNB (Oxford virulent).

Laperouse (tested as WI4592) is a medium-height, medium-spring, two-row barley bred by the University of Adelaide barley breeding program, licenced to SECOBRA Recherches. It was registered as a variety in September 2019 and is being commercialised by Seednet. The breeder has engaged with malt companies operating in WA, and there is positive interest in Laperouse subject to Grains Australia accreditation and sufficient scale of production.

Laperouse is targeted for sowing in medium to higher rainfall areas. It has good straw strength and head retention but no tolerance to IMI-herbicides. Across 119 WA barley NVT (2018–2022), Laperouse yielded less than Maximus CL in 26% of trials, the same in 44% and higher in 30%, with a statewide MET yield the same as Maximus CL at 106% of the site mean (Tables 10 and 11). Since 2020, the yield of Laperouse and Maximus CL (assessed by linear regression) has been similar at sites ranging from 1 to 7t/ha (Figure 4). Across 119 WA barley NVT (2018–2022), Laperouse yielded more than RGT Planet at just over half the sites (Table 11), with this yield advantage over RGT Planet apparent at sites where the yield is below 4.5t/ha (Figure 4).

When grown under the same management in NVT trials, Laperouse grain tends to have a slightly lower hectolitre weight than Maximus CL (Figure 5), with fewer screenings (Figure 6) and a lower grain protein concentration at the same grain yield (data not shown). Laperouse's grain quality profile suggests that the probability of receival MALT1 would be higher than RGT Planet if accredited by Grains Australia and segregated in WA.

Laperouse has excellent resistance to PM and useful resistance to NFNB and SFNB. It is rated MRMS as a seedling to SFNB and MSS as an adult plant, limiting disease expression. Laperouse is less suited to areas where scald is a regular production constraint (Tables 13 and 14). While RGT Planet may have a yield advantage over Laperouse at sites that yield more than 5t/ha, Laperouse is likely to have a lower fungicide cost in these environments due to a higher resistance level to NFNB and SFNB.

Seed is available for planting in 2024 from Seednet partners. In WA, farmer-to-farmer trading is also allowed.

Minotaur

Key points:

- In Stage Two assessment for malt accreditation in 2023, with the earliest accreditation date March 2024.
- Targeted for sowing in medium to high rainfall zones.
- Minotaur has been tested in WA barley NVT since 2020.
- Statewide performance is an improvement over RGT Planet in environments that yield less than 4t/ha.
- Below 4t/ha, Minotaur is not competitive against Cyclops or Rosalind.
- Requires management for scald, SFNB, PM and BLR.

Minotaur (tested as AGTB0213) is a medium-height, medium-spring, two-row variety bred by AGT and registered as a variety in August 2021. Minotaur has the prostrate growth habit of RGT Planet with a medium coleoptile. Minotaur was produced by crossing European and Australian genetics. The breeder has engaged with grain marketers and malt companies operating in WA, and there is positive interest in Minotaur subject to Grains Australia accreditation and sufficient scale of production.

Across 79 WA barley NVT (2020–2022), Minotaur yielded less than RGT Planet in 13% of trials, a similar amount in 33% of trials and higher in 54% of trials (Table 11), with an advantage at sites yielding less than 4t/ha (Figure 4). In those same trials, Minotaur yielded less than Maximus CL in 32% of trials, similar in 27% and higher in 54%, with an advantage above 5t/ha.

Minotaur is suited to a broader range of environments than RGT Planet and offers improvements in physical grain quality, often delivering a higher hectolitre weight (Figure 5). Minotaur's hectolitre weight is, however, poorer than Maximus CL (Figure 5). Grain plumpness is slightly better than RGT Planet but not as good as Maximus CL (Figure 6). If accredited by Grains Australia and segregated in WA, Minotaur should have a higher probability of receival as MALT1 than RGT Planet but lower than Maximus CL.

Minotaur has excellent resistance to NFNB (Beecher virulent and avirulent) and limited resistance to NFNB (Oxford avirulent) but needs management for scald, SFNB, PM and BLR (Tables 13 and 14). Minotaur is rated as VS to scald and should be closely monitored.

Seed is available for planting in 2024 from AGT Affiliates and resellers. Seed is also free to trade from farmer to farmer by complying with the AGT Seed Sharing Licence Agreement (agtbreeding.com.au/sourcing-seed/seed-sharing).

Neo CL

Key points:

- Has been entered into Stage One of the Grains Australia Malt Accreditation program in 2023, with the earliest accreditation date being March 2025.
- Targeted for sowing in medium and high rainfall areas.
- Neo CL first entered WA barley NVT in 2023 with little independent data available in WA from environments that yield less than 3t/ha. Trials undertaken by DPIRD and FAR Australia in 2022 had yield potentials above 4t/ha.
- InterGrain internal data suggests Neo CL is a new yield benchmark for IMI-tolerant varieties in WA.
- Later flowering than RGT Planet when sown in mid-April, but similar in May.
- The InterGrain brochure indicates improved SFNB and NFNB resistance compared to RGT Planet.

Neo CL (tested as IGB22102T) is an IMI-tolerant, medium-height, medium-spring, two-row barley bred by InterGrain and registered as a variety in August 2022. Neo CL is a cross between Australian genetics with tolerance to IMI-herbicides and RGT Planet, with RGT Planet representing 25% of the pedigree.

Due to the lack of independent data available for Neo CL, growers should be cautious in purchasing seed. With Neo CL only being tested in WA barley NVT for the first time in 2023, growers should not assume that its performance in 2023 represents future performance. At least three seasons of data are generally required to indicate long-term performance. The 2023 WA barley NVT and additional data collected by DPIRD will, however, provide a broader picture of the adaptation of Neo CL to environments that yield from 1–7t/ha to support seed purchasing decisions.

DPIRD data from 2022 saw Neo CL yielding similar to or higher than Maximus CL and RGT Planet at a range of nitrogen (N) levels when averaged over three sites (all sites yielded more than 4t/ha) (Figure 7). The hectolitre weight of Neo CL was similar to RGT Planet but poorer than Maximus CL and Spartacus CL. The grain plumpness of Neo CL was comparable to Spartacus CL, lower than Maximus CL and an improvement over RGT Planet. DPIRD's observations from a limited number of sites align with comments made by the Neo CL breeder.

Neo CL has been screened in NVT disease trials for only one season (2022), so its disease resistance ratings are provisional. According to the breeder, Neo CL appears to have helpful resistance to scald, NTNB, SFNB, and PM, improving the resistance of RGT Planet to NFNB and SFNB.

Seed will be available for planting in 2024 from Seedclub members and resellers. It is not legal to acquire Neo CL via farmer-to-farmer trading.

Titan AX

Key points:

- Has been entered into Stage One of the Grains Australia Malt Accreditation program in 2023, with the earliest accreditation date being March 2025.
- Targeted for sowing in low to medium rainfall zones.
- Titan AX has been tested in WA barley NVT since 2021, with only five sites in 2021 and 29 in 2022.
- Tolerant to Group 1 herbicide Aggressor® (quizalofop-P-ethyl).
- Requires management for scald and BLR.

Titan AX (tested as AGTB0325) is a herbicide tolerant, tall-height, medium-spring, two-row variety bred by AGT and was registered as a variety in April 2022. Titan AX has a similar genetic background to Compass. According to the breeder, Titan AX suits low and medium rainfall environments where early vigour and longer straw are preferred, and lodging is less of an issue.

Straw strength may be an issue in longer-growing environments and sites with high-yield potential. Head loss risk is expected to be like Compass.

Titan AX has not yet undergone any evaluation by DPIRD in small plot trials (aside from phenology). As such, we have limited independent information to help guide growers and the industry of its weaknesses and strengths. With Titan AX only being tested in WA barley NVT for the first time in 2021, and only five sites in Agzone 5 in its first year, growers should not assume that its statewide performance in 2022 represents future performance. At least three seasons of data are generally required to indicate long-term performance.

Across 34 WA barley NVT (2021–2022), Titan AX yielded less than Maximus CL in 26% of trials, the same in 27% and higher in 47% of trials (Table 11). The sites where Titan AX performed better than Maximus CL did not appear related to site potential (data not shown). The performance of Titan AX has been comparable to Beast. Across 34 WA barley NVT (2021–2022), Titan AX yielded less than Beast in 26% of trials, the same in 53% and higher in 21% of trials (data not shown).

Titan AX is the first barley variety in the world to carry tolerance to the herbicide Aggressor®, which allows growers to control susceptible populations of barley grass, brome grass, annual ryegrass, wild oats and other grass weeds in the barley phase of the rotation without the residue issues (soil and grain) associated with IMI-herbicide systems.

Titan AX has valuable resistance to NFNB (Beecher virulent and avirulent) and PM (may be susceptible to the *MlLa* virulence) but is less tolerant of scald, NFNB (Oxford virulent), SFNB and BLR.

Seed is available for planting in 2024 from AGT Affiliates and resellers. Seed is also free to trade from farmer to farmer by complying with the AGT Seed Sharing licence (agtbreeding.com.au/sourcing-seed/seed-sharing). All Titan AX growers must complete an online CoAXium® stewardship program(coaxium.com.au/stewardship). Sipcam administers the distribution of Aggressor® herbicide and the CoAXium® stewardship program.

Zena CL

Key points:

- In Stage Two assessment for malt accreditation in 2023, with the earliest accreditation date March 2024.
- Targeted for sowing in medium to high rainfall zones.
- Zena CL has been tested in WA barley NVT since 2021.
- Statewide NVT yields were comparable to RGT Planet.
- Zena CL, like Commodus CL, Spartacus CL and Maximus CL, possesses the gene conferring tolerance to label application rates of registered IMI products.
- As with RGT Planet, it requires management for NFNB (Oxford virulent) and SFNB.

Zena CL (tested as IGB20125T) is an IMI-tolerant, medium height, medium spring, two-row variety bred and developed collaboratively by InterGrain and Grains Innovations Australia (GIA). It was registered as a variety in February 2022. Zena CL has the same genetic background as RGT Planet but possesses the Clearfield® herbicide tolerance trait developed by Agriculture Victoria Services, which is currently exclusively licensed to InterGrain. If accredited by Grains Australia, the breeder expects the variety to have a similar malt and brewing market fit as RGT Planet.

Zena CL is best suited to medium and high rainfall environments. Across 52 WA barley NVT (2021–2022), Zena CL yielded the same as RGT Planet in all trials (Table 11). It has good early canopy size and ground coverage for weed suppression, with similar agronomic and grain quality characteristics as RGT Planet. Unlike RGT Planet, it is tolerant of IMI herbicides.

Zena CL has excellent resistance to scald, NFNB (Beecher avirulent), PM and BLR but will need management for NFNB (Oxford virulent) and SFNB. The same disease risks that exist with RGT Planet apply to Zena CL.

Seed is available for planting in 2024 from Seedclub members and resellers. It is not legal to acquire Zena CL via farmer-to-farmer trading.

Other considerations for barley growers

Changes in disease pathogens

New pathotypes and diseases detected in WA in recent years have ramifications for variety choices and fungicide strategies. Growers, particularly those on the south coast, should be watchful for the Oxford virulent NFNB pathotype, Ramularia leaf spot (RLS) and potential changes in the virulence of PM with the detection of virulence to the *MlLa* gene (such as is present in Compass, Rosalind, and Spartacus CL).

Tips for managing grain protein in malt barley

When growing barley for malting, higher protein levels can be achieved by altering the timing of nitrogen (N) supply, applying more N, sowing into legume stubble or planting a higher-protein variety.

The grain protein concentration of a crop is determined by the balance of N supply and demand, a relationship heavily influenced by seasonal conditions. While it is common practice to apply the bulk of fertiliser N from seeding up to four weeks after seeding, it is not necessarily the most effective strategy for producing yield and protein. Strategies to boost grain protein include applying higher levels of N fertiliser and incorporating legumes into the rotation to increase soil N supply. Variety choice and the timing of fertiliser N applications are additional management options that can assist if current practices are not consistently delivering grain above 9.5% protein. Sowing higher protein varieties, such as Bass or even Spartacus CL and Maximus CL (where suitable), can achieve a grain protein concentration 1% higher than sowing lower protein varieties (at a similar yield level). Targeting around two-thirds of the recommended N fertiliser rate for application around the stem elongation stage of crop growth can also increase grain protein with negligible impacts on grain yield. Additional N application around flag leaf emergence can boost grain protein in some seasons. Ensuring adequate and appropriate N supply is critical in maximising grain yield at a sufficient grain protein concentration. However, delayed N strategies have the added benefit of providing a greater understanding of season potential at the time of N application.

Target plant density

When chasing grain yield in medium to higher rainfall areas, the target density for feed barley is higher than when growing barley for delivery into malt segregations.

When considering the seed rate for planting, it is essential to consider target plant density (plants per square metre) rather than set machinery seeding rates (kg/ha). While plant density is a fixed target, a fixed seeding rate in kg/ha will show variable plant density across seasons due to seed size (which varies with variety and seed source), seed viability and establishment conditions.

For malt barley, a target density of 150–180 plants/m^2 is appropriate to maximise yield while maintaining grain quality. For feed barley, a higher target density of 180–220 plants/m^2 is suggested to improve the competitiveness of the crop against weeds and maximise yield. If growing feed barley in paddocks without weeds, the target density can be adjusted downwards to 150–180 plants/m^2. There is, however, a 1–3% yield advantage obtained by keeping target densities at the higher density (180–220 plants/m^2) suggested for feed barley, even in the absence of weeds. The impact of sowing at a higher plant density to maximise grain yield on feed grain quality is low, with a reduced hectolitre weight of less than 0.5kg/hL expected.

The target density in plants/m^2 determines the seeding rate in kg/ha and is calculated using the following formula:

$$\text{Seed rate (kg/ha)} = \frac{\text{1000 kernel weight (g) x target density (plants/m}^2\text{)}}{\text{germination \% x establishment \% x 100}}$$

For example, if sowing RGT Planet barley with a kernel weight of 45g per 1000 kernels at a target density of 180 plants/m^2 with a germination of 96% and an expected establishment of 80%, then the seed rate in kg/ha required to establish 180 plants/m^2 is:

$$\text{seed rate in kg/ha} = 105 \text{ kg/ha} = \frac{45 \times 180}{0.96 \times 0.80 \times 100}$$

Table 3. Western Australian malt barley variety segregation recommendations by Port Zone for the 2024–2025 harvest

YES	This is a recommended variety for this production zone. Segregations will be preferentially allocated to this variety.
Limited	Limited segregations are likely due to low production hectares, limited market demand, a new variety going through market development or phasing out an old variety.
Niche	Subject to availability. Niche segregation is only available if a marketer has sufficient tonnage to supply domestic or international customers. Marketers should contact CBH to negotiate niche segregation and growers should contact their preferred marketer to determine availability.
NO	**Variety has been phased out, or marketers are not looking to accumulate this variety in this production zone.**

Port Zone	Geraldton	Kwinana			Albany		Esperance	Comments
		North (Midlands)	South	North (East)	North	South		
Bass	NO	Limited	Limited	NO	NO	NO	NO	Limited supply available due to low hectares sown. Important variety for markets that do not allow processing aids during malting. 2024–25 harvest will be the last harvest Bass is segregated in WA.
Buff	NO	NO	NO	Limited	NO	NO	NO	Popular variety in eastern wheatbelt with good volumes expected at the 2024–25 harvest. Interest for domestic processing as an additive-free malt variety.
Maximus CL	YES	YES	YES	YES	YES	YES	YES	The dominant variety in each port zone. Not yet approved by all export malt and brewing customers. Market expects full acceptance by the 2024–25 harvest.
RGT Planet	NO	YES	YES	NO	YES	YES	YES	Medium market pull. Important variety for customers seeking malt made without processing aids.
Spartacus CL	NO	YES	YES	YES	YES	YES	YES	Well regarded and in-demand variety, but on-farm production is being rapidly replaced by Maximus CL.

Source: GIWA Barley Council

Market feedback

Grain Industry Association of Western Australia (GIWA)

For the 2024–25 harvest, the following observations are relevant:

- While there has been increased trade to Mexico and South America in recent years there has not been any material change in the quality profile sought by brewers in those countries relative to the quality profile previously bought by China. Mexico and South America markets have been pleased with Spartacus CL, and traders of Australian grain expect this to roll onto Maximus CL. The likelihood that international traders will seek varieties with a lower fermentability profile (e.g. Compass) for export from WA remains low.
- Perth's Boortmalt and United Malt malthouses are the largest customers of WA malt barley grain. The two Perth plants procure over 300,000 tonnes of malting barley grain annually from growers in the Kwinana and parts of the Albany port zones.
- Both domestic processors have strong demand from South-East Asia and Japan for barley varieties that malt without processing aids, namely Bass, Flinders and RGT Planet. Due to tight supply, premiums for these three varieties through the 2022–23 harvest were significant. Growers should expect premiums to remain in the 2023–24 and 2024–25 harvests.
- Unfortunately, the low supply of Bass, Flinders and RGT Planet will exclude WA malt barley from several premium markets in Asia until the production of new varieties suited to malting without processing aids ramps up.
- Growers planning to continue sowing Bass and Flinders should communicate with domestic processors (through their buyers) to help procure enough of these high market-demand varieties. Sales might be through direct contracts rather than through delivering into the CBH system.
- Growers delivering RGT Planet into Albany port zone sites should be aware of the high demand for this variety. A higher return after costs could be achieved by instead delivering RGT Planet to a receival point in the Kwinana port zone. As Chinese maltsters and brewers will be familiar with RGT Planet from non-Australian origins, there could be strong support for exporting RGT Planet from the Albany and Esperance port zones as they learn how to brew with Maximus CL.
- Segregations of Flinders will cease after the 2023–24 harvest, while the 2024–25 harvest will be the last harvest for Bass segregations. The industry is carefully watching the decline in production of RGT Planet and are seeking a better understanding of the new options that growers in WA may adopt. Potential options include recently accredited varieties Bottler, Buff and LG Alestar, and those in Stage 2 accreditation, particularly Cyclops, Laperouse, Minotaur and Zena CL.
- Production volumes of Bottler and LG Alestar are too low to support segregation in WA and their pathway to market for domestic processing is only via direct contracts. Bottler and LG Alestar are suitable for malting without processing aids. Another advantage of LG Alestar for domestic processors is its quick time from germination to finished malt, which is quicker than most varieties in the market. These varieties require a sustainable production level in WA to warrant further evaluation and domestic demand.
- Production volumes of Buff are sufficient to support segregations in the Kwinana port zone. Feedback from the domestic maltsters suggests Buff could be suitable for malting without processing aids, as with Bass, Flinders and RGT Planet.
- Maximus CL is now the dominant barley variety in WA. Not all our brewing customers have approved its use, especially those in China. Maximus CL has different malting characteristics to Spartacus CL. Malt premiums might be lower than established varieties until full brewer approval occurs, which is expected within 12 months.
- Spartacus CL has good international market recognition, with export market opportunities in Asia, China, Mexico, South Africa and South America. Maximus CL has quickly replaced Spartacus CL on-farm, and there is an expectation that most international markets will likewise support Maximus CL.
- Segregation opportunities for Bass, Buff, Maximus CL, RGT Planet and Spartacus CL vary by port zone across WA and within a port zone for the Kwinana and Albany ports (Table 3).

Why rationalise malt varieties?

In line with previous advice, the WA barley industry supports the long-term aim of segregating up to two major malt varieties per port zone, with limited segregations for minor, new or niche malt varieties. Segregating fewer malt varieties improves logistics (reducing storage and handling costs), makes segregation planning at a bin level easier and encourages more robust demand from traders who are unwilling to risk buying small, unsaleable parcels.

At the same time, it is vital to have a range of varieties differing in management, to spread agronomic risk, and in malt characteristics to allow the blending of processed malt to customer specifications. Treating malt barley crops with some chemicals could limit market access, as not all markets have import tolerances equal to Australia. For example, opportunistic markets like Europe currently do not purchase barley with imazapyr residue nor barley with detectable levels of diquat herbicide. Such markets might require specific segregations if they became regular and not opportunistic.

GIWA (through the GIWA Barley Council) developed these recommendations in consultation with the WA barley supply chain with the aim of guiding growers and consultants in the planning of the 2024 barley cropping program. A plan review will occur in Autumn 2024, and any changes in demand will be presented to growers. Malt variety recommendations in this document could differ from those of eastern Australia due to WA's focus on international markets.

Malt variety-specific recommendations

With new malt varieties being released and adopted by growers faster than the phasing out of old malt varieties, the rapid turnover of varieties is a common sticking point for end-users who desire long-term supply and familiarity to optimise their end-use. New varieties also create inefficiency for bulk handlers, with each malt segregation adding to storage and handling costs. The GIWA barley variety rationalisation plan attempts to balance the benefits to growers from access to new malt varieties with the demand from customers for access to large parcels of the same malt variety over at least five years.

Each malt barley variety grown in WA has unique malting attributes. Consequently, brewers purchase varieties subject to their availability, familiarity, price, style of beer they produce and the type and level of adjunct used in their brewing recipe.

Growers should use the market signals in this document to help decide which malt variety or varieties to sow in 2024. Market demand, pricing signals and segregation locations should be considered in determining malt variety choice, along with the agronomic management required and the risk associated with delivering malt-grade barley. Varieties listed as PREFERRED are more likely to attract higher premiums than ACCEPTABLE varieties. As these industry recommendations are a guide, the segregations implemented at the 2024–25 harvest might differ from those proposed in this document. Growers should liaise regularly with their bulk handlers to confirm segregation.

The malt barley recommendations for the 2024 season are as follows:

Bass

- Bass is a 'market leader' for malt quality, with demand for domestic processing and exporting as malt. It is acceptable for export as grain, but volumes do not support segregation.
- Not suitable for the manufacture of shochu in Japan.
- Bass is well recognised in the international malt barley market and until there is a replacement will remain a critical malt variety in the supply of premium malt to key customers.
- South-East Asia and Japan seek malt made without processing aids. Bass is suitable for additive-free malting. WA's low supply of Bass limits sales to these markets and might result in our exclusion from several premium markets until production of varieties that malt well without processing aids ramps up.
- Frequently used when blending malt to customer specifications.
- Bass malt has excellent extract and filterability, and its quality profile matches the market needs of brewers using high levels of starch adjuncts. Bass grain has a higher grain protein concentration than other malt varieties received, which makes it attractive to starch-adjunct brewers, but not all brewers we service.

- Bass has a higher selection rate for malt than Maximus CL, RGT Planet and Spartacus CL but is outclassed for grain yield.
- Target production zones in 2024 are Kwinana-North (Midlands) and Kwinana-South. Limited segregation opportunities (if any) will be offered due to low production.

Buff

- Buff is being assessed for export as malt, with international grain markets not yet exposed to Buff (and unlikely to be).
- Buff is not being assessed for the manufacture of shochu in Japan.
- Preliminary data suggests it could be malted effectively without processing additives. In the presence of declining Bass and RGT Planet supply, Buff could potentially assist the WA industry to continue supplying additive-free malt to South-East Asia and Japan.
- Grains Australia has indicated that Buff is a variety with a high fermentability profile and, consequently, would be ideally suited to adjunct brewing.
- Target production zones in 2024 are Kwinana-North (East).

Maximus CL

- Maximus CL is acceptable for export as grain and malt and is being assessed for the manufacture of shochu in Japan.
- Maximus CL malt has a high extract with a high enzyme potential and is suitable for high fermentability, starch-adjunct brewing (barleyaustralia.com.au/wp/wp-content/uploads/Tier-1-Malt-Performance-Summary-Maximus.pdf).
- Grower take-up of Maximus CL has occurred rapidly, mainly replacing the area in the rotation previously planted to Spartacus CL.
- Maximus CL has not been approved by all brewing customers, especially those in China. Even with the resumption of trade with China, grower production is still expected to exceed market demand in the short term. Malt premiums could be lower than established varieties until full brewer approval occurs, which is expected within 12 months.
- Use recommended imidazolinone herbicides and be aware of market advice regarding delivering grain from paddocks sprayed with an imidazolinone herbicide.
- Target production zones in 2024 are Geraldton, Kwinana, Albany and Esperance port zones.

RGT Planet

- RGT Planet is preferred for export as grain and as malt.
- Not suitable for the manufacture of shochu in Japan.
- RGT Planet malt has excellent extract with a moderate enzyme potential and is suitable for sugar- and starch-adjunct brewing.
- RGT Planet is a globally recognised malt variety suitable for malting without processing aids. RGT Planet is a critical malt variety to maintain our ability to supply premium malt to key customers in South-East Asia and Japan. China, having most likely used RGT Planet from non-Australian origins since 2020, are expected to be interested in Australian-grown RGT Planet.
- There is currently insufficient MALT1 grade RGT Planet supply to meet demand, resulting in premiums above Maximus CL and Spartacus CL, in some cases.
- Target production zones in 2024 are Kwinana-North (Midlands), Kwinana-South and Albany port zones, with limited segregations offered in the Esperance port zone.

Spartacus CL

- Spartacus CL is acceptable for export as grain and malt and is preferred for manufacturing shochu in Japan.
- Spartacus CL malt has a high extract with very good enzyme potential and is suitable for starch-adjunct brewing.
- Spartacus CL exhibits different malting characteristics than Maximus CL. For some customers, these differences are desirable. The rapid decline in grower production of Spartacus CL will limit our opportunity to meet some customer specifications for export malt.
- Use recommended imidazolinone herbicides and be aware of market advice regarding delivering grain from paddocks sprayed with an imidazolinone herbicide.
- Target production zones in 2024 are Kwinana, Albany and Esperance port zones.

Grain yield

Blakely Paynter (DPIRD)

National Variety Trials (NVT) are managed by the Grains Research and Development Corporation (GRDC) to assess varietal performance across Australia independently of breeders. The trial results enable growers to select the best variety for their environment. Results from the NVT are available as individual site reports or multi-environment (MET) long-term summaries. The MET analysis generates a table of performance values for each variety compared to the mean of the NVT site. Growers and consultants can select a specific state, region, location or group of locations to help choose the best variety for their environment. Both the single-site and multi-year MET analyses are available at nvtonline.com.au.

Tables 4 to 10 present data extracted from the Long-Term MET Yield Reporter, available at nvtonline.com.au. MET data (accuracy ≥ 0.8 and VAF ≥ 25%) are presented for each year (2018–2022) for each of the six Agzones in WA and then combined across the six Agzones to provide a statewide MET. If there are four or more observations, a five-year weighted average has been calculated from the MET data. Caution should be exercised when looking at the weighted average as it masks varietal performance over seasons within an Agzone.

Neo CL is being released solely on its performance in internal breeder trials. Neo CL has been included in WA barley NVT for the first time in 2023. Before purchasing seed, growers should consult NVT Online and assess any data published by DPIRD.

Tables 11 and 12 use single-site MET data to highlight the probability of one variety yielding either less, the same or more than another variety when grown with the same agronomy. Grain yields are compared using the least significant difference (p=0.05) calculated from the single-site MET analysis standard error. Only barley NVT trials where both varieties have been sown and harvested are included.

It is important to note that the single-site MET analyses only represent varietal performance under one specific set of seasonal and site conditions. Growers should not use the single-site MET analysis as their sole data source when comparing the performance of a new variety. MET analyses based on the average varietal performance of Agzones can mask variety by environment (GxE) interactions across the locations (and seasons) within the Agzone. For this reason, the relative performance of varieties in each year from 2018 to 2022 helps explain the variability in relative varietal performance across seasons. While Agzones are a simple way to group trials across environments, they might not accurately reflect a specific location in every season.

Differences in comparative grain yield performance between varieties can depend on the yield potential of the site. To help assess relative varietal performance at different site yields, NVT Online (through the Long-Term MET Yield Reporter) presents data at half-tonne yield intervals (called ‘yield groups’) based on trials that match the yield range. This guide presents an alternative method of viewing yield performance at different site yields and uses data extracted from the ‘Statewide tables of yield and grain quality’ available at nvtonline.com.au. Figures 2 to 4 use linear regression to compare varieties at different yield potentials and present varietal trends as the site-mean yield increases (the average yield of the varieties compared).

The graphs in this document were developed by calculating differences between the grain yield of a variety relative to the site-mean yield (the ‘deviation’), with the deviation assessed for quadratic or linear trends. If the quadratic trend was significant, a quadratic polynomial was fitted to the data ($p<0.05$). If the linear trend (but not the quadratic trend) was significant ($p<0.05$), a linear polynomial was fitted to the data. If neither the quadratic nor the linear trend was significant, the grain yield response of a variety was deemed to run parallel to the site-mean yield at the average deviation for that variety. It is worth noting that depending on the year and location analysed, the relative performance of varieties can differ. This highlights the importance of examining more than one dataset and comparing the performance of new varieties over at least three seasons.

Table 4. Grain yield of barley varieties in AGZONE 1 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		4.27	0.61	4.98	3.43	5.05	3.67
Variety	(No. trials)	(2)	(2)	(1)	(2)	(2)	(9)
Deliverable as a malt variety							
Bass	(9)	90	83	93	89	90	**89**
Buff	(8)	113	135	99	109	104	**113**
Maximus CL	(9)	103	118	100	116	104	**109**
RGT Planet	(9)	99	84	107	97	104	**97**
Spartacus CL	(9)	99	109	98	108	99	**103**
Stage Two malt accreditation							
Beast	(7)	-	123	105	111	108	**112**
Commodus CL	(5)	-	-	100	100	101	**103**
Cyclops	(5)	-	-	106	113	108	**112**
Laperouse	(9)	107	113	103	109	105	**108**
Minotaur	(5)	-	-	107	108	106	**102**
Zena CL	(4)	-	-	-	98	104	**98**
Deliverable as a feed variety							
Combat	(4)	-	-	-	114	113	**111**
Compass	(9)	109	119	102	103	104	**108**
Fathom	(9)	108	121	99	103	102	**107**
Flinders	(5)	88	78	95	-	-	**89**
La Trobe	(9)	102	112	99	106	101	**105**
Litmus	(7)	-	112	98	93	98	**100**
Mundah	(5)	98	100	96	-	-	**95**
Neo CL	(0)	-	-	-	-	-	**-**
Rosalind	(9)	107	120	106	117	109	**112**
Scope CL	(9)	98	105	93	93	94	**97**
Titan AX	(2)	-	-	-	-	106	**-**

Source: based on MET analysis from NVT Online, nvtonline.com.au

Table 5. Grain yield of barley varieties in AGZONE 2 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		4.33	2.23	3.20	4.24	5.41	3.88
Variety	(No. trials)	(7)	(7)	(6)	(7)	(7)	(34)
Deliverable as a malt variety							
Bass	(34)	92	92	92	91	92	**92**
Buff	(33)	106	110	103	105	103	**105**
Maximus CL	(34)	103	109	109	106	104	**106**
RGT Planet	(33)	100	95	99	103	104	**100**
Spartacus CL	(34)	100	105	105	100	100	**102**
Stage Two malt accreditation							
Beast	(27)	-	111	110	104	104	**108**
Commodus CL	(20)	-	-	102	97	99	**101**
Cyclops	(20)	-	-	110	110	106	**108**
Laperouse	(34)	106	105	107	106	103	**105**
Minotaur	(20)	-	-	106	107	106	**104**
Zena CL	(14)	-	-	-	103	105	**101**
Deliverable as a feed variety							
Combat	(14)	-	-	-	113	111	**110**
Compass	(34)	106	109	105	99	101	**104**
Fathom	(34)	104	108	103	100	100	**103**
Flinders	(20)	92	91	94	-	-	**94**
La Trobe	(34)	102	106	104	100	100	**102**
Litmus	(27)	-	106	93	89	98	**97**
Mundah	(18)	96	100	92	-	-	**94**
Neo CL	(0)	-	-	-	-	-	**-**
Rosalind	(34)	106	112	110	107	108	**109**
Scope CL	(34)	96	100	94	93	94	**95**
Titan AX	(7)	-	-	-	-	103	**105**

Source: based on MET analysis from NVT Online, nvtonline.com.au

Table 6. Grain yield of barley varieties in AGZONE 3 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		3.71	4.30	4.71	5.57	6.02	4.86
Variety	(No. trials)	(4)	(4)	(6)	(5)	(6)	(25)
Deliverable as a malt variety							
Bass	(25)	94	92	93	91	94	**93**
Buff	(25)	102	100	101	104	98	**101**
Maximus CL	(25)	102	107	108	97	101	**103**
RGT Planet	(25)	104	103	101	106	107	**104**
Spartacus CL	(25)	98	103	103	94	97	**99**
Stage Two malt accreditation							
Beast	(21)	-	107	106	104	102	**104**
Commodus CL	(17)	-	-	99	100	98	**99**
Cyclops	(17)	-	-	110	109	108	**109**
Laperouse	(25)	104	106	107	105	104	**105**
Minotaur	(17)	-	-	107	103	108	**106**
Zena CL	(11)	-	-	-	104	106	**103**
Deliverable as a feed variety							
Combat	(11)	-	-	-	111	112	**111**
Compass	(25)	99	102	100	103	98	**100**
Fathom	(25)	99	100	100	101	97	**99**
Flinders	(25)	97	96	97	92	98	**96**
La Trobe	(25)	99	102	101	97	98	**99**
Litmus	(17)	-	-	88	92	88	**90**
Mundah	(12)	92	91	88	-	-	**91**
Neo CL	(0)	-	-	-	-	-	**-**
Rosalind	(25)	103	109	107	101	103	**105**
Scope CL	(25)	94	92	92	94	91	**92**
Titan AX	(6)	-	-	-	-	103	**104**

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

Table 7. Grain yield of barley varieties in AGZONE 4 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		3.36	0.79	2.57	4.18	5.47	3.27
Variety	(No. trials)	(2)	(1)	(5)	(3)	(5)	(16)
Deliverable as a malt variety							
Bass	(16)	89	85	94	94	94	**93**
Buff	(16)	123	149	104	100	103	**108**
Maximus CL	(16)	101	108	110	111	100	**106**
RGT Planet	(16)	100	85	96	98	104	**99**
Spartacus CL	(16)	96	102	107	107	97	**102**
Stage Two malt accreditation							
Beast	(14)	-	105	113	113	104	**108**
Commodus CL	(13)	-	-	107	103	100	**102**
Cyclops	(13)	-	-	104	113	107	**106**
Laperouse	(16)	100	99	103	110	104	**104**
Minotaur	(13)	-	-	103	107	103	**102**
Zena CL	(8)	-	-	-	96	103	**99**
Deliverable as a feed variety							
Combat	(8)	-	-	-	111	109	**107**
Compass	(16)	98	109	111	106	102	**106**
Fathom	(15)	105	119	106	103	101	**105**
Flinders	(8)	92	81	92	-	-	**93**
La Trobe	(16)	99	107	108	105	99	**103**
Litmus	(14)		148	111	83	94	**103**
Mundah	(8)	100	115	104	-	-	**98**
Neo CL	(0)	-	-	-	-	-	**-**
Rosalind	(16)	107	118	116	109	102	**109**
Scope CL	(16)	104	119	99	91	95	**98**
Titan AX	(5)	-	-	-	-	106	**104**

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

Table 8. Grain yield of barley varieties in AGZONE 5 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		2.90	1.97	2.45	4.23	3.97	3.10
Variety	(No. trials)	(3)	(4)	(6)	(5)	(6)	(24)
Deliverable as a malt variety							
Bass	(24)	91	90	92	91	92	**91**
Buff	(24)	104	104	101	103	102	**103**
Maximus CL	(24)	107	126	120	104	107	**113**
RGT Planet	(24)	103	93	91	102	101	**98**
Spartacus CL	(24)	101	118	114	100	102	**107**
Stage Two malt accreditation							
Beast	(21)	-	121	126	112	110	**116**
Commodus CL	(17)	-	-	112	104	102	**105**
Cyclops	(17)	-	-	120	112	112	**113**
Laperouse	(24)	106	107	116	108	108	**110**
Minotaur	(17)	-	-	107	105	106	**107**
Zena CL	(11)	-	-	-	101	100	**98**
Deliverable as a feed variety							
Combat	(11)	-	-	-	112	112	**113**
Compass	(24)	100	111	116	108	104	**109**
Fathom	(24)	100	106	110	104	102	**105**
Flinders	(13)	95	93	89	-	-	**92**
La Trobe	(24)	101	115	112	102	102	**107**
Litmus	(0)	-	-	-	-	-	**-**
Mundah	(13)	89	97	89	-	-	**92**
Neo CL	(0)	-	-	-	-	-	**-**
Rosalind	(24)	109	131	116	107	107	**114**
Scope CL	(0)	-	-	-	-	-	**-**
Titan AX	(11)	-	-	-	109	106	**106**

Source: based on MET analysis from NVT Online, nvtonline.com.au

Table 9. Grain yield of barley varieties in AGZONE 6 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		4.91	4.14	4.07	6.05	4.91	4.82
Variety	(No. trials)	(2)	(3)	(3)	(1)	(3)	(12)
Deliverable as a malt variety							
Bass	(12)	90	90	91	93	90	**91**
Buff	(12)	103	103	95	101	100	**100**
Maximus CL	(12)	99	106	106	98	105	**104**
RGT Planet	(12)	111	106	108	108	108	**108**
Spartacus CL	(12)	94	99	100	95	99	**98**
Stage Two malt accreditation							
Beast	(10)	-	102	106	103	100	**102**
Commodus CL	(7)	-	-	98	99	92	**95**
Cyclops	(7)	-	-	114	105	112	**111**
Laperouse	(12)	101	107	109	102	107	**106**
Minotaur	(7)	-	-	114	106	113	**112**
Zena CL	(4)	-	-	-	107	107	**107**
Deliverable as a feed variety							
Combat	(4)	-	-	-	111	118	**117**
Compass	(12)	93	95	98	101	92	**95**
Fathom	(12)	95	96	96	99	94	**96**
Flinders	(12)	97	97	97	95	99	**97**
La Trobe	(12)	95	98	98	98	97	**97**
Litmus	(0)	-	-	-	-	-	**-**
Mundah	(8)	89	82	81	-	-	**83**
Neo CL	(0)	-	-	-	-	-	**-**
Rosalind	(12)	105	107	106	104	106	**106**
Scope CL	(0)	-	-	-	-	-	**-**
Titan AX	(3)	-	-	-	-	101	**-**

Source: based on MET analysis from NVT Online, nvtonline.com.au

Table 10. Grain yield of barley varieties averaged across AGZONES 1–6 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		3.93	2.69	3.44	4.53	5.17	3.95
Variety	(No. trials)	(20)	(21)	(27)	(23)	(29)	(120)
Deliverable as a malt variety							
Bass	(120)	91	91	93	91	92	**92**
Buff	(118)	107	106	101	104	101	**103**
Maximus CL	(120)	103	110	110	104	103	**106**
RGT Planet	(119)	102	99	100	103	105	**102**
Spartacus CL	(120)	99	105	105	100	99	**102**
Stage Two malt accreditation							
Beast	(100)	-	110	111	107	104	**107**
Commodus CL	(79)	-	-	103	100	99	**100**
Cyclops	(79)	-	-	111	110	108	**109**
Laperouse	(120)	105	106	108	107	105	**106**
Minotaur	(79)	-	-	107	105	107	**106**
Zena CL	(52)	-	-	-	102	104	**101**
Deliverable as a feed variety							
Combat	(52)	-	-	-	112	112	**111**
Compass	(120)	102	104	105	103	100	**103**
Fathom	(119)	102	103	102	102	99	**101**
Flinders	(83)	93	94	95	93	96	**94**
La Trobe	(120)	100	104	104	100	99	**101**
Litmus	(65)	-	98	90	91	91	**93**
Mundah	(64)	94	93	91	-	-	**92**
Neo CL	(0)	-	-	-	-	-	**-**
Rosalind	(120)	106	113	110	106	105	**108**
Scope CL	(84)	96	95	92	93	93	**94**
Titan AX	(34)	-	-	-	106	104	**105**

Source: based on MET analysis from NVT Online, nvtonline.com.au

Table 11. Direct comparisons between two varieties (yield difference compared using least significant difference, p=0.05, calculated using standard errors from single-site MET) – how many times (as a percentage) was variety A (comparator variety) lower-yielding, the same yield or higher-yielding than variety B (base variety) when sown together in WA barley NVT?

Variety A	Percentage of trials			Number of trials	Comparison years	Comparison
	Variety A is lower yielding than Variety B	Variety A and B yield the same	Variety A is higher yielding than Variety B			
Variety B: Maximus CL						
Bass	96%	3%	1%	119	2018–2022	Bass < Maximus CL
Beast	19%	37%	44%	100	2019–2022	Beast ≥ Maximus CL
Buff	50%	16%	34%	118	2018–2022	Buff = Maximus CL
Combat	8%	19%	73%	52	2021–2022	Combat > Maximus CL
Commodus CL	53%	34%	13%	79	2020–2022	Commodus CL ≤ Maximus CL
Compass	46%	27%	27%	119	2018–2022	Compass = Maximus CL
Cyclops	15%	27%	58%	79	2020–2022	Cyclops ≥ Maximus CL
Fathom	54%	28%	18%	118	2018–2022	Fathom ≤ Maximus CL
Flinders	89%	11%	0%	82	2018–2022	Flinders < Maximus CL
La Trobe	51%	46%	3%	119	2018-2022	La Trobe ≤ Maximus CL
Laperouse	26%	44%	30%	119	2018–2022	Laperouse = Maximus CL
Litmus	65%	17%	18%	65	2019–2022	Litmus ≤ Maximus CL
Minotaur	32%	27%	42%	79	2020–2022	Minotaur = Maximus CL
Mundah	88%	9%	3%	64	2018–2020	Mundah < Maximus CL
Neo CL	-	-	-	-	-	*No data available*
RGT Planet	54%	16%	30%	119	2018–2022	RGT Planet = Maximus CL
Rosalind	13%	40%	46%	119	2018–2022	Rosalind ≥ Maximus CL
Scope CL	78%	13%	8%	83	2018–2022	Scope CL < Maximus CL
Spartacus CL	76%	24%	0%	119	2018–2022	Spartacus CL < Maximus CL
Titan AX	26%	27%	47%	34	2021–2022	Titan AX = Maximus CL
Zena CL	40%	17%	42%	52	2021–2022	Zena CL = Maximus CL
Variety B: RGT Planet						
Bass	74%	21%	5%	119	2018–2022	Bass < RGT Planet
Beast	22%	16%	62%	100	2019–2022	Beast ≥ RGT Planet
Buff	33%	25%	42%	118	2018–2022	Buff = RGT Planet
Combat	0%	15%	85%	52	2021–2022	Combat > RGT Planet
Commodus CL	47%	22%	32%	79	2020–2022	Commodus CL = RGT Planet
Compass	32%	27%	41%	119	2018–2022	Compass = RGT Planet
Cyclops	15%	19%	66%	79	2020–2022	Cyclops ≥ RGT Planet
Fathom	41%	18%	42%	118	2018–2022	Fathom = RGT Planet
Flinders	62%	32%	6%	82	2018–2022	Flinders ≤ RGT Planet
La Trobe	40%	18%	42%	119	2018–2022	La Trobe = RGT Planet
Laperouse	20%	24%	55%	119	2018–2022	Laperouse ≥ RGT Planet
Litmus	63%	12%	25%	65	2019–2022	Litmus ≤ RGT Planet
Maximus CL	30%	16%	54%	119	2018–2022	Maximus CL = RGT Planet
Minotaur	13%	33%	54%	79	2020–2022	Minotaur ≥ RGT Planet
Mundah	52%	22%	27%	64	2017–2020	Mundah = RGT Planet
Neo CL	-	-	-	-	-	*No data available*
Rosalind	17%	25%	58%	119	2018–2022	Rosalind ≥ RGT Planet
Scope CL	60%	24%	16%	83	2018–2022	Scope CL ≤ RGT Planet
Spartacus CL	45%	13%	42%	119	2018–2022	Spartacus CL = RGT Planet
Titan AX	29%	47%	24%	34	2021–2022	Titan AX = RGT Planet
Zena CL	0%	100%	0%	52	2021–2022	Zena CL = RGT Planet

Source: based on single-site MET data from NVT Online, **nvtonline.com.au**

Table 12. Direct comparisons between two varieties (yield difference compared using least significant difference, p=0.05, calculated using standard errors from single-site MET) – how many times (as a percentage) was variety A (comparator variety) lower-yielding, the same yield or higher-yielding than variety B (base variety) when sown together in WA barley NVT?

Variety A	Percentage of trials			Number of trials	Comparison years	Comparison
	Variety A is lower yielding than Variety B	Variety A and B yield the same	Variety A is higher yielding than Variety B			
Variety B: Rosalind						
Bass	98%	2%	0%	119	2018–2022	Bass < Rosalind
Beast	31%	39%	30%	100	2019–2022	Beast = Rosalind
Buff	62%	18%	20%	118	2018–2022	Buff ≤ Rosalind
Combat	4%	21%	75%	52	2021–2022	Combat > Rosalind
Commodus CL	70%	27%	4%	79	2020–2022	Commodus CL < Rosalind
Compass	58%	29%	13%	119	2018–2022	Compass ≤ Rosalind
Cyclops	22%	38%	41%	79	2020–2022	Cyclops ≥ Rosalind
Fathom	69%	21%	9%	118	2018–2022	Fathom < Rosalind
Flinders	93%	7%	0%	82	2018–2022	Flinders < Rosalind
La Trobe	79%	20%	1%	119	2018–2022	La Trobe < Rosalind
Laperouse	46%	34%	20%	119	2018-2022	Laperouse ≤ Rosalind
Litmus	77%	18%	5%	65	2019–2022	Litmus < Rosalind
Maximus CL	46%	40%	13%	119	2018–2022	Maximus CL ≤ Rosalind
Minotaur	37%	41%	23%	79	2020–2022	Minotaur ≤ Rosalind
Mundah	94%	6%	0%	64	2018–2020	Mundah < Rosalind
Neo CL	-	-	-	-	-	*No data available*
RGT Planet	58%	25%	17%	119	2018–2022	RGT Planet ≤ Rosalind
Scope CL	88%	11%	1%	83	2018–2022	Scope CL < Rosalind
Spartacus CL	76%	21%	3%	119	2018–2022	Spartacus CL < Rosalind
Titan AX	44%	35%	21%	34	2021–2022	Titan AX ≤ Rosalind
Zena CL	48%	29%	23%	52	2021–2022	Zena CL ≤ Rosalind

Source: based on single-site MET data from NVT Online, **nvtonline.com.au**

Grain yield – comparisons

The benchmark barley varieties for grain yield in WA are now Beast and Combat, replacing Rosalind and RGT Planet. RGT Planet was the benchmark at sites with a yield potential above 5t/ha, while Rosalind was the benchmark at yield potentials below 4t/ha on non-acidic soils. Beast is now the benchmark below 2t/ha, while Combat is the benchmark above 5t/ha. (Figures 2–4, Tables 1, 2, 4–12). Between 2 and 5t/ha, Beast, Combat, Cyclops, Laperouse, Maximus CL and Rosalind are competitive, with different business cases based on farming systems on non-acidic soils and if using IMI-herbicides in the rotation. Buff is, however, the benchmark on soils with an acidic profile (pH_{Ca} below 4.8). Where early vigour and weed competitiveness are primary factors in the variety choice in sub-3t/ha environments, Beast, Commodus CL, Compass and Titan AX are considerations. Above 3.5t/ha, Laperouse is a higher-yielding and more effective weed-suppressive option than Commodus CL and Compass. While not included in this sowing guide, Banks is worth considering for early sowing opportunities in April due to its longer duration to flowering than RGT Planet and Rosalind. Where SFNB is an issue, Combat is now the best option and outclasses Fathom for grain yield and overall agronomic performance, especially in environments that yield more than 3t/ha.

RGT Planet set a new yield benchmark for varieties segregated for malt following its release in WA in 2016. Since 2017, it has yielded higher in three-quarters of comparisons with Bass and just over two in every five comparisons with Spartacus CL (Table 11). Maximus CL is a more competitive yield option than Bass and Spartacus CL against RGT Planet, yielding higher than RGT Planet in nearly three out of every five WA barley NVT since 2018. The yield advantage of RGT Planet has not been apparent until the site yield exceeds 5.5t/ha. Maximus CL has a clear yield advantage over

RGT Planet at sites with a yield potential below 4t/ha (Figures 2–4). Buff is not competing with RGT Planet on-farm, as Buff is suited to lower rainfall areas and environments that yield less than 3t/ha. Buff is also better suited to paddocks of low soil pH.

Beast, Commodus CL, Cyclops, Laperouse, Minotaur and Zena CL are in Stage Two of the Grains Australia Malt Accreditation program, with a decision on all six varieties expected in March 2024. Each variety has a good fit in specific systems:

- **Beast** – has matched or bettered Rosalind at many WA barley NVT (Figures 2–3, Tables 4–12) and is an alternative to Rosalind, where a more vigorous early growth habit for weed suppression and/or taller straw is needed.
- **Commodus CL** – is not yield competitive with Rosalind above 2t/ha but is comparable in its yield to Compass and Spartacus CL (Tables 4–12). It offers growers a more vigorous plant type for early-season weed suppression than Spartacus CL and Maximus CL in an IMI-tolerant background. The poor straw strength of Commodus CL will limit its use in higher rainfall and early sowing opportunities; this is where Zena CL becomes an opportunity.
- **Cyclops** – since 2020, has had a yield advantage over Rosalind and most varieties (except Combat) at sites that yielded more than 3t/ha (Figures 2–4). Cyclops has the same erect growth habit as Spartacus CL and Maximus CL but with different genetics and no tolerance to IMI-herbicides.
- **Laperouse** – competes well with Rosalind (data not shown) and Maximus CL (Figure 4) at a range of yield potentials. Laperouse performs better than RGT Planet, where the site yield is less than 4t/ha.
- **Minotaur** – a semi-dwarf alternative to Bass, Flinders, RGT Planet and Zena CL. Since 2020, Minotaur has shown a clear advantage over RGT Planet at sites that yield less than 4.5t/ha (Figure 4). Minotaur, however, was outclassed by Cyclops across most of the environments in those same trials.
- **Zena CL** – effectively RGT Planet with IMI-herbicide tolerance, bred through mutation breeding from RGT Planet. Zena CL has mirrored RGT Planet for grain yield in WA (Figure 3, Tables 4–11).

More years of data are needed to confirm the yield relativity of Titan AX, but it looks comparable to Beast in the limited NVT datasets available. Beast may have an advantage below 4 t/ha, but more data is needed to confirm those observations.

Neo CL is a new variety labelled as a step change improvement in yield, with 2023 the first year it has been sown in WA barley NVT. Data from a range of seasons is now needed to confirm the yield relativity of Neo CL in WA. DPIRD internal trial data from 2022 shows a yield improvement over Maximus CL, Spartacus CL and RGT Planet (Figure 7), which supports the internal data published by InterGrain.

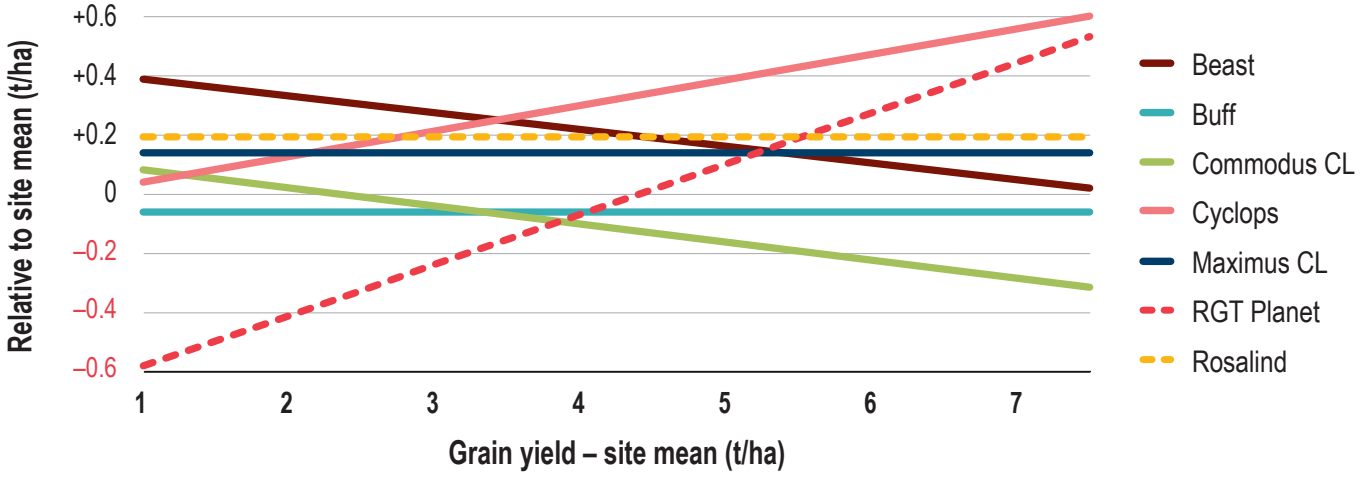


Figure 2. Fitted grain yield of Beast, Buff, Commodus CL, Cyclops, Maximus CL, RGT Planet and Rosalind at different site means.

Source: based on NVT statewide tables of yield and grain quality (2020–2022). Each variety sown in all 79 trial-years of data, NVT Online **nvtonline.com.au**

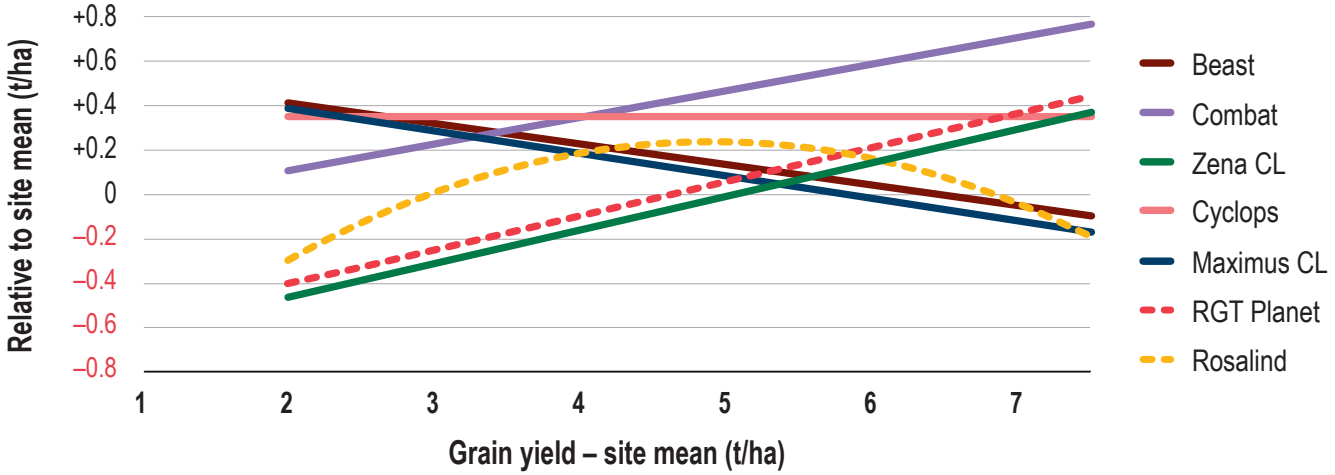


Figure 3. Fitted grain yield of Beast, Combat, Cyclops, Maximus CL, RGT Planet and Zena CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2021–2022). Each variety sown in all 59 trial-years of data, NVT Online **nvtonline.com.au**

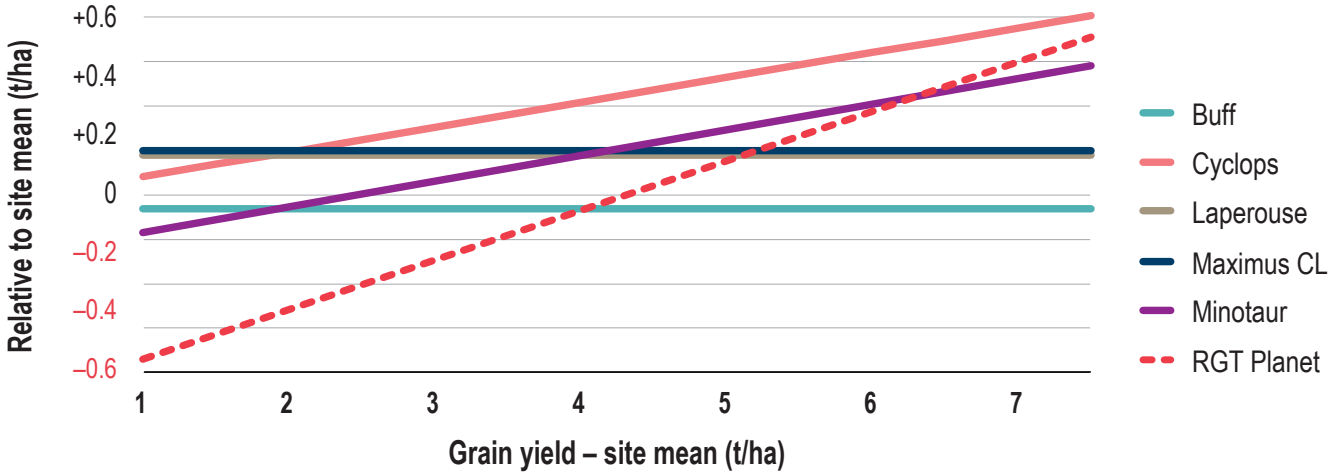


Figure 4. Fitted grain yield of Buff, Cyclops, Laperouse, Maximus CL, Minotaur and RGT Planet at different site means.

Source: based on NVT statewide tables of yield and grain quality (2020–2022). Each variety sown in all 79 trial-years of data, NVT Online **nvtonline.com.au**

Grain quality

Blakely Paynter (DPIRD)

When comparing feed barley varieties, it is necessary to consider grain yield potential alongside disease resistance and agronomic features like straw strength and head loss resistance. However, while grain yield is essential when comparing varieties segregated for malt, grain quality characteristics are equally important for those chasing the premium for delivery as a MALT1 barley. As the premium increases, varietal differences in grain quality increase in importance, especially in seasons with a drier finish.

As with the grain yield data presented in Figures 2 and 4, the physical grain qualities (hectolitre weight and retention above a 2.5mm slotted sieve) of a variety have been plotted relative to the site mean as the site mean increases (Figures 5–6). The deviation from the site mean was similarly assessed for quadratic and linear trends. If neither the quadratic nor the linear trend was significant, the grain quality response of a variety was deemed to run parallel to the site mean quality at the average deviation for that variety. The data used for this analysis has been extracted from the 'NVT Statewide tables of yield and grain quality' available at nvtonline.com.au.

Grain quality – hectolitre weight comparisons

Figure 5 compares the hectolitre weight of three varieties in Stage Two of the Grains Australia Malt Accreditation program (Cyclops, Laperouse and Minotaur), one new malt variety (Buff), and two established malt varieties (Maximus CL and RGT Planet).

Bass has been the benchmark variety for hectolitre weight for varieties segregated for malt in WA. Maximus CL and Spartacus CL are similar to Bass. Hectolitre weight is not likely to be a limiting factor in their receival as MALT1. RGT Planet has the highest risk of not meeting MALT1 hectolitre specifications in WA. It is 3–4kg/hL lighter than Maximus CL below 68kg/hL, where the risk of dropping out of MALT1 is higher (Figure 5). Conditions favouring a low hectolitre weight in RGT Planet are often associated with high grain plumpness.

Conversely, high hectolitre is often related to low grain plumpness in RGT Planet. These observations reflect the elongated grain shape of RGT Planet. Like RGT Planet, Buff has a lower hectolitre weight than Maximus CL, about 2–2.5kg/hL lower but is an improvement over RGT Planet (Figure 5). Low hectolitre weight may be an issue for Buff in some seasons.

Three of the varieties in Figure 5, Cyclops, Laperouse and Minotaur, have a potential market fit in WA if accredited by Grains Australia. There is positive interest in them from grain marketers and malting companies. The hectolitre weight of

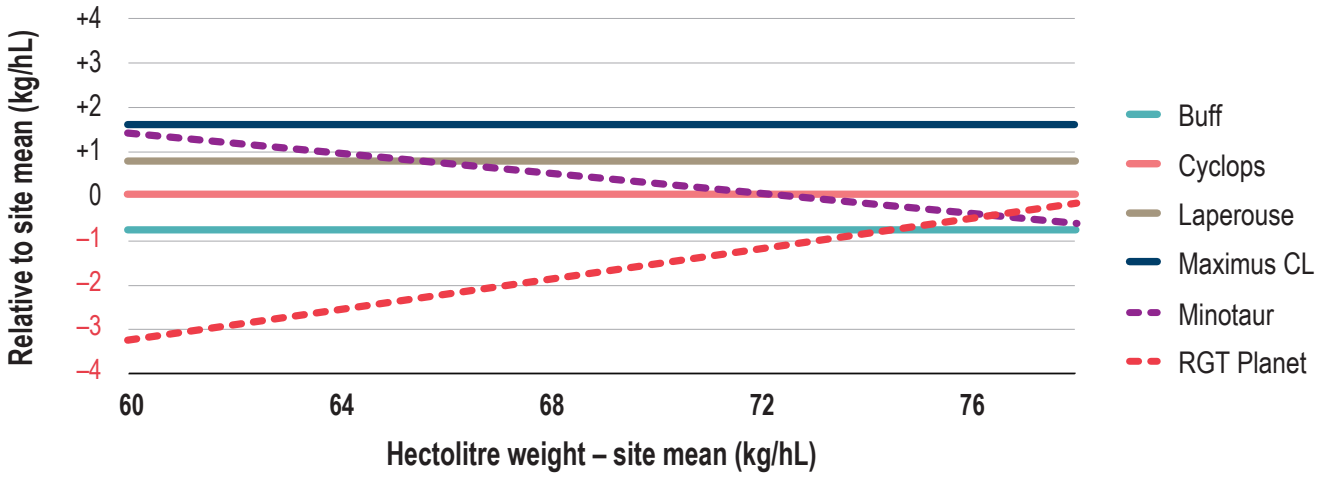


Figure 5. Fitted hectolitre weight of Buff, Cyclops, Laperouse, Maximus CL, Minotaur and RGT Planet at different site means.

Source: based on NVT statewide tables of yield and grain quality (2020–2022). Each variety sown in all 79 trial-years of data, NVT Online nvtonline.com.au

Cyclops, Laperouse and Minotaur, while lower than Maximus CL (Figure 5), is unlikely to cause issues for delivery as MALT1 as has occurred with RGT Planet. Zena CL, not included in Figure 5, is another variety in Stage Two accreditation with a potential market fit in WA. Zena CL has the same grain shape and hectolitre weight as RGT Planet. Zena CL will have the same risk of not meeting MALT1 hectolitre weight specifications as RGT Planet.

Neo CL is in Stage One of Grains Australia's Malt Accreditation program. It had a similar hectolitre weight to RGT Planet in DPIRD internal trials conducted in 2022 (Figure 7) and reflects the observations and variety notes of InterGrain. Data from a more comprehensive range of seasons than that tested by InterGrain and DPIRD is now needed to confirm the hectolitre weight relativity of Neo CL in WA. If the data reflects current observations, delivery of Neo CL as MALT1 in some seasons and environments may be restricted by low hectolitre weight as has occurred with RGT Planet.

Grain quality – grain plumpness comparisons

Figure 6 compares the retention of three varieties in Stage Two of the Grains Australia Malt Accreditation program (Cyclops, Laperouse, and Minotaur), one new malt variety (Buff) and two established malt varieties (Maximus CL and RGT Planet).

Bass is the benchmark malt variety for grain plumpness. Bass has higher retention over a range of retention levels (percentage above a 2.5mm sieve) compared with other varieties segregated for malt in WA (data not shown). Maximus CL has an improved grain shape over Spartacus CL, resulting in higher retention. Across 79 WA barley NVT (2020–2022), Maximus CL retention was 3% above Spartacus CL and 1–3% lower than Bass (data not shown). A higher selection rate for receival as MALT1 should be achievable for Maximus CL relative to Spartacus CL. RGT Planet behaves more like Baudin (data not shown) than Bass, with retention significantly lower than Spartacus CL and Maximus CL except at sites with retention above 90% (Figure 6). RGT Planet has a lower selection rate for MALT1 than Maximus CL due to its poorer grain shape. The grain plumpness of Buff is not as good as Bass (data not shown) or Maximus CL (Figure 6) and is comparable to Spartacus CL (data not shown). The grain shape of Buff (lower hectolitre weight and moderate grain plumpness) may limit a high delivery probability as MALT1.

The grain plumpness of Laperouse is an improvement over Maximus CL and a significant improvement over RGT Planet (Figure 6). The grain plumpness of Laperouse is comparable to Bass (data not shown), which when combined with its good hectolitre weight, should result in a high probability of delivery as MALT1 if accredited by Grains Australia and received in WA.

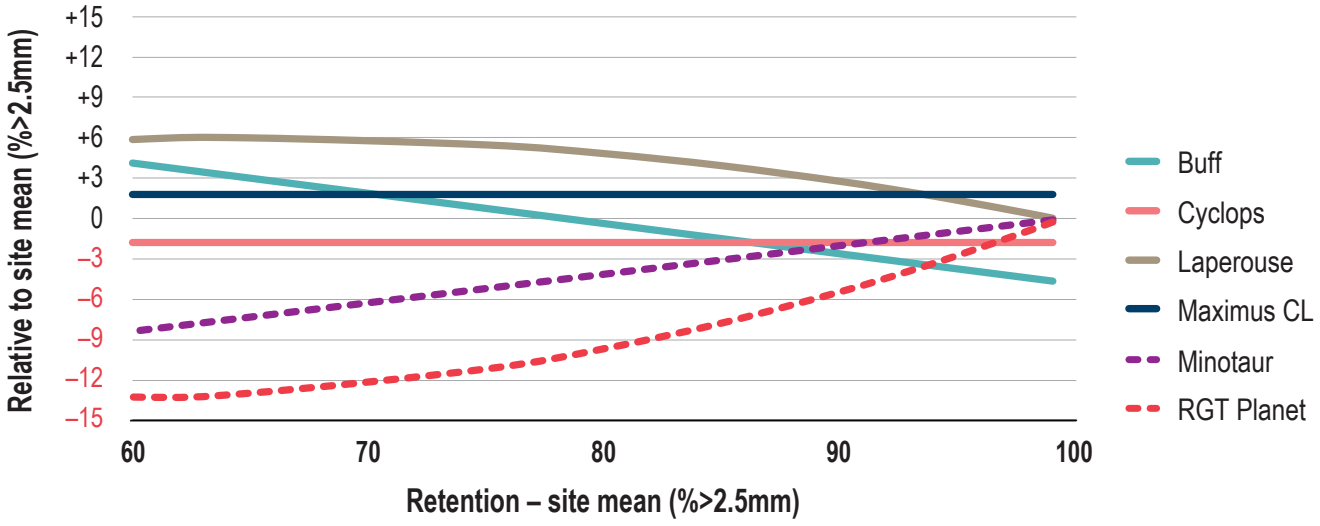


Figure 6. Fitted grain plumpness of Buff, Cyclops, Laperouse, Maximus CL, Minotaur and RGT Planet at different site means.

Source: based on NVT statewide tables of yield and grain quality (2020–2022). Each variety sown in all 79 trial-years of data, NVT Online **nvtonline.com.au**

The grain plumpness of Cyclops is comparable to Spartacus CL (data not shown) but not as good as Maximus CL (Figure 6). If accredited and received in WA, the receival probability of Cyclops should be similar to that achieved by Spartacus CL.

While an improvement over RGT Planet, the grain plumpness of Minotaur could limit delivery as MALT1 in some seasons (if accredited and segregated in WA) as it is poorer than Spartacus CL (data not shown) and Maximus CL (Figure 6).

Zena CL has the same grain plumpness as RGT Planet (data not shown). Growers should expect it to meet (or fail to meet) MALT1 receival specifications for grain plumpness with the same probability as RGT Planet.

In DPIRD trials in 2022, grain plumpness of Neo CL was similar to Spartacus CL, better than RGT Planet and poorer than Maximus CL (Figure 7). These results reflected InterGrain's observations and variety notes for Neo CL vs RGT Planet but not Maximus CL. Data from a wider range of seasons are now needed to confirm the relative grain plumpness of Neo CL in WA. If future results reflect current observations, grain plumpness is unlikely to be a major factor restricting the delivery of Neo CL as MALT1, unlike RGT Planet. For Neo CL, low hectolitre weight may be the issue that limits receival as MALT1 rather than grain plumpness.

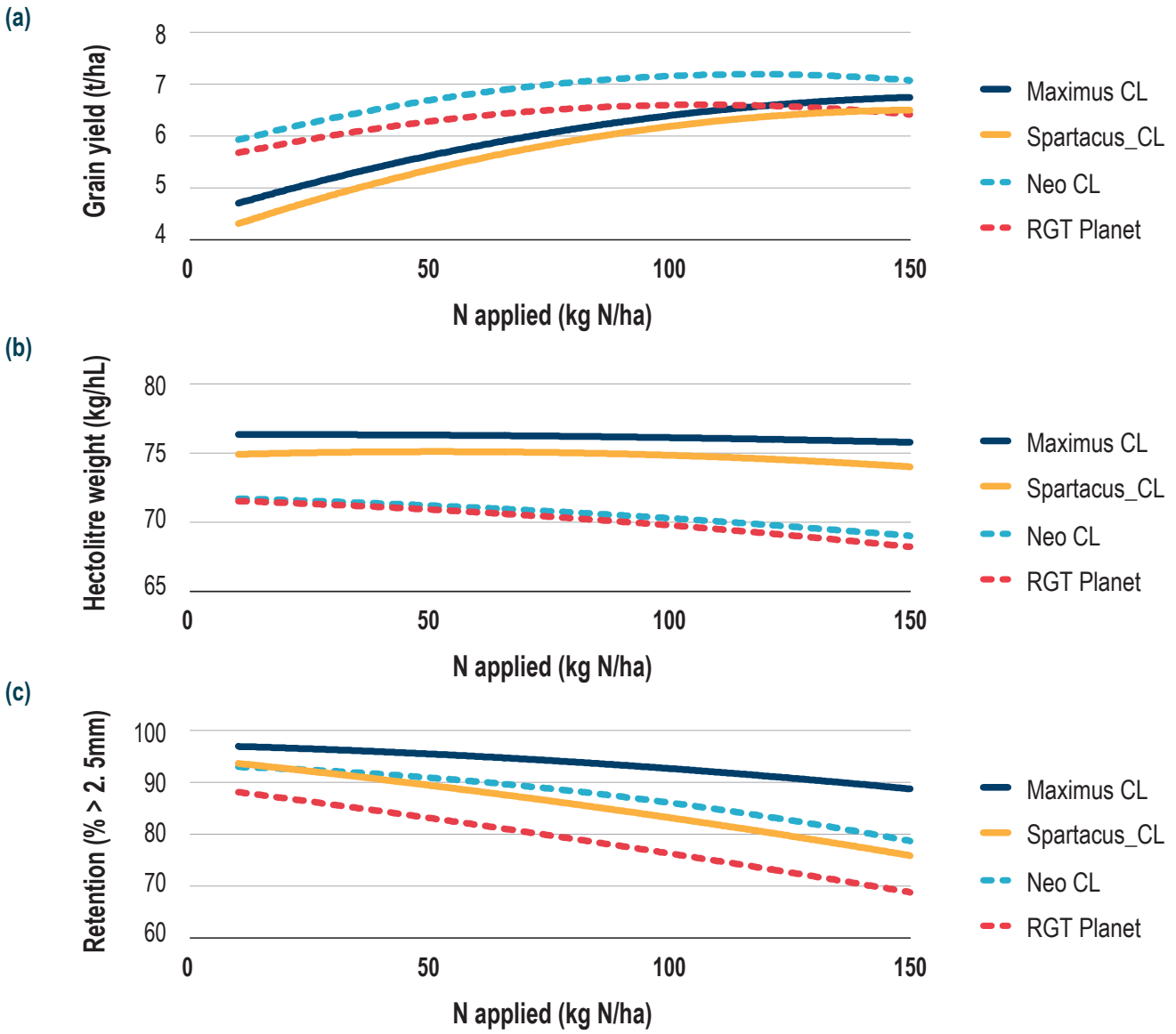


Figure 7. Fitted response of Maximus CL, Neo CL, RGT Planet and Spartacus CL to increasing N fertiliser for a) grain yield b) hectolitre weight and c) grain plumpness.

Source: Blakely Paynter, data averaged across three DPIRD sites (Wongan Hills, Yerecoin, and York) from 2022.

Disease and pest resistance

Sanjiv Gupta (Murdoch), Geoff Thomas, Carla Wilkinson, Sarah Collins, Daniel Huberli, Kithsiri Jayasena, Andrea Hills and Blakely Paynter (DPIRD)

Foliar disease abbreviations:

- **BLR** = barley leaf rust.
- **BYD/CYD** = barley yellow dwarf/cereal yellow dwarf.
- **CCN** = cereal cyst nematode.
- **CR** = crown rot.
- **NFNB** = net-form net blotch.
- **PM** = powdery mildew.
- **RLS** = ramularia leaf spot.
- **RLN** = root lesion nematode.
- **Sc** = scald.
- **SFNB** = spot-form net blotch.

Disease resistance abbreviations:

- **VS** = very susceptible.
- **SVS** = susceptible to very susceptible.
- **S** = susceptible.
- **MSS** = moderately susceptible to susceptible.
- **MS** = moderately susceptible.
- **MRMS** = moderately resistant to moderately susceptible.
- **MR** = moderately resistant.
- **RMR** = resistant to moderately resistant.
- **R** = resistant.
- **APR** = adult plant resistance.
- *p* = provisional rating.

Refer to page 4 to interpret resistance classifications.

Fungicide abbreviations:

- **DMI** = demethylation inhibitor.
- **SDHI** = succinate dehydrogenase inhibitor.
- **QoI** = Qo Inhibitor fungicides (strobilurin fungicide).

Seedling and adult resistance

Disease, virus and nematode resistance data is presented in Tables 13 to 15 and in the variety snapshots. Leaf disease ratings in this guide include seedling and adult plant stage resistance ratings for the foliar leaf diseases NFNB, SFNB, PM and BLR. There is no seedling resistance data for scald, only for adult plant stage resistance.

Seedling ratings are applicable at early growth stages (two- to three-leaf stage) and are important for deciding on seed- or fertiliser-applied fungicide treatments. They are also helpful in assessing the likely response of a variety to early disease pressure. Varieties susceptible to stubble-borne diseases such as scald, NFNB and SFNB are at high risk of initial infection if sown onto one- or two-year-old barley stubble.

Variations in seedling and adult ratings of a variety are primarily due to the differential effectiveness of resistance genes at one stage or the other. Adult plant ratings are applicable at later plant growth stages (after flag leaf emergence). However, adult ratings may be relevant as early as late tillering to stem elongation in some varieties and for some diseases.

Variety disease ratings vary over time due to seasonal changes in disease pressure, regional disease spread, climatic conditions, stubble retention and the development of new pathotypes/races. As a result, minor changes in resistance scores of varieties can occur between sowing guides. However, in this 2024 guide, there have been no significant changes in resistance scores due to a new pathotype.

New pathotype – net-form net blotch (NFNB)

Watch for increasing NFNB with a new aggressive pathotype, Oxford virulent, detected across the State. NFNB surveys indicate increasing variation in this pathogen. Future surveys will help provide information on the extent of the variation and if new virulence exists in WA. Minotaur (MS as

seedling and adult) has the best resistance to the Oxford pathotype, whereas many varieties included in this sowing guide have some tolerance as an adult (MSS) but are susceptible at a seedling stage (Tables 13 and 14).

New virulence to powdery mildew (PM)

Rosalind shows a susceptible reaction in the presence of PM with *MlLa* virulence. Virulence to the *MlLa* gene has been confirmed in PM isolates in WA's Albany and Esperance port zones, following detection in northern NSW and Queensland. Other potentially impacted varieties include Beast, Commodus CL, Compass and Spartacus CL. In the 2023 season, Maximus CL showed a more susceptible reaction type in a report from the Narrogin district. In eastern Australia, Maximus CL is rated as MS. Close monitoring of these varieties is recommended in mildew favourable environments. Growers should report a suspected breakdown in varietal resistance for PM in varieties rated as MRMS and above.

Pathotype surveillance and fungicide resistance

Growers and consultants observing barley varieties rated as MRMS, MR or R that carry significantly higher leaf disease levels than expected should collect infected material for pathotype identification and fungicide resistance testing. Collect leaf samples before spraying the crop with a fungicide to ensure sample viability.

Place infected Sc, NFNB, SFNB and BLR leaf material in paper envelopes marked with the location, variety, disease and date collected. Fold the leaf in half so the infected area is on the inside. Please do not wrap leaf material in plastic or send it in plastic-lined envelopes. Unlike other leaf diseases, PM-infected leaves should be placed into agar tubes to maintain a live culture for pathotyping. Sample collection kits for PM must be arranged before sampling and, therefore, before spraying.

Send Sc, NFNB and SFNB infected leaf material in paper envelopes to DPIRD, Locked Bag 4, Bentley Delivery Centre WA 6983 and marked attention, Simon Rogers. For more information, contact Simon Rogers via email at simon.rogers@dpird.wa.gov.au or phone (08) 9368 3445.

There is currently no funding for the Centre for Crop and Disease Management (CCDM) or DPIRD to support assessing virulence changes in PM in WA. If there is an unexpected susceptible response to PM of a resistant variety, growers and consultants should contact the CCDM or DPIRD for advice before sending any samples.

Send BLR samples in paper envelopes directly to the University of Sydney, Australian Rust Survey, Reply Paid 88076 Narellan NSW 2567. For more information on sample collection and submission, contact Matthew Williams (ACRCP Operations and Technical Officer) via email at matthew.williams@sydney.edu.au or phone (02) 9351 8808.

To manage fungicide resistance and reduce future resistance development, rotate fungicide groups or use fungicide mixtures that contain different modes of action, including DMI (e.g. prothioconazole and epoxiconazole), QoI (e.g. azoxystrobin and pyraclostrobin) and SDHI (e.g. fluxapyroxad and bixafen). Avoiding repetitive applications of single active ingredients or fungicide groups is another critical tool to reduce the risk of resistance. Isolates of NFNB, SFNB and PM expressing resistance to DMI fungicides and net blotches (NFNB and SFNB) expressing resistance to SDHI fungicides are present in WA. When disease response to fungicide control in barley crops is of concern, samples can be sent to Fran Lopez-Ruiz, CCDM, Curtin University, PO Box U1987, Perth, WA 6845. Contact the Fungicide Resistance Group at frg@curtin.edu.au for details on collecting and submitting a sample.

Plants with symptoms suspected to be RLS or those thought to be physiological leaf spotting (PLS) that respond to fungicide application should be sent for laboratory testing to DPIRD, Locked Bag 4, Bentley Delivery Centre WA 6983 and marked attention, Jason Bradley. For more information, contact Jason Bradley via email at jason.bradley@dpird.wa.gov.au or phone (08) 9368 3982.

Scald (Sc)

Sc starts as pale grey-green, water-soaked blotches on older leaves. The blotches become elongated, often diamond-shaped and bleached with a distinctive brown margin. Lesions usually join to form necrotic areas; eventually, the entire leaf withers and dies. Sc is very damaging in barley as infection can kill leaves prematurely and reduce seed weight. Increased plantings of varieties with a susceptible rating increase Sc's prevalence, especially with an early sowing. A severe initial infection can reduce head and grain numbers.

Yield losses of up to 45% are possible in S to VS varieties with associated quality defects. Sc can survive between seasons on infested stubble and barley grass and carried through infected seeds.

Sc hot spots are apparent in WA. Varieties with the highest risk are Beast (S), Combat (S), Laperouse (S), Litmus (SVS), Minotaur (VS), Mundah (S) and Titan AX (S). A concern for the future is that the widespread adoption of susceptible varieties could see the prevalence of Sc re-emerge as a severe disease affecting barley performance in WA. Using registered seed dressings and in-crop fungicides and avoiding sowing susceptible varieties in 'barley-on-barley' situations are essential considerations for managing Sc.

Net-form net blotch (NFNB)

NFNB starts as pinpoint brown lesions that elongate and produce fine, dark brown streaks along and across the leaf blades, creating a distinctive net-like pattern. Older lesions continue to elongate along leaf veins. NFNB can reduce grain yield by 20–30% and impact grain quality. Double cropping of barley significantly increases the risk of infection.

CCDM has reported populations of NFNB with resistance to the triazole-based DMI fungicide tebuconazole and some other triazole fungicide actives such as prothioconazole and epoxiconazole. Fungicide management is often required to manage the disease in varieties with poor resistance or when the pathotype changes. Resistance has been observed in the central and southern regions of WA. Populations exist in the Esperance region with reduced sensitivity to the DMI fungicides tebuconazole and propiconazole, and resistant populations are present across the lower great southern of the Albany Port zone. In 2022, CCDM also found NFNB with resistance and reduced sensitivity to SDHI. Presently, reports of resistance and reduced sensitivity to SDHI are only from the lower great southern of the Albany Port zone. Fungicide management of NFNB to address current resistance issues and to reduce future resistance development will increasingly require the use of fungicide mixtures containing different modes of action, including DMI (e.g. prothioconazole), QoI (e.g. azoxystrobin and pyraclostrobin) and SDHI (e.g. fluxapyroxad, benzovindiflupyr and bixafen).

Net-form blotch net blotch

Virulence of the NFNB pathogen can vary across time and regions depending on the varieties and resistance genes deployed. Historically, two distinct pathotypes of NFNB existed in WA, Beecher virulent (95NB100) and Beecher avirulent (97NB1). The Beecher avirulent is a dominant pathotype and is prevalent throughout the state. In contrast, the Beecher virulent isolate is now relatively uncommon. Another pathotype, Oxford virulent, has also become evident in the state, particularly in the Albany and Esperance port zones. NFNB surveys indicate increasing variation in the NFNB pathogen. Future surveys and pathotyping of isolates will establish if any new virulence is more widespread in the state.

As different pathotypes of NFNB exist in WA, varietal responses vary accordingly. Litmus is the most vulnerable to NFNB, susceptible to all three major NFNB pathotypes in WA. At the same time, RGT Planet and Zena CL are particularly susceptible to the Oxford pathotype. In the presence of the Oxford virulent pathotype, Buff, Combat, Minotaur, Scope CL and Titan AX have slightly better resistance (MS) as adult plants than other varieties (MSS–SVS). Fungicide, crop rotation and reducing acreage of susceptible varieties remain critical tools in reducing the annual risk of NFNB.

Spot-form net blotch (SFNB)

SFNB develops as small circular or elliptical dark brown spots that become surrounded by a chlorotic zone of varying width. These spots do not elongate to the net-like pattern characteristic of NFNB. The spots may grow to 3–6mm in diameter. SFNB can reduce grain yield by 10–50% and reduce grain quality. Double cropping of barley significantly increases the risk of infection.

The CCDM discovered SFNB populations with resistance and/or reduced sensitivity to DMI fungicides across the Albany, Esperance and Kwinana port zones (including lower and medium rainfall areas). Fungicide compounds most affected by this resistance are tebuconazole and propiconazole. Newer DMIs, such as prothioconazole, are impacted to a lesser degree.

In 2020, the CCDM reported resistance and reduced sensitivity to SDHI fungicide (e.g. fluxapyroxad) in SFNB in the Cunderdin region of WA. In 2021, another confirmed detection of reduced sensitivity to SDHI was found in the Amelup-Borden region.

Fungicide management of SFNB, to address current resistance issues in both DMI and SDHI fungicides and reduce future development regionally, will increasingly require the use of fungicide mixtures and rotation of products including effective DMI ingredients and alternate modes of action including Qol (e.g. azoxystrobin and pyraclostrobin) and SDHI (e.g. fluxapyroxad and bixafen). Where fungicide resistance is suspected, please send samples to the CCDM for assessment.

Combat and Fathom (MR as a seedling and MRMS as an adult) have the most effective combined seedling and adult resistance to SFNB. Beast, Commodus CL, Compass, Cyclops, Laperouse, Maximus CL and Titan AX have some tolerance to SFNB and are rated as MSS or better as seedlings and MSS as adult plants.

Partial tolerance at the seedling stage reduces the likelihood of severe early infection, but SFNB can still infect these varieties at the adult stage. Under high disease pressure, such as sowing into barley stubble, these varieties may still exhibit significant levels of disease at an early stage.

Powdery mildew (PM)

PM appears as fluffy white growths on the surface of the leaves. The area surrounding the spores turns yellow as the fungus depletes leaf nutrients. Older infections become grey and may develop small black fruiting bodies. Early infection can cause yield losses of up to 25%, whereas yield losses at the end of stem elongation reduce yields by about 10%.

Genetic resistance is the best management against PM, especially since a mutation of the *CYP51* gene in powdery mildew has resulted in the compromised efficacy of many DMI fungicides

Powdery mildew

(e.g. tebuconazole, triadimefon and flutriafol) in controlling powdery mildew at label rates. Higher value DMI fungicides and alternative modes of action, such as strobilurins (e.g. azoxystrobin and pyraclostrobin), SDHI (for instance, fluxapyroxad) and amines (e.g. spiroxamine) are still active against PM.

Varieties grown in WA with intermediate resistance or better (MRMS, MR and R) to PM fit into nine broad groups based on postulated or known effective genes that control their resistance. The diversity of resistance genes and the presence of multiple genes in some varieties means that not all varieties will be rendered susceptible simultaneously if mutations occur or known mutations become widespread. Only those varieties carrying the *mlo* gene, like LG Alestar and RGT Planet, have durable resistance to PM. The rest of the widely grown varieties in WA are vulnerable to mutations of the PM fungus. Field scouting indicates increasing variation in the PM pathogen with confirmation of virulence to the *MlLa* gene in southern regions of WA. The variety Rosalind is significantly affected by the new virulence. Other varieties, including Beast, Commodus CL and Compass can potentially show variable responses across WA.

Barley leaf rust (BLR)

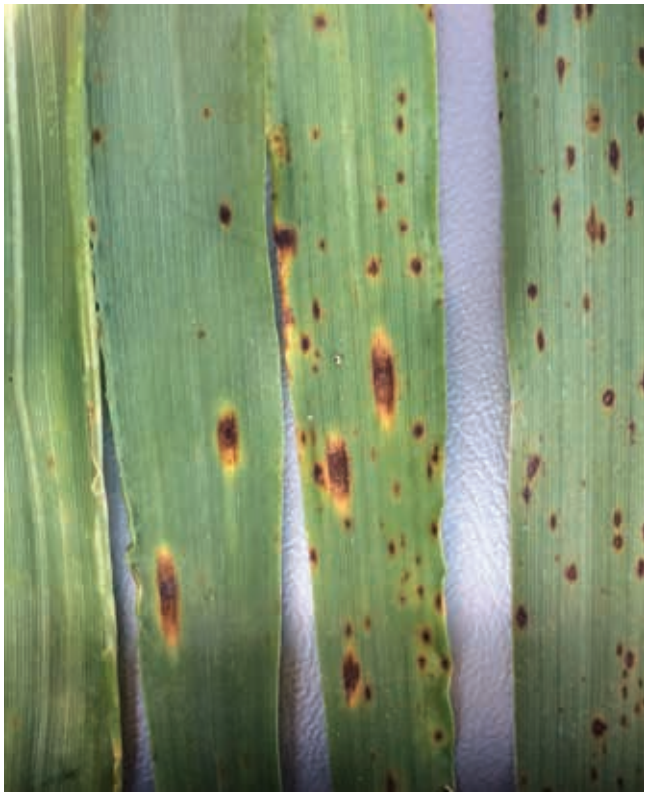
BLR appears as small, circular-to-oval pustules with light-brown powdery spores on the upper surface of leaves (rarely on the back of the leaf blade) and leaf sheaths in heavy infections. As the crop matures, pustules darken, producing black spores embedded in leaf tissue. BLR can reduce grain yield by more than 30% in severe infections.

Most of the major genes for BLR resistance present in Australian varieties are no longer effective against the dominant pathotypes in WA (5457 P- and 5656 P+). Rosalind (MR) has the best rating amongst current varieties. Several varieties, including Combat, Fathom, Flinders, RGT Planet, and Zena CL, have MRMS ratings associated with a late expression of APR. Temperature and varietal background influence the effectiveness of the APR *Rph20* gene. For example, while Flinders and RGT Planet carry two APR genes (*Rph20* and *Rph24*), their field reaction may vary depending on which allele they have and which other minor genes they carry. As they are not pathotype-specific, APR genes are unlikely to be affected by future pathotype changes. APR only develops fully at the adult plant stage, generally after flag leaf emergence, although it may be apparent from earlier growth stages in some seasons. It may still be necessary to protect those varieties with APR genes at early growth stages from the initial infection as they remain vulnerable to rust infection before heading.

Ramularia leaf spot (RLS)

Growers should watch for the leaf disease RLS caused by the fungus *Ramularia collo-cygni*. This disease was first detected in WA in 2018 in three locations across the south coast. In 2019, it was present in seed samples from the mid-west, central and southern wheatbelt, including low rainfall areas. Further testing suggests the disease is not widespread.

Where established, RLS can commonly cause yield losses of up to 25%. The fungus is primarily a disease of barley; however, it can infect many hosts, including oats, wheat and other grasses. Infected seeds are likely to be the primary source of long-distance disease spread and introduction of the disease to new areas. The more localised disease spreads via airborne spores from infected barley and grasses. However, localised spread requires prolonged periods of leaf wetness, and, as a result, a higher disease incidence is expected in medium and high-rainfall areas.



Ramularia leaf spot

Identifying the disease can be difficult as lesions are generally not evident until after flowering. RLS can be easily confused with fungal leaf spotting diseases such as SFNB or abiotic symptoms caused by physiological leaf spotting (PLS) and boron toxicity. Abiotic spots caused by PLS generally do not respond to fungicide application. Research in Europe indicates that varieties carrying the *mlo* gene for resistance to PM are often susceptible to RLS, but this is not always true. The potential impact of this disease on WA barley crops is unknown. However, following detection in 2018, significant crop infection has not been reported in WA. Varietal responses to RLS are, therefore, not available.

There are no specific management recommendations for the disease in WA. However, the fungicides currently used to manage net blotches in barley are likely to be active on RLS when applied at the booting stage. Two products are registered for RLS management, Elatus® Ace (benzovindiflupyr + propiconazole) and Maxentis® (azoxystrobin + prothioconazole). As RLS is at high risk of developing fungicide resistance, sustainable rotation of fungicides should always be practised.

Crown rot (CR)

Crown rot (CR, *Fusarium pseudograminearum*) is a fungal, stubble-borne disease most common in cereal rotations. It infects the sub-crown internode, crown and lower stems and is not usually noticed until after heading when whiteheads are visible. Symptoms can include whiteheads scattered throughout the crop but not in distinct patches as with take-all. Infected tiller bases on individual plants are honey-brown, especially under leaf sheaths. A pink discolouration often forms around or in the crown or under leaf sheaths. The browning at the base of infected tillers is the most reliable indicator of CR, as whiteheads may not occur in seasons with good spring rain. Significant yield losses can occur when high disease levels coincide with moisture stress during grain fill. Affected heads have shrivelled or no grain.

Seed dressings are registered to suppress CR. However, no fungicide options exist to control CR once the crop has been established. Including non-cereals in the rotation (such as pulses, oilseed, lupin and grass-free pasture) can reduce inoculum levels. Inter-row seeding and maintaining reasonable grass weed control in break crops and between crops are also effective measures. Varietal resistance and tolerance to CR are limited. DPIRD research in WA suggests that varietal differences in barley exist, but most barley varieties are susceptible and suffer yield loss to CR. Litmus has the lowest yield loss of the varieties tested in the presence of high CR.

Barley and cereal yellow dwarf (BYD/CYD)

Both barley yellow dwarf (BYD) and cereal yellow dwarf (CYD) viruses occurin WA. As the screening for varietal resistance to BYD and CYD occurs in the field, resistance scores reflect the rating for the presence of both viruses. However, BYD is more frequent than CYD at a ratio of about 2:1. BYD can reduce grain yield by up to 80% with seedling infection and up to 20% with later infection. Barley plants primarily become infected from infected oat (*Rhopalosiphum padi*) or corn leaf (*Rhopalosiphum maidis*) aphids.

Varietal resistance reduces the impact of the virus, but not aphid feeding, on plant growth. Therefore, even with varietal resistance to BYD and CYD, aphids must be sprayed once they reach threshold levels in the crop (50% of tillers with 15 or more aphids) to prevent yield loss from feeding damage.

Root lesion nematode (RLN)

Root lesion nematodes (RLN, *Pratylenchus species*) are microscopic, worm-like animals that feed on plant roots, causing yield loss in susceptible crops, including wheat, barley and canola. Growing susceptible crops and varieties will increase RLN population numbers and increase the risk of yield losses. RLN can be found across about 6.25 million hectares (nearly 74% of the winter cropping area of WA). *Pratylenchus neglectus* is the dominant species found in 70% of paddocks in WA, followed by *P. quasitereoides* (formerly *P. teres*), with most paddocks carrying more than one RLN species. The RLN species *P. neglectus* and *P. quasitereoides* can cause up to 18% yield loss in barley.

The key to managing RLN is identifying paddocks with yield-limiting nematode numbers and incorporating resistant crops and varieties or a fallow into the rotation to reduce numbers. RLN species often have different crop-feeding preferences, so it is important to understand which species is present to develop effective management strategies. In the barley section of this guide, *P. neglectus* and *P. quasitereoides* nematode resistance scores are from WA glasshouse and field trials. Varieties tested in fewer than five trials or where no field trial verification of a glasshouse rating exists have received provisional ratings.

Cereal cyst nematode (CCN)

Cereal cyst nematode (CCN, *Heterodea avenae*) is present in cropping regions around Geraldton, Esperance and the Avon Valley but can occur sporadically across the WA grainbelt. CCN feeds on cereals and grasses and can cause large crop losses in wheat and oats. Barley is more tolerant of CCN, and yield loss is limited even when an infection occurs. Planting CCN-resistant wheat and barley varieties and rotation with grass-free legumes or pasture retards nematode development, leading to lower nematode numbers in the soil. CCN resistance ratings in this guide have not been tested in WA and should only be used as a guide.

Table 13. Seedling (two- to three-leaf stage) leaf disease resistance profiles when grown in WA

Disease[1]	Scald	Net-form net blotch[4]			Spot-form net blotch	Powdery mildew[5]	Barley leaf rust
Pathotype[2]	Medina	Beecher virulent (95NB100)	Beecher avirulent (97NB1)	Oxford virulent (EDRS)	(South Perth)	(South Perth)	(5457 P-)
Growth stage[3]	Seedling	Seedling	Seedling	Seedling	Seedling	Seedling	Seedling
Deliverable as a malt variety							
Bass	-	MRMS	S	SVS	MRMS	S	SVS
Buff	-	MS	MRMS	S	MS	S	SVS
Maximus CL	-	MRMS	MRMS	S	MS	RMR	S
RGT Planet	-	MRMS	MS	SVS	S	R	MSS
Spartacus CL	-	MRMS	MRMS	S	S	MS	S
Stage Two malt accreditation							
Beast	-	MRMS	MS	SVS	MS	MR	S
Commodus CL	-	MRMS	MRMS	S	MRMS	MR	S
Cyclops	-	MR	MRMS	S	MSS	MR	S
Laperouse	-	MS	MRMS	S	MRMS	RMR	MS
Minotaur	-	MRMS	MRMS	MS	S	SVS	S
Zena CL	-	MRMS	MRMS	S	MSS	R	MSS
Deliverable as a feed variety							
Combat	-	S	MRMS	SVS	MR	RMR	MSS
Compass	-	MRMS	MS	SVS	MRMS	MR	S
Fathom	-	SVS	MS	S	MR	MRMS	MS
Flinders	-	MRMS	MSS	S	MS	R	MS
La Trobe	-	MRMS	MRMS	S	S	MS	MS
Litmus	-	S	MSS	S	MS	RMR	S
Mundah	-	S	MS	MSS	MSS	S	S
Neo CL	-	-	-	-	-	-	-
Rosalind	-	MR	MR	S	MS	MSS	MRMS
Scope CL	-	MRMS	MR	S	MS	MR	S
Titan AX	-	MS	MS	SVS	MS	R	MSS

[1] Resistance rating: VS = very susceptible, SVS = susceptible to very susceptible, S = susceptible, MSS = moderately susceptible to susceptible, MS = moderately susceptible, MRMS = moderately resistant to moderately susceptible, MR = moderately resistant, RMR = resistant to moderately resistant, R = resistant. *Refer to page 4 for interpreting resistance classification. p* = provisional rating. No score '-' = no rating is currently available.

[2] Pathotype: the strain of the pathogen used in evaluating the disease reaction of the different barley varieties, which represents the most common pathotype present in WA. Therefore, on-farm reactions of varieties may differ if the pathotype present differs from the pathotype used in testing.

[3] Growth stage: the seedling resistance score reflects resistance at the two to the three-leaf stage (use data cautiously after the four-leaf stage). Varieties with a VS or S rating at the seedling stage are at a higher risk of early infection.

[4] Net-form net blotch: three pathotypes (95NB100, 97NB1 and Oxford) of NFNB are present in WA. Beecher avirulent (97NB1) pathotype is dominant, while the Oxford virulent pathotype is also prevalent in the state. Beecher virulent (95NB100) can be present but occurs less frequently. New NFNB pathotypes have been detected and their impact on varietal resistance is being surveyed.

[5] Powdery mildew: varieties with a VS or S rating at the seedling stage (i.e. Bass, Buff and Minotaur) should be treated with a seed dressing active against powdery mildew to prevent early infection during the tillering phase. Resistant varieties (non-*mlo*) may show a variable reaction to strains of PM present in the southern regions of WA. Maximus CL should be monitored for reaction to PM following a report of increased virulence in the Narrogin region.

Table 14. Adult (after flag leaf emergence) leaf disease resistance profiles when grown in WA

Disease[1]	Scald	Net-form net blotch[4]			Spot-form net blotch	Powdery mildew[5]	Barley leaf rust
Pathotype[2]	Medina	Beecher virulent (95NB100)	Beecher avirulent (97NB1)	Oxford virulent (EDRS)	(South Perth)	(South Perth)	(5457 P-)
Growth stage[3]	Adult	Adult	Adult	Adult	Adult	Adult	Adult
Deliverable as a malt variety							
Bass	MRMS	MS	MSS	S	S	MSS	VS
Buff	MS	MS	MRMS	MS	S	S	S
Maximus CL	MR	MRMS	MRMS	S	MSS	RMR	MSS
RGT Planet	MR	S	MS	SVS	S	R	MRMS (late APR)
Spartacus CL	MR	MS	MS	S	SVS	MS	MSS
Stage Two malt accreditation							
Beast	S	MRMS	MS	MSS	MSS	MR	MSS
Commodus CL	MSS	MRMS	MRMS	MSS	MSS	MR	MSS
Cyclops	MRMS	MRMS	MRMS	MSS	MSS	MR	S
Laperouse	S	MRMS	MRMS	MSS	MSS	MR	MSS
Minotaur	VS	MRMS	MRMS	MS	S	S	S
Zena CL	MR	MS	MRMS	SVS	SVS	R	MRMS (late APR)
Deliverable as a feed variety							
Combat	S	MSS	MSS	MS	MRMS	R	MRMS*p* (late APR)
Compass	MS	MRMS	MS	S	MSS	MR	S
Fathom	MR	S	MS	S	MRMS	MRMS	MRMS (late APR)
Flinders	MSS	MRMS	MS	S	S	RMR	MRMS (late APR)
La Trobe	MR	MRMS	MS	MSS	S	MSS	MSS
Litmus	SVS	S	S	S	S	MR	S
Mundah	S	S	MS	MSS	S	MSS	S
Neo CL	-	-	-	-	-	-	-
Rosalind	MSS	MS	MR	MSS	S	MSS	MR
Scope CL	MS	MRMS	MRMS	MS	S	MR	MSS
Titan AX	S	MRMS	MRMS	MS	MSS	RMR	S

[1] Resistance rating: VS = very susceptible, SVS = susceptible to very susceptible, S = susceptible, MSS = moderately susceptible to susceptible, MS = moderately susceptible, MRMS = moderately resistant to moderately susceptible, MR = moderately resistant, RMR = resistant to moderately resistant, R = resistant. *Refer to page 4 for interpreting resistance classification. p* = provisional rating. No score '-' = no rating is currently available.

[2] Pathotype: the strain of the pathogen used in evaluating the disease reaction of the different barley varieties, which represents the most common pathotype present in WA. Therefore, on-farm reactions of varieties may differ if the pathotype present differs from the pathotype used in testing.

[3] Growth stage: the seedling resistance score reflects resistance at the two to the three-leaf stage (use data cautiously after the four-leaf stage). Varieties with a VS or S rating at the seedling stage are at a higher risk of early infection.

[4] Net-form net blotch: three pathotypes (95NB100, 97NB1 and Oxford) of NFNB are present in WA. Beecher avirulent (97NB1) pathotype is dominant, while the Oxford virulent pathotype is also prevalent in the state. Beecher virulent (95NB100) can be present but occurs less frequently. New NFNB pathotypes have been detected and their impact on varietal resistance is being surveyed.

[5] Powdery mildew: varieties with a VS or S rating at the seedling stage (i.e. Bass, Buff and Minotaur) should be treated with a seed dressing active against powdery mildew to prevent early infection during the tillering phase. Resistant varieties (non-*mlo*) may show a variable reaction to strains of PM present in the southern regions of WA. Maximus CL should be monitored for reaction to PM following a report of increased virulence in the Narrogin region.

Table 15. Crown rot yield loss and virus and nematode seedling and adult resistance profiles when grown in WA

Disease[1]	Crown rot yield loss	Barley and cereal yellow dwarf[3]	Root lesion nematode[4]	Root lesion nematode[4]	Cereal cyst nematode[5]
Pathotype	*Fusarium pseudograminearum*	–	*Pratylenchus neglectus*	*Pratylenchus quasitereoides*	*Heterodera avenae*
Growth stage[2]	Seedling and adult	Seedling and adult	Seedling and adult	Seedling and adult	Seedling and adult
Deliverable as a malt variety					
Bass	High	MRMS	MSS	MSS	S
Buff	-	MRMS	-	S	S*p*
Maximus CL	-	MRMS	-	S	R
RGT Planet	-	MRMS	MSS	MS	R*p*
Spartacus CL	Moderate	MS	MSS	MSS	R
Stage Two malt accreditation					
Beast	-	MS	-	MS*p*	MR
Commodus CL	-	MRMS	-	MS*p*	R
Cyclops	-	S	-	MSS*p*	S
Laperouse	-	MRMS	-	MS*p*	S
Minotaur	-	MSS	-	MS*p*	R
Zena CL	-	MRMS	-	-	R
Deliverable as a feed variety					
Combat	-	MRMS	-	-	MRMS
Compass	High	MS	MSS	S	R
Fathom	Moderate	MRMS	MS*p*	MSS	R
Flinders	High	MRMS	MS*p*	MSS*p*	S
La Trobe	Moderate	MSS	MS	S	R
Litmus	Low	S	-	MSS*p*	MS
Mundah	Moderate	MS	-	MS*p*	S
Neo CL	-	-	-	-	R*p*
Rosalind	Moderate	MRMS	-	MSS	R
Scope CL	High	MRMS	MSS	MRMS	S
Titan AX	-	MS	-	-	MR*p*

[1] Resistance rating: VS = very susceptible, SVS = susceptible to very susceptible, S = susceptible, MSS = moderately susceptible to susceptible, MS = moderately susceptible, MRMS = moderately resistant to moderately susceptible, MR = moderately resistant, RMR = resistant to moderately resistant, R = resistant. *Refer to page 4 for interpreting resistance classification. p* = provisional rating. No score '-' = no rating is currently available.

[2] Growth stage: the resistance to barley and cereal yellow dwarf virus and the varietal impacts on nematode numbers do not differ between growth stages. It applies equally throughout the life of the plant.

[3] Barley and cereal yellow dwarf: plants become infected from infected oat and corn leaf aphids. Varietal resistance reduces the effect of the virus on plant growth but does not reduce the impact of aphid feeding on plant growth.

[4] Root lesion nematode: barley varieties vary in the impact of root-lesion nematode on their growth. A resistant variety retards nematode development, leading to lower nematode levels in the soil for subsequent crops. Ratings are based on data collected in WA.

[5] Cereal cyst nematode: all barley varieties are tolerant of cereal cyst nematode, but a resistant variety retards nematode development, leading to lower nematode levels in the soil for subsequent crops. CCN resistance data is based on variety responses in SA.

Variety snapshots

Blakely Paynter (DPIRD)

Variety snapshots are presented for:

- five varieties (Bass, Buff, Maximus CL, RGT Planet and Spartacus CL) that can be delivered into malt segregations in WA at the 2024–25 harvest (as per the GIWA Western Australian malt barley variety receival recommendations for the 2024–25 harvest).
- six varieties undergoing Stage Two malt accreditation with Grains Australia (Beast, Commodus CL, Cyclops, Laperouse, Minotaur and Zena CL).
- twelve varieties that can only be delivered into bulk handling feed segregations (Beast, Combat, Compass, Fathom, Flinders, La Trobe, Litmus, Mundah, Neo CL, Rosalind, Scope CL and Titan AX).

The comment section in each snapshot describes essential varietal characteristics, including yield relative to another variety, key weaknesses and strengths (including, where appropriate, disease resistance, straw strength and head loss) and relevant market information for varieties that are segregated as malt.

Grain yield data extracted from the Long Term MET Yield Reporter (available at NVT online, nvtonline.com.au) are presented relative to a control variety (typically Maximus CL) rather than the site mean yield (as shown in Tables 4 to 10) for each year in the period 2018 to 2022. Single-site MET data has been used in the comments section to highlight the probability of one variety yielding less, the same, or more than another variety when grown using the same agronomy (in the same trial).

Disease and nematode resistance ratings are sourced from Tables 13 to 15 and presented for seedling and adult plant growth stages (if known).

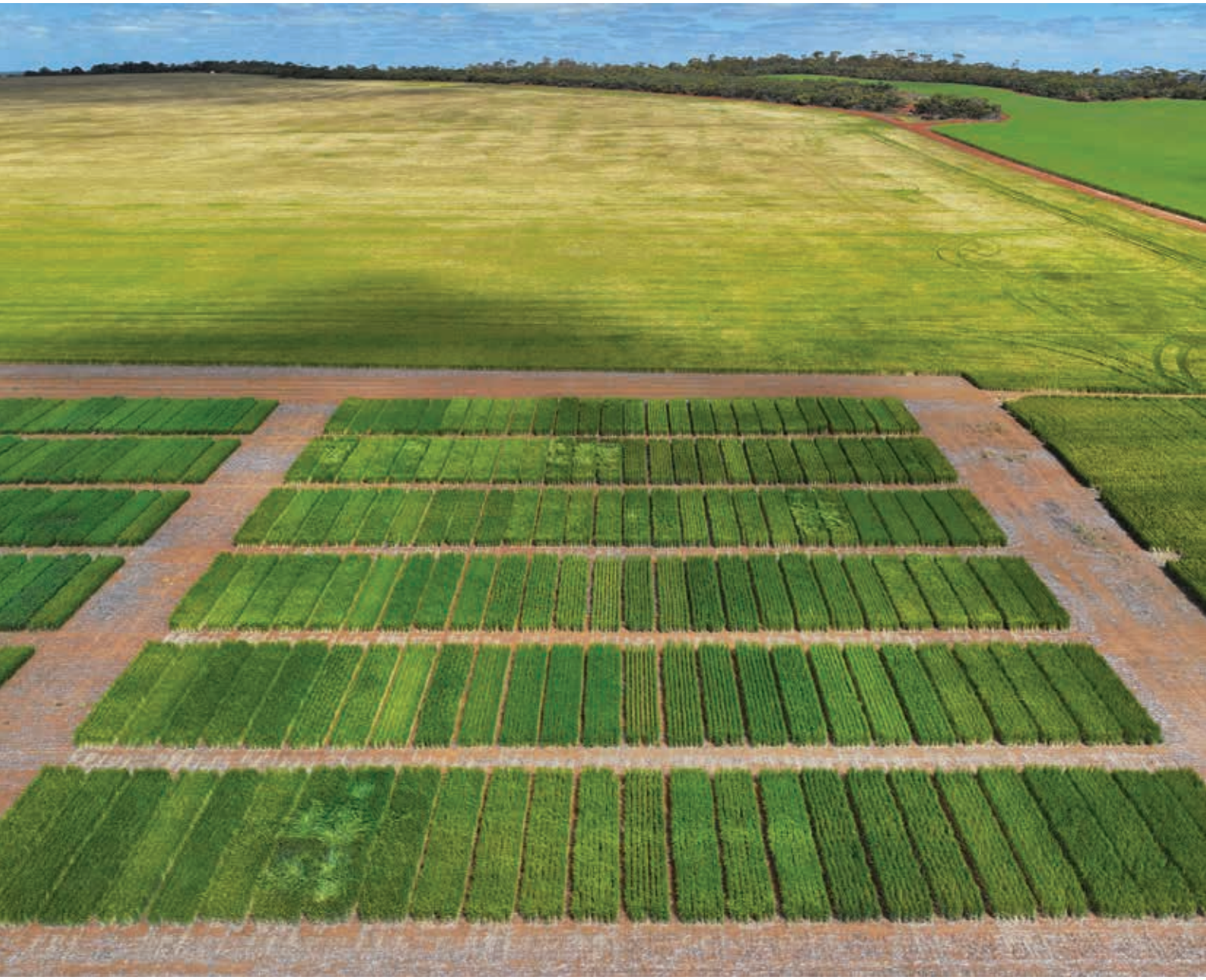
Phenology information is an output of the new flowering date predictive program, "FlowerPower" barley (available at fp.dpird.app/), developed by DPIRD. "FlowerPower" barley is a statistical model that predicts the date of awn emergence (Z49) for barley across multiple WA environments. Model predictions use historical temperature data from 2011, sourced from the SILO database hosted by the Queensland Department of Environment and Science (longpaddock.qld.gov.au/silo/point-data/). The phenology data presented in the snapshots are the median predicted date to Z49 (date expected for 50% of seasons) based on "FlowerPower" barley version v7.1.0.10. Data are presented relative to a control variety (typically Spartacus CL) for four model environments (Carnamah, Cunderdin, Katanning and Grass Patch) for four sowing dates (15-April, 05-May, 25-May and 15-June). The prediction data for Carnamah is less precise than the other three locations due to no available research site in that part of WA.

Agronomic traits are tabulated based on published data, data collected by DPIRD, data generated from the DPIRD-GRDC co-funded projects DAW00190 and DAW00224 and, in some cases, from the breeder. The data presented includes:

- Maturity (days to Z49) relative to Stirling when sown on 25 May at Northam based on "FlowerPower" barley version v7.1.0.10 (normal season, 50% years). Very early = -15 to -4 days, early = -3 to +3 days, medium = +4 to +10 days and late = +11 to +17 days. The maturity ranking with a late May sowing differs from that when sown in April or after mid-June. Where DPIRD collected data is not yet available in "FlowerPower", unpublished or breeder information is used.
- Coleoptile length as measured by DPIRD, after germinating seeds in rolled, moistened filter paper for 15 days at 15°C in the dark. Short = 40–60mm, medium = 60–80mm, long = 80–100mm and * = limited data available to rank the variety.
- Plant height to the base of the ear (cm) at maturity at sites where the straw of control varieties (Stirling, Buloke and Scope CL) was 65–75cm long. Very short = <45cm, short = 45–55cm, medium = 55–65cm and tall = 65–75cm. Data from DPIRD-GRDC and DPIRD internal agronomy trials.
- Straw strength is based on lodging scores taken at maturity and ranked relative to control varieties. Data from DPIRD-GRDC and DPIRD internal agronomy trials.

- Head loss risk was assessed in small plot trials and ranked based on counting heads post-harvest at sites where high levels of head loss were recorded in high-risk varieties (i.e. Scope CL). Data from DPIRD-GRDC and DPIRD internal agronomy trials.
- Grain protein deviation (relative to average) as calculated and ranked using NVT trials (2005–2022) and DPIRD-GRDC funded barley agronomy trials (2006–2020). Lower = <-0.3%, slightly lower = -0.3 to -0.1%, average = -0.1 to +0.1%, slightly higher = +0.1 to +0.3% and higher = > +0.3%. Grain protein deviation analyses the relationship between grain yield and grain protein concentration in barley varieties grown under similar management and environmental conditions in WA. A typical relationship exists in which grain yield increases and grain protein concentration decreases (yield dilution). Deviations from this relationship between grain yield and grain protein were used to classify varieties for their grain protein deviation and determine relative levels of inherent grain protein concentration.

Variety information, including the seed licensee, seed trading restrictions and the EPR payable, sourced from breeding companies, Variety Central (varietycentral.com.au/) and IP Australia Plant Breeders Rights database (pericles.ipaustralia.gov.au/pbr_db/search.cfm).



Bass(b)

Deliverable as a malt variety

Comments

Bass (tested as WABAR2315) is a short-height, medium-spring malt barley. Bass is a 'market leader' for malt quality, with demand for domestic processing and exporting as malt. It is acceptable for export as grain, but production volumes do not support segregation. Bass has strong market demand for malting without processing aids in Japan and Southeast Asia, often resulting in a price premium. Bass is outclassed for grain yield but has a better grain quality package than Maximus CL, RGT Planet, and Spartacus CL, often resulting in a higher strike rate into MALT1 segregations. Best suited to environments with a yield potential above 3t/ha. Fungicides may be required to manage NFNB (Oxford virulent), SFNB, PM and BLR. Weed competitiveness is similar to other semi-dwarf varieties. The acreage of Bass has continued to decline despite solid market demand, and it accounted for less than 1% of the state's barley acreage in 2022 and is almost exclusively planted in the Kwinana Port Zone. Target production zones in 2024 are Kwinana-North (Midlands) and Kwinana-South. Limited segregation opportunities (if any) will be offered due to low production. The 2024–25 harvest will be the last harvest for Bass segregations.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	87	70	93	77	87
Agzone 2	89	84	84	86	88
Agzone 3	92	86	86	94	93
Agzone 4	88	79	85	85	94
Agzone 5	85	71	77	88	86
Agzone 6	91	85	86	95	86
Statewide	88	83	85	88	89

Disease resistance	Seedling	Adult
Sc	-	MRMS
NFNB (Beecher virulent)	MRMS	MS
NFNB (Beecher avirulent)	S	MSS
NFNB (Oxford virulent)	SVS	S
SFNB	MRMS	S
PM	S	MSS
BLR (5457P-)	SVS	VS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	MSS	MSS
CCN	S	S

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	+2	+3	+4	+3
Katanning	+4	+5	+6	+4
Grass Patch	+1	+3	+3	+2

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Medium
Plant height	Short
Straw strength	Very good
Head loss risk	Medium
Grain protein deviation	Higher

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.50

Refer to page 4 for interpreting resistance classification.

Buff(b)

Deliverable as a malt variety

Comments

Buff (tested as IGB1506) is a medium-height, medium-spring, malt barley. Buff has Al tolerance genetics similar to Litmus. Buff has a white aleurone, unlike Litmus. Buff is competitive with feed and malt varieties on non-acidic soils, except where IMI chemistry is used. Across 65 WA barley NVT trials (2019–2022), Buff has yielded less than Litmus in 9%, the same in 25% and higher in 66%. Across 119 WA barley NVT trials (2018–2022), Buff has yielded less than Maximus CL in 50%, the same in 16% and higher in 34%. The grain quality package of Buff is okay, but not great, having a lower hectolitre weight, with a similar retention risk as Spartacus CL. Fungicides may be required to manage SFNB, PM and BLR. Its weed competitiveness has not been tested. Buff may be at a medium risk of head loss and has a short coleoptile. Buff was the fifth most popular barley variety in 2022, accounting for 3.5% of the state's barley acreage, predominantly in the Geraldton and Kwinana Port Zone. Target production zones in 2024 are Kwinana-North (East).

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	110	114	99	94	100
Agzone 2	103	101	94	99	99
Agzone 3	100	93	94	107	97
Agzone 4	122	138	95	90	103
Agzone 5	97	83	84	99	95
Agzone 6	104	97	90	103	95
Statewide	104	96	92	100	98

Disease resistance	Seedling	Adult
Sc	-	MS
NFNB (Beecher virulent)	MS	MS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	MS
SFNB	MS	S
PM	S	S
BLR (5457P-)	SVS	S
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	S	S
CCN	S*p*	S*p*

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-10	-2	+1	-2
Cunderdin	-8	+0	+2	+0
Katanning	-7	+0	+2	+0
Grass Patch	-9	-1	+1	-1

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Plant height	Medium
Straw strength	Moderately good
Head loss risk	Medium
Grain protein deviation	Slightly lower

Variety information	
Breeder / Seed licensee	AgVic Services / InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.50

Refer to page 4 for interpreting resistance classification.

p = provisional rating

Maximus CL(þ)

Deliverable as a malt variety

Comments

Maximus CL (tested as IGB1705T) is an IMI-tolerant, medium-height, early-spring, malt barley. Maximus CL is acceptable for export as grain and malt and is being assessed for the manufacture of shochu in Japan. Maximus CL has not been approved by all brewing customers, especially those in China. Full approval is expected within 12 months. Maximus CL has a short coleoptile and should not be sown deep. Across 119 WA barley NVT (2018–2022), Maximus CL yielded less than RGT Planet in 30% of trials, the same in 16% and higher in 54%, performing better in environments that yield less than 4t/ha. Maximus CL grain is plumper than Spartacus CL grain with a similar hectolitre weight resulting in a higher probability of receival as MALT1. Use recommended IMI-herbicides and be aware of market advice regarding delivering grain from paddocks sprayed with an IMI- herbicide. Maximus CL is a general improvement over Spartacus CL for NFNB (except Oxford virulent) as an adult, SFNB and PM (even in the presence of *MlLa* virulence). Fungicides may be required to manage smut, NFNB (Oxford virulent) and BLR. Maximus CL appears to have a low risk of head loss. Maximus CL was the most popular variety in 2022, sown on 32% of the barley acreage, just pipping Spartacus CL at 30%. Target production zones in 2024 are Geraldton, Kwinana, Albany, and Esperance Port Zones.

Yield (% Spartacus CL)	2018	2019	2020	2021	2022
Agzone 1	104	108	102	107	105
Agzone 2	103	104	104	106	104
Agzone 3	104	104	105	103	104
Agzone 4	105	106	103	104	103
Agzone 5	106	107	105	104	105
Agzone 6	105	107	106	103	106
Statewide	104	105	105	104	104

Disease resistance	Seedling	Adult
Sc	-	MR
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	S
SFNB	MS	MSS
PM	RMR	RMR
BLR (5457P-)	S	MSS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	S	S
CCN	R	R

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+9	+3	+2	+4
Cunderdin	+6	+1	+0	+2
Katanning	+7	+2	+1	+3
Grass Patch	+7	+2	+1	+3

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Plant height	Medium
Straw strength	Good
Head loss risk	Low
Grain protein deviation	Slightly higher

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl. GST)	$4.25

Refer to page 4 for interpreting resistance classification.

RGT Planet(þ)

Deliverable as a malt variety

Comments

RGT Planet (tested as SFR85-104) is a medium-height, medium-spring, malt barley preferred for export as grain and as malt but not for shochu. Suited to environments with a yield potential above 5t/ha and mixed farms practising grain and graze due to its early vigour. Across 119 WA barley NVT (2018–2022), RGT Planet yielded less than Rosalind in 58% of trials, the same in 25% and higher in 17%. The physical grain quality package of RGT Planet is inferior to Bass, Maximus CL, and Spartacus CL, often resulting in a lower frequency of delivery as MALT1. Excellent resistance in WA to PM (due to the *mlo* gene). Fungicides may be required to manage NFNB, SFNB and BLR (under high pressure). It appears to have a similar level of weed competitiveness (tested against oats) to Compass and Fathom. The popularity of RGT Planet, the third most popular barley variety in 2022 at 13% of the state's barley acreage, is declining. There is currently insufficient MALT1 grade RGT Planet supply to meet the demand for malting without processing aids, resulting in premiums above Maximus CL and Spartacus CL in some cases. Target production zones in 2024 are Kwinana-North (Midlands), Kwinana-South, and Albany Port Zones, with limited segregations offered in the Esperance Port Zone.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	96	71	107	84	100
Agzone 2	97	87	91	97	100
Agzone 3	102	96	94	109	106
Agzone 4	99	79	87	88	104
Agzone 5	96	74	76	98	94
Agzone 6	112	100	102	110	103
Statewide	99	90	91	99	102

Disease resistance	Seedling	Adult
Sc	-	MR
NFNB (Beecher virulent)	MRMS	S
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	SVS	SVS
SFNB	S	S
PM	R	R
BLR (5457P-)	MSS	MRMS (late APR)
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	MS	MS
CCN	R*p*	R*p*

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-1	+3	+5	+5
Katanning	+0	+3	+5	+5
Grass Patch	-2	+2	+4	+5

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Medium
Plant height	Medium
Straw strength	Good
Head loss risk	Low
Grain protein deviation	Slightly lower

Variety information	
Breeder / Seed licensee	RAGT Semences / Seed Force
Access to seed	RAGT Broadacre partners
EPR ($/t, excl. GST)	$4.00

Refer to page 4 for interpreting resistance classification.

p = provisional rating.

Spartacus CL(Þ)

Deliverable as a malt variety

Comments

Spartacus CL (tested as IGB1334T) is an IMI-tolerant, medium-height, early-spring, malt barley that is acceptable for export as grain and malt and is preferred for manufacturing shochu in Japan. Spartacus CL has a short coleoptile and should not be sown deep. Across 119 WA barley NVT (2018–2022), Spartacus CL yielded less than Maximus CL in 76% of trials, the same in 24% and higher in 0%. Use recommended IMI-herbicides and be aware of market advice regarding delivering grain from paddocks sprayed with an IMI-herbicide. Fungicides may be required to manage smut, NFNB (Oxford virulent), SFNB and BLR. Spartacus CL appears to be a weak competitor with weeds (based on data from eastern Australia). The popularity of Spartacus CL is declining, being swapped out for Maximus CL. It was the second most popular barley variety in 2022, accounting for 30% of the state's barley acreage. Spartacus CL exhibits different malting characteristics than Maximus CL. These differences are desirable for some customers and will limit our opportunity to meet some customer specifications for export malt. Target production zones in 2024 are Kwinana, Albany, and Esperance Port Zones.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	96	92	98	93	95
Agzone 2	97	96	96	94	96
Agzone 3	96	96	95	97	96
Agzone 4	95	94	97	96	97
Agzone 5	94	94	95	96	95
Agzone 6	95	93	94	97	94
Statewide	96	95	95	96	96

Disease resistance	Seedling	Adult
Sc	-	MR
NFNB (Beecher virulent)	MRMS	MS
NFNB (Beecher avirulent)	MRMS	MS
NFNB (Oxford virulent)	S	S
SFNB	S	SVS
PM	MS	MS
BLR (5457P-)	S	MSS
BYD and CYD	MS	MS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	MSS	MSS
CCN	R	R

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-9	-3	-2	-4
Cunderdin	-6	-1	+0	-2
Katanning	-7	-2	-1	-3
Grass Patch	-7	-2	-1	-3

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Plant height	Medium
Straw strength	Good
Head loss risk	Low
Grain protein deviation	Slightly lower

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl. GST)	$4.25

Refer to page 4 for interpreting resistance classification.

Beast(Þ)

Stage Two malt accreditation

Comments

Beast (tested as AGTB0113) is a tall-height, early-spring barley under Stage Two evaluation in 2023 by Grains Australia for its malting and brewing potential. Beast suits low- to medium-rainfall environments and has good early vigour to assist with weed suppression, with a similar plant type to Compass. It combines the genetics of Compass and Hindmarsh. Across 100 WA barley NVT (2019–2022), Beast yielded less than Rosalind in 31% of trials, the same in 39% and higher in 30%. The primary advantage over Rosalind is in the sub-2t/ha environments where taller straw at harvest and a longer coleoptile at seeding are beneficial. Beast appears to have helpful resistance to NFNB (except Oxford virulent as a seedling), SFNB and PM but may need management for scald and BLR. Beast grain has good plumpness (better than Maximus CL) but with a lower hectolitre weight than Maximus CL. Lodging risk is similar to Compass. Beast has been released as a feed variety pending malting and brewing evaluation (expected in March 2024). Given its malt profile (low fermentability), Beast is not expected to be segregated in WA even if it meets the Grains Australia malting and brewing accreditation requirements.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	-	104	105	96	104
Agzone 2	-	102	101	98	100
Agzone 3	-	100	98	107	101
Agzone 4	-	97	103	102	104
Agzone 5	-	96	105	108	103
Agzone 6	-	96	100	105	95
Statewide	-	100	101	103	101

Disease resistance	Seedling	Adult
Sc	-	S
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	SVS	MSS
SFNB	MS	MSS
PM	MR	MR
BLR (5457P-)	S	MSS
BYD and CYD	MS	MS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MSp	MSp
CCN	MR	MR

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-2	-1	-1	-2
Katanning	+0	+1	+1	-1
Grass Patch	-3	-2	-2	-3

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Medium
Plant height	Tall
Straw strength	Fair
Head loss risk	Medium
Grain protein deviation	Slightly higher

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	AGT Affiliates and Seed Sharing™
EPR ($/t, excl. GST)	$4.00

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Commodus CL(þ)

Stage Two malt accreditation

Comments

Commodus CL (tested as IGB1908T) is an IMI-tolerant, tall-height, early-spring barley modelled off Compass barley. Commodus CL is undergoing Stage Two evaluation in 2023 by Grains Australia for its malting and brewing potential. Commodus CL is suited to low- to medium-rainfall areas and lighter soils. It has good early canopy size and ground coverage for weed suppression, high grain plumpness but poor hectolitre weight and is of a similar plant height to Compass. Has a medium coleoptile length. Commodus CL has the same IMI herbicide tolerance as Maximus CL but with greater early vigour. Across 79 WA barley NVT (2020–2022), Commodus CL yielded less than Maximus CL in 53% of trials, the same in 34% and higher in 13%. Relative to Compass in those same trials, Commodus CL yielded less than Compass in 29% of trials, the same in 71% and higher in 0%. Commodus CL appears to have useful resistance to NFNB, SFNB and PM but may need management for scald and BLR. Lodging risk is similar to Compass. Commodus CL has been released as a feed variety pending malting and brewing evaluation (expected in March 2024). Given its malt profile (low fermentability), Commodus CL is not expected to be segregated in WA even if it meets the Grains Australia malting and brewing accreditation requirements.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	-	-	100	86	97
Agzone 2	-	-	94	92	95
Agzone 3	-	-	92	103	97
Agzone 4	-	-	97	93	100
Agzone 5	-	-	93	100	95
Agzone 6	-	-	92	101	88
Statewide	-	-	94	96	96

Disease resistance	Seedling	Adult
Sc	-	MSS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	MSS
SFNB	MRMS	MSS
PM	MR	MR
BLR (5457P-)	S	MSS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	R	R

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-1	+0	+0	+1
Katanning	+0	+0	+1	+1
Grass Patch	-2	-2	-1	+0

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Medium
Plant height	Tall
Straw strength	Fair
Head loss risk	Medium
Grain protein deviation	Slightly lower

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl. GST)	$4.25

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Cyclops(þ)

Stage Two malt accreditation

Comments

Cyclops (tested as AGTB0200) is a medium-height, early-spring barley under Stage Two evaluation in 2023 by Grains Australia for its malting and brewing potential. Cyclops has a short coleoptile and should not be sown deep. Cyclops has the same erect growing habit as Maximus CL but with different genetics and no tolerance to IMI chemistry. Across 79 WA barley NVT (2020–2022), Cyclops yielded less than Maximus CL in 15% of trials, the same in 27% and higher in 58%, being a higher-yielding option in environments that yield more than 3t/ha. Cyclops appears to have useful resistance to scald, NFNB, SFNB, and PM but may need BLR management. Grain plumpness and hectolitre weight are lower than Maximus CL, with plumpness similar to Spartacus CL. Cyclops appears to have a low lodging and head loss risk. The breeder of Cyclops has engaged with grain marketers and malt companies operating in WA, and there is positive interest in Cyclops subject to accreditation and sufficient scale of production. The earliest accreditation date is March 2024.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	-	-	106	97	104
Agzone 2	-	-	101	104	102
Agzone 3	-	-	102	112	107
Agzone 4	-	-	95	102	107
Agzone 5	-	-	100	108	105
Agzone 6	-	-	108	107	107
Statewide	-	-	101	106	105

Disease resistance	Seedling	Adult
Sc	-	MRMS
NFNB (Beecher virulent)	MR	MRMS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	MSS
SFNB	MSS	MSS
PM	MR	MR
BLR (5457P-)	S	S
BYD and CYD	S	S
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	S	S

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-	-	-	-
Katanning	-	-	-	-
Grass Patch	-	-	-	-

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Plant height	Medium
Straw strength	Good
Head loss risk	Low
Grain protein deviation	Slightly higher

Variety information	
Breeder / Seed licensee	AGT
Access to seed	AGT Affiliates and Seed Sharing™
EPR ($/t, excl. GST)	$4.00

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Laperouse(Þ)

Stage Two malt accreditation

Comments

Laperouse (tested as WI4952) is a medium-height, medium-spring barley under Stage Two evaluation in 2023 by Grains Australia for its malting and brewing potential. Across 119 WA barley NVT (2018–2022), Laperouse yielded less than RGT Planet in 20% of trials, the same in 24% and higher in 56%. Performs better than RGT Planet when the site yield is below 4.5t/ha. It has a better grain quality package than RGT Planet, with a higher hectolitre weight and plumper grain (similar to Bass), lending to a high probability of being received as MALT1 if received in WA. Laperouse has helpful resistance to NTNB, STNB and PM, but fungicides may be required to manage scald and BLR. Its weed competitiveness has not been evaluated. It appears to have good straw strength and a low head loss risk. Farmer production of Laperouse is more advanced than that of Cyclops, Minotaur, and Zena CL. The greatest grower production is found in the western to central areas of the Albany Port Zone. The breeder of Laperouse has engaged with malt companies operating in WA and overseas companies, and there is positive interest in Laperouse subject to accreditation and sufficient scale of production. The earliest accreditation date is March 2024.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	104	96	103	94	101
Agzone 2	103	96	98	100	99
Agzone 3	102	99	99	108	103
Agzone 4	99	92	94	99	104
Agzone 5	99	85	97	104	101
Agzone 6	102	101	103	104	102
Statewide	102	96	98	103	102

Disease resistance	Seedling	Adult
Sc	-	S
NFNB (Beecher virulent)	MS	MRMS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	MSS
SFNB	MRMS	MSS
PM	RMR	MR
BLR (5457P-)	MS	MSS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	S	S

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	+2	+4	+4	+2
Katanning	+5	+6	+6	+4
Grass Patch	+2	+3	+3	+2

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Short
Plant height	Medium
Straw strength	Good
Head loss risk	Low
Grain protein deviation	Slightly lower

Variety information	
Breeder / Seed licensee	SECOBRA Recherches / Seednet
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.80

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Minotaur(Þ)

Stage Two malt accreditation

Comments

Minotaur (tested as AGTB0213) is a medium-height, medium-spring barley with no IMI tolerance produced by crossing European and Australian genetics. Minotaur is under Stage Two evaluation in 2023 by Grains Australia for its malting and brewing potential. Across 79 WA barley NVT (2020–2022), Minotaur yielded less than RGT Planet in 13% of trials, the same in 33% and higher in 54%. Performs better than RGT Planet when the site yield is below 4.5t/ha. Relative to Cyclops, Minotaur yielded less in 47% of trials, the same in 42% and higher in 11%. Hectolitre weight and grain plumpness are an improvement over RGT Planet but not as good as Bass, Maximus CL or Spartacus CL. Minotaur has useful resistance to NFNB but may need management for SFNB, PM, and BLR and is very sensitive to scald. Minotaur appears to have a low lodging and head loss risk. The breeder of Minotaur has engaged with grain marketers and malt companies operating in WA, and there is positive interest in Minotaur subject to accreditation and sufficient scale of production. The earliest accreditation date is March 2024.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	-	-	107	93	102
Agzone 2	-	-	97	101	102
Agzone 3	-	-	99	106	107
Agzone 4	-	-	94	96	103
Agzone 5	-	-	89	101	99
Agzone 6	-	-	108	108	108
Statewide	-	-	97	101	104

Disease resistance	Seedling	Adult
Sc	-	VS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	MS	MS
SFNB	S	S
PM	SVS	S
BLR (5457P-)	S	S
BYD and CYD	MSS	MSS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	R	R

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-	-	-	-
Katanning	-	-	-	-
Grass Patch	-	-	-	-

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Medium
Plant height	Short
Straw strength	Good
Head loss risk	-
Grain protein deviation	Slightly lower

Variety information	
Breeder / Seed licensee	AGT
Access to seed	AGT Affiliates and Seed Sharing™
EPR ($/t, excl. GST)	$4.00

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Zena CL(Þ)

Stage Two malt accreditation

Comments

Zena CL (tested as IGB20125T) is an IMI-tolerant, medium-height, medium-spring barley modelled on RGT Planet. Zena CL is under Stage Two evaluation in 2023 by Grains Australia for its malting and brewing potential. Across 52 WA barley NVT (2021–2022), Zena CL yielded the same as RGT Planet in all 52 trials. Zena CL has a similar agronomic fit (i.e., coleoptile length, phenology, straw strength, and head loss risk) and grain quality profile as RGT Planet, except it is tolerant of IMI herbicides. Disease screening data suggest a slight improvement over RGT Planet for NFNB (Beecher virulent and avirulent), similar for scald, NFNB (Oxford virulent), PM, and BLR, and slightly worse for SFNB. The breeder of Zena CL has engaged with malt companies operating in WA, and there is positive interest in Zena CL subject to accreditation and sufficient scale of production. The breeder expects the variety to have a similar market fit to RGT Planet. The earliest accreditation date is March 2024.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	84	100
Agzone 2	-	-	-	97	101
Agzone 3	-	-	-	107	105
Agzone 4	-	-	-	86	103
Agzone 5	-	-	-	97	93
Agzone 6	-	-	-	109	102
Statewide	-	-	-	98	101

Disease resistance	Seedling	Adult
Sc	-	MR
NFNB (Beecher virulent)	MRMS	MS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	SVS
SFNB	MSS	SVS
PM	R	R
BLR (5457P-)	MSS	MRMS (late APR)
BYD and CYD	MRMS	MRMS
RLN (P. neglectus)	-	-
RLN (P. quasitereoides)	-	-
CCN	R	R

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-1	+3	+5	+5
Katanning	+0	+3	+5	+5
Grass Patch	-2	+2	+4	+5

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Medium
Plant height	Medium
Straw strength	Good
Head loss risk	Low
Grain protein deviation	Slightly lower

Variety information	
Breeder / Seed licensee	GIA / Intergrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl. GST)	$4.25

Refer to page 4 for interpreting resistance classification.

Combat(Þ)

Deliverable as a feed variety

Comments

Combat (IGB1944) is a medium-height, medium-spring, feed variety. Combat has a semi-prostrate growth habit expected to provide a more weed-competitive behaviour than Rosalind. Combat is moderately susceptible to lodging and head loss. Across 52 WA barley NVT (2021–2022), Combat yielded lower than Rosalind in 4%, the same in 21% and higher in 75% of trials. Combat had a yield advantage over other varieties when the site yielded more than 4.5t/ha. Combat has useful resistance to NFNB and BLR (APR) and excellent resistance to SFNB and PM but may need management for scald. Combat is not being submitted for malting and brewing evaluation and has been released as a feed-only variety.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	98	109
Agzone 2	-	-	-	107	107
Agzone 3	-	-	-	114	111
Agzone 4	-	-	-	100	109
Agzone 5	-	-	-	108	105
Agzone 6	-	-	-	113	112
Statewide	-	-	-	108	109

Disease resistance	Seedling	Adult
Sc	-	S
NFNB (Beecher virulent)	S	MSS
NFNB (Beecher avirulent)	MRMS	MSS
NFNB (Oxford virulent)	SVS	MS
SFNB	MR	MRMS
PM	RMR	R
BLR (5457P-)	MSS	MRMS*p* (late APR)
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	MRMS	MRMS

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-	-	-	-
Katanning	-	-	-	-
Grass Patch	-	-	-	-

Agronomic traits	
Early growth habit	Semi-prostrate
Coleoptile length	-
Plant height	-
Straw strength	-
Head loss risk	-

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl. GST)	$3.50

Refer to page 4 for interpreting resistance classification.

Compass(Þ)

Deliverable as a feed variety

Comments

Compass (tested as WI4593) is a tall-height, early-spring barley, only deliverable into feed stacks in WA. Best suited to environments with a yield potential below 4t/ha and where weed-competitive barley is required. Compass has a similar grain yield potential to Spartacus CL in WA and can out-yield RGT Planet, where the yield potential is below 3t/ha. Across 119 WA barley NVT (2018–2022), Compass yielded less than Rosalind in 58% of trials, the same in 29% and higher in 13%. Compass is susceptible to lodging, particularly in high-yielding situations. It has good tolerance to NFNB (Beecher virulent and avirulent) and PM (except in the presence of *MlLa* virulence). Fungicides may be required to control NFNB (Oxford virulent) and BLR. While it was accredited as a malt variety by Grains Australia in March 2018, no malt segregations are available in WA. Therefore, Compass is received as a feed variety in WA. Compass was the twelfth most popular barley variety in 2022 but only accounted for just over 0.5% of the state's barley acreage. Compass is superseded by new varieties, including Beast, Combat, Commodus CL, Cyclops, Maximus CL, Laperouse, Minotaur, and Titan AX — depending on the farming system.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	106	101	102	89	100
Agzone 2	103	100	96	93	97
Agzone 3	97	95	93	106	97
Agzone 4	97	101	101	95	102
Agzone 5	93	88	97	104	97
Agzone 6	94	90	92	103	88
Statewide	99	95	95	99	97

Disease resistance	Seedling	Adult
Sc	-	MS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	SVS	S
SFNB	MRMS	MSS
PM	MR	MR
BLR (5457P-)	S	S
BYD and CYD	MS	MS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	S	S
CCN	R	R

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-4	-1	+0	+1
Katanning	-3	-1	+1	+1
Grass Patch	-5	-2	+0	+0

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Medium
Plant height	Tall
Straw strength	Fair
Head loss risk	Medium

Variety information	
Breeder / Seed licensee	University of Adelaide / Seednet
Access to seed	Seednet Partners
EPR ($/t, excl. GST)	$3.80

Refer to page 4 for interpreting resistance classification.

Fathom(Þ)

Deliverable as a feed variety

Comments

Fathom (tested as WI4483) is a medium-height, medium-spring, feed barley. Fathom has good early vigour for weed suppression and a long coleoptile, allowing deeper sowing when required. Best suited to environments with a yield potential below 3t/ha and where there is a high risk of SFNB. Across 118 WA barley NVT (2018–2022), Fathom yielded less than Rosalind in 69% of trials, the same in 21% and higher in 9%. Combat supersedes Fathom. Across 52 WA barley NVT (2020–2022), Fathom yielded less than Combat in 88% of trials, the same in 12% and higher in 0%. It has excellent tolerance to scald and SFNB and practical tolerance to PM but may require management for NFNB (Beecher virulent and Oxford virulent) and BLR (late APR). It is mixed for its head colour, having green and waxy green heads. Fathom was the fifteenth most popular barley variety in 2022, accounting for just under 0.5% of the state's barley acreage.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	105	103	99	89	98
Agzone 2	101	99	94	94	96
Agzone 3	97	93	93	104	96
Agzone 4	104	110	96	93	101
Agzone 5	93	84	92	100	95
Agzone 6	96	91	91	101	90
Statewide	99	94	93	98	96

Disease resistance	Seedling	Adult
Sc	-	MR
NFNB (Beecher virulent)	SVS	S
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	S	S
SFNB	MR	MRMS
PM	MRMS	MRMS
BLR (5457P-)	MS	MRMS (late APR)
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MS*p*	MS*p*
RLN (*P. quasitereoides*)	MSS	MSS
CCN	R	R

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+8	+6	+4	+2
Cunderdin	+8	+6	+4	+2
Katanning	+8	+5	+3	+1
Grass Patch	+8	+5	+3	+2

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Long
Plant height	Medium
Straw strength	Fair
Head loss risk	Low

Variety information	
Breeder / Seed licensee	University of Adelaide / Seednet
Access to seed	Seednet Partners
EPR ($/t, excl. GST)	$2.00

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Flinders(þ)

Deliverable as a feed variety

Comments

Flinders (tested as WABAR2537) is a short-height, medium-spring barley no longer deliverable to malt barley segregations after the 2023–24 harvest due to the low production volumes. Best suited to environments with a yield potential above 3t/ha and environments where short, stiff straw and good head retention are essential. Across 82 WA barley NVT (2018–2022), Flinders yielded less than RGT Planet in 62% of trials, the same in 32% and higher in 6%. Across 82 WA barley NVT (2018–2022), Flinders yielded less than Rosalind in 93% of trials, the same in 7% and higher in 0%. Flinders is resistant to PM (non-*mlo*). Fungicides may be required to manage NFNB (Oxford virulent), SFNB and BLR (despite having APR). Weed competitiveness is similar to other semi-dwarf varieties. The acreage of Flinders is declining, and it accounted for 0.6% of the state's barley acreage in 2022, with production predominantly in the Albany and Esperance Port Zones.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	85	66	95	-	-
Agzone 2	89	83	86	-	-
Agzone 3	95	90	90	95	97
Agzone 4	91	75	84	-	-
Agzone 5	89	74	74	-	-
Agzone 6	98	92	92	97	94
Statewide	90	85	86	89	93

Disease resistance	Seedling	Adult
Sc	-	MSS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MSS	MS
NFNB (Oxford virulent)	S	S
SFNB	MS	S
PM	R	RMR
BLR (5457P-)	MS	MRMS (late APR)
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MS*p*	MS*p*
RLN (*P. quasitereoides*)	MSS*p*	MSS*p*
CCN	S	S

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+1	+5	+6	+5
Cunderdin	+3	+6	+7	+7
Katanning	+5	+7	+8	+8
Grass Patch	+3	+6	+7	+6

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Short
Plant height	Short
Straw strength	Very good
Head loss risk	Low

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.80

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

La Trobe(þ)

Deliverable as a feed variety

Comments

La Trobe (tested as IGB1101) is a medium-height, early-spring barley no longer deliverable to malt barley segregations in WA after the 2022–23 harvest. Best suited to environments with a yield potential below 4t/ha. Across 119 WA barley NVT (2018–2022), La Trobe yielded less than Rosalind in 79% of trials, the same in 20% and higher in 1%. Has practical tolerance to scald and NFNB (Beecher virulent and avirulent), but fungicides may be required to manage smut, NFNB (Oxford virulent), SFNB and BLR. La Trobe was the eighth most popular barley variety in 2022, accounting for 2% of the state's barley acreage. La Trobe is superseded by Maximus CL, where malt is a target, and Beast, Combat, Cyclops, Laperouse, Minotaur, and Titan AX when growing barley for a feed outcome.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	99	95	99	91	97
Agzone 2	99	97	95	94	96
Agzone 3	97	95	94	100	97
Agzone 4	98	99	98	95	99
Agzone 5	94	91	93	98	95
Agzone 6	96	92	92	100	92
Statewide	97	95	95	96	96

Disease resistance	Seedling	Adult
Sc	-	MR
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MRMS	MS
NFNB (Oxford virulent)	S	MSS
SFNB	S	S
PM	MS	MSS
BLR (5457P-)	MS	MSS
BYD and CYD	MSS	MSS
RLN (*P. neglectus*)	MS	MS
RLN (*P. quasitereoides*)	S	S
CCN	R	R

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-5	+0	+1	-1
Cunderdin	-6	-2	-1	-2
Katanning	-5	-2	-1	-3
Grass Patch	-6	-2	-1	-3

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Medium
Plant height	Medium
Straw strength	Moderately good
Head loss risk	Medium

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$4.00

Refer to page 4 for interpreting resistance classification.

Litmus(ϕ)

Deliverable as a feed variety

Comments

Litmus (tested as WABAR2625) is a tall-height, early-spring, feed barley with improved tolerance to low pH and high soil Al that Buff supersedes. It is best suited to environments where the soil at 10–30cm has a pH_{Ca} below 4.8. Across 65 WA barley NVT (2019–2022), Litmus yielded less than Buff in 66% of trials, the same in 25% and higher in 9%. Litmus has fair straw strength and is susceptible to all leaf diseases but has the lowest yield loss in the presence of crown rot. Fungicides may be required to manage all leaf diseases except PM. Its reaction to weed competition is unknown. Due to the presence of blue aleurone in its grain, it is only deliverable to sites where active management of blue aleurone in feed barley stacks is available. Litmus was the tenth most popular barley variety in 2022, accounting for just over 1% of the state's barley acreage, with production restricted to the Geraldton and Kwinana Port Zones. Growers are switching to Buff in preference to Litmus.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	-	95	98	80	94
Agzone 2	-	97	85	84	94
Agzone 3	-	-	81	95	87
Agzone 4	-	137	101	75	94
Agzone 5	-	-	-	-	-
Agzone 6	-	-	-	-	-
Statewide	-	89	82	88	88

Disease resistance	Seedling	Adult
Sc	-	SVS
NFNB (Beecher virulent)	S	S
NFNB (Beecher avirulent)	MSS	S
NFNB (Oxford virulent)	S	S
SFNB	MS	S
PM	RMR	MR
BLR (5457P-)	S	S
BYD and CYD	S	S
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	MS	MS

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-18	-9	-6	-7
Cunderdin	-15	-7	-4	-4
Katanning	-14	-7	-3	-4
Grass Patch	-16	-8	-4	-5

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Medium
Plant height	Tall
Straw strength	Fair
Head loss risk	Medium

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.80

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Mundah

Deliverable as a feed variety

Comments

Mundah (tested as 85S:514) is a medium-height, very early-spring, feed barley. Best suited to environments with a yield potential below 2t/ha and later sowing systems (i.e. June and July) where early season weed control is necessary. Across 64 WA barley NVT (2018–2020), Mundah yielded less than Rosalind in 94% of trials, the same in 6% and higher in 0%. Mundah can suffer from head loss and lodging. Fungicides may be required to manage scald, NFNB (Beecher virulent and Oxford virulent), SFNB, PM and BLR. Mundah appears to have similar weed competitiveness to Compass and Fathom, although it has not been tested side by side in the same trials. Mundah was the eleventh most popular barley variety in 2022, accounting for 0.6% of the state's barley acreage. Mundah is no longer sown in WA barley NVT. Mundah is superseded by new varieties, including Beast, Buff, Combat, Commodus CL, Cyclops, Laperouse, Litmus, and Titan AX — depending on the farming system.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	95	85	96	-	-
Agzone 2	93	92	84	-	-
Agzone 3	90	85	81	-	-
Agzone 4	99	106	95	-	-
Agzone 5	83	77	74	-	-
Agzone 6	90	77	76	-	-
Statewide	91	85	83	-	-

Disease resistance	Seedling	Adult
Sc	-	S
NFNB (Beecher virulent)	S	S
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	MSS	MSS
SFNB	MSS	S
PM	S	MSS
BLR (5457P-)	S	S
BYD and CYD	MS	MS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	S	S

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-20	-13	-11	-10
Cunderdin	-15	-10	-7	-6
Katanning	-13	-8	-5	-5
Grass Patch	-16	-11	-8	-7

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Medium
Plant height	Medium
Straw strength	Fair
Head loss risk	Medium

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	No EPR payable

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Neo CL(b)

Deliverable as a feed variety

Comments

Neo CL (tested as IGB22102T) is an IMI-tolerant, medium-height, medium-spring, two-row barley. Neo CL is a cross between Australian genetics carrying tolerance to IMI-herbicides and RGT Planet, with RGT Planet representing 25% of the pedigree. DPIRD phenology data from 2022 suggest that Neo CL is later flowering than RGT Planet when sown in mid-April, but similar in May. Above 4t/ha, Neo CL has shown a high yield potential in DPIRD testing (2022 season only) and InterGrain testing, with little data available for environments that yield less than 3t/ha. Neo CL has been entered into WA barley NVT for the first time in 2023, so independent data from a broader spread of environments will be available in 2024. Neo CL grain appears to have a similar hectolitre weight to RGT Planet but with improved grain plumpness (potentially similar to Spartacus CL). According to the breeder, Neo CL appears to have useful resistance to scald, NTNB, SFNB, and PM, but notably improved resistance to NFNB and SFNB over RGT Planet. Neo CL is in Stage One of the Grains Australia Malt Accreditation program in 2023, with the earliest accreditation being in March 2025.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	-	-	-	-	-
Agzone 3	-	-	-	-	-
Agzone 4	-	-	-	-	-
Agzone 5	-	-	-	-	-
Agzone 6	-	-	-	-	-
Statewide	-	-	-	-	-

Disease resistance	Seedling	Adult
Sc	-	-
NFNB (Beecher virulent)	-	-
NFNB (Beecher avirulent)	-	-
NFNB (Oxford virulent)	-	-
SFNB	-	-
PM	-	-
BLR (5457P-)	-	-
BYD and CYD	-	-
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	R*p*	R*p*

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-	-	-	-
Katanning	-	-	-	-
Grass Patch	-	-	-	-

Agronomic traits	
Early growth habit	Semi-prostrate
Coleoptile length	-
Plant height	Medium
Straw strength	Good
Head loss risk	Low

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl. GST)	$4.25

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

Rosalind(b)

Deliverable as a feed variety

Comments

Rosalind (tested as IGB1302) is a medium-height, early-spring, feed barley. It suits all environments with a low probability of delivering malt-grade barley. Rosalind has been the yield benchmark for barley in WA but is now challenged by Combat and Cyclops. Across 52 WA barley NVT (2021–2022), Rosalind yielded less than Combat in 75% of trials, the same in 21% and higher in 4%, with Combat having a yield advantage at all levels of yield potential. Across 79 WA barley NVT (2020–2022), Rosalind yielded less than Cyclops in 41% of trials, the same in 38% and higher in 22%, with Cyclops showing an advantage above 4t/ha. Good straw strength and head retention. Fungicides may be required to manage scald, NFNB (Oxford virulent), SFNB, and where *MILa* virulent PM is present. Its weed competitiveness is unknown. Rosalind was the fourth most popular barley variety in 2022, accounting for 7% of the state's barley acreage, being more prevalent in southern cropping areas than northern cropping areas.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	104	102	106	101	105
Agzone 2	103	103	101	101	104
Agzone 3	101	102	99	104	102
Agzone 4	106	109	105	98	102
Agzone 5	102	104	97	103	100
Agzone 6	106	101	100	106	101
Statewide	103	103	100	102	102

Disease resistance	Seedling	Adult
Sc	-	MSS
NFNB (Beecher virulent)	MR	MS
NFNB (Beecher avirulent)	MR	MR
NFNB (Oxford virulent)	S	MSS
SFNB	MS	S
PM	MSS	MSS
BLR (5457P-)	MRMS	MR
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MSS	MSS
CCN	R	R

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-8	-1	+1	+0
Cunderdin	-9	-3	-1	-2
Katanning	-8	-3	-1	-2
Grass Patch	-9	-4	-1	-2

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Plant height	Medium
Straw strength	Good
Head loss risk	Low

Variety information	
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.50

Refer to page 4 for interpreting resistance classification.

Scope CL(Þ)

Deliverable as a feed variety

Comments

Scope CL (tested as VBHT0805) is an IMI-tolerant, tall-height, medium-spring barley no longer segregated as a malt variety in WA and deliverable only into feed stacks. Better adapted than Commodus CL, Maximus CL, and Spartacus CL to April sowing opportunities when sowing into non-Clearfield® wheat stubble (allowing control of in-crop wheat volunteers). Across 83 WA barley NVT (2018–2022), Scope CL yielded less than Maximus CL in 78% of trials, the same in 13% and higher in 8%. Fungicides may be required to manage NFNB (Oxford virulent), SFNB and BLR. It should be harvested when ripe due to a high head loss risk. While it was accredited as a malt variety by Barley Australia in March 2013, malt segregations are no longer offered in WA. Scope CL is still very popular in the Geraldton and Kwinana Port Zone and was the sixth most popular barley variety across WA in 2022, accounting for just over 2% of the state's barley acreage.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	95	89	93	80	90
Agzone 2	93	92	86	88	90
Agzone 3	92	86	85	97	90
Agzone 4	103	110	90	82	95
Agzone 5	-	-	-	-	-
Agzone 6	-	-	-	-	-
Statewide	93	86	84	89	90

Disease resistance	Seedling	Adult
Sc	-	MS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MR	MRMS
NFNB (Oxford virulent)	S	MS
SFNB	MS	S
PM	MR	MR
BLR (5457P-)	S	MSS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	MRMS	MRMS
CCN	S	S

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+6	+7	+6	+5
Cunderdin	+5	+5	+5	+3
Katanning	+7	+6	+6	+4
Grass Patch	+5	+4	+4	+3

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Medium
Plant height	Tall
Straw strength	Fair
Head loss risk	High

Variety information	
Breeder / Seed licensee	AgVic Services / Seednet
Access to seed	Seednet Partners
EPR ($/t, excl. GST)	$3.50

Refer to page 4 for interpreting resistance classification.

Titan AX(Þ)

Deliverable as a feed variety

Comments

Titan AX (tested as AGTB0325) is a herbicide-tolerant, tall-height, medium-spring barley. Titan AX tolerates the Aggressor herbicide (Group 1, quizalofop-P-ethyl), allowing in-crop control of grass weeds, including barley grass, brome grass, and wild oats. The plant type of Titan AX is similar to that of Compass with good early vigour, similar lodging and head loss risk, a medium coleoptile, and a maturity slightly later than Compass or similar to RGT Planet. Titan AX is suggested for low- to medium-rainfall environments. Growers should be cautious in their expectations due to the lack of public field trial data. In 34 WA barley NVT (2021–2022), Titan AX yielded less than Rosalind in 44% of trials, the same in 35%, and higher in 21%. In the same trials, Titan AX yielded less than Maximus CL in 26% of trials, the same in 26%, and higher in 46%. Titan AX has useful resistance to NFNB, STNB, and PM but may need management for scald and BLR. Titan AX is in Stage One of the Grains Australia Malt Accreditation program in 2023, with the earliest accreditation being in March 2025.

Yield (% Maximus CL)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	102
Agzone 2	-	-	-	-	99
Agzone 3	-	-	-	-	102
Agzone 4	-	-	-	-	106
Agzone 5	-	-	-	105	99
Agzone 6	-	-	-	-	96
Statewide	-	-	-	102	101

Disease resistance	Seedling	Adult
Sc	-	S
NFNB (Beecher virulent)	MS	MRMS
NFNB (Beecher avirulent)	MS	MRMS
NFNB (Oxford virulent)	SVS	MS
SFNB	MS	MSS
PM	R	RMR
BLR (5457P-)	MSS	S
BYD and CYD	MS	MS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	MR*p*	MR*p*

'FlowerPower' predicted flowering date (days to Z49)	Relative to Maximus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-	-	-	-
Katanning	-	-	-	-
Grass Patch	-	-	-	-

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Medium
Plant height	Tall
Straw strength	Fair
Head loss risk	Medium

Variety information	
Breeder / Seed licensee	AGT
Access to seed	AGT Affiliates and Seed Sharing™
EPR ($/t, excl. GST)	$4.55

Refer to page 4 for interpreting resistance classification.
p = provisional rating.

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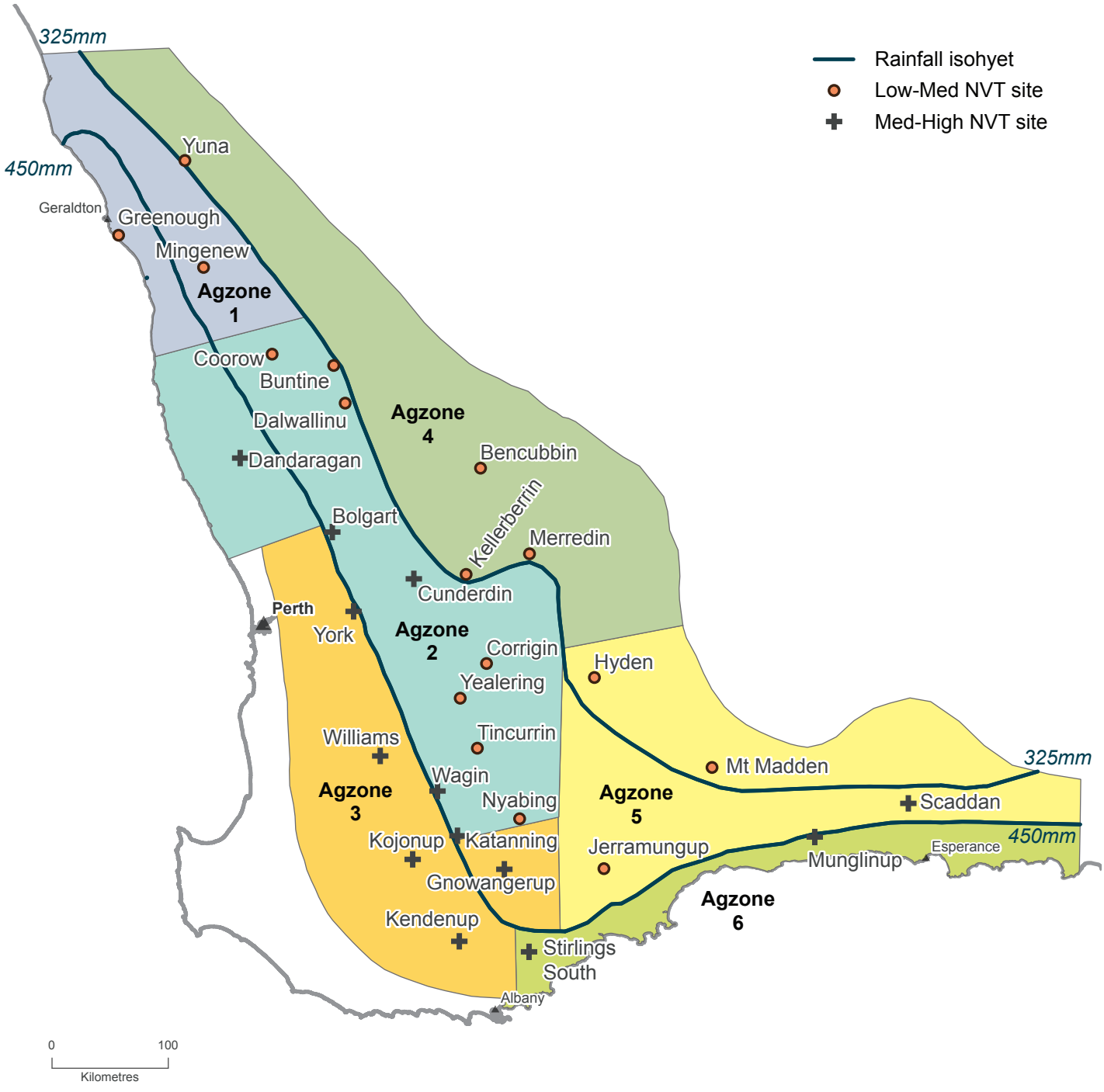

Figure 1. Location of Low-Med Rainfall and Med-High Rainfall canola NVT across Western Australian agzones

Canola

By Stacey Power, DPIRD

Introduction

The 2022 season

Canola National Variety Trial (NVT) yields in 2022 were uniformly high, with all trial series averaging more than 2.4t/ha and the medium-high rainfall Clearfield® series averaging 3.7t/ha. This reflected the good season in 2022, with high average yields achieved across the State. Western Australia produced about 4.3 million tonnes of canola in 2022 from just under 2.2 million hectares of land, which accounted for 56% of Australian canola production (GIWA crop report February 2023). The productive season came at a good time for growers, with canola prices still high. However, two years of large plantings may limit the area sown to canola in 2023 and beyond as growers avoid tight rotations.

Choosing a canola variety

Considerations to make when choosing a canola variety include:

- **Herbicide tolerance.** Successful weed control is a key benefit of growing canola. Choose herbicide tolerance depending on weeds present in the paddock, intended application timing of herbicide and any residues that might be present from herbicides used in previous years.
- **Yield.** Choose varieties with proven high yields and reliability across seasons and yield ranges.
- **Variety maturity.** Match maturity to sowing time. Longer varieties will generally perform best when sown early and shorter maturity varieties will perform best when sown later. Early-mid and mid-maturing varieties can be adaptable across both early and late sowing times.
- **Blackleg resistance.** Select a variety with the highest possible blackleg resistance rating and follow the eight management steps to control blackleg as listed in the GRDC Blackleg Management Guide (grdc.com.au/GRDC-FS-BlacklegManagementGuide).
- **Risk.** Yield potential of the season and variety choice need to be balanced with the costs of seed and other inputs such as herbicide, fungicide and fertiliser.
- **Oil content.** Oil contents are likely to be greatest with early sowing, however yield will generally impact profit more than oil content.

Herbicide tolerance, blackleg resistance, maturity and oil content of current canola varieties can be found in Table 1. Yield data from GRDC NVT trials is presented in Tables 2 to 7.

Canola types

The most widely grown herbicide tolerance group in canola is TT (triazine tolerant). Other options include GT (glyphosate tolerant), CL (Clearfield®, imidazolinone tolerant) and LL (Liberty Link®, tolerant of glufosinate-ammonium). Canola varieties with TT, GT and CL single herbicide tolerance are available to WA growers. There are also many varieties offered with dual or 'stacked' combinations of TT + LL, TT + CL, GT + CL and, with the introduction of InVigor LR 4540P, the GT + LL combination is now available (Table 1).

The GT group includes both Roundup Ready® and TruFlex® types, which share the same single gene genetic modification licenced from Bayer. With the introduction of new varieties PY422G and PY525G, both from Pioneer, the GT group now also includes Optimum Gly® varieties. TruFlex® canola types allow for higher glyphosate rates and a wider application window than Roundup Ready® canola. Optimum Gly® types have a similar glyphosate application pattern to TruFlex® canola but are based on a different gene modification. For more detailed information on herbicide tolerance and weed control in canola see Dhammu et al (2020).

Canola is available as open pollinated (OP) or hybrid breeding types. OP seed is created through self-pollination. Harvested OP seed is often retained on-farm for use at sowing time.

Only TT and conventional canola are available for purchase as OP varieties (Table 1). Hybrid seed is produced from managed crosses between elite canola lines. Hybrid TT varieties are higher yielding than OP varieties and are a good choice where there is high yield potential. Lower-yielding, low cost, OP varieties might be a better choice in higher risk scenarios.

Some longer maturity 'winter types' with Clearfield® herbicide tolerance are available for dual purpose use (Graze n Grain) (Table 1). These varieties need a long period of cold before entering the reproductive stage and are suitable only for cooler southern areas. Dual purpose types provide an opportunity to graze the vegetative crop before flowering begins. Graze n Grain varieties are not included in NVT trials and are not reported in yield tables in this guide. Information on their management and yield are available from private company websites.

Due to a lack of chemical options for wild radish control, very little conventional canola (<0.5% of the total canola area) is grown in WA. Annual ryegrass control is also difficult due to Group 1 (previously Group A) herbicide resistance in the WA grainbelt. Conventional varieties are no longer tested in WA NVT trials, but trial results are available for the years up until 2020 for New South Wales, South Australia and Victoria at nvtonline.com.au.

New varieties for 2024

OP TT varieties

- **ATR Swordfish** is an early-mid maturing variety from Nuseed with an oil content 0.6% higher than the average for TT varieties (44.8%). It has an MRMS rating for blackleg and is suited to low-medium rainfall zones.
- **DG Avon TT** is an early maturing variety from Nutrien Ag Solutions that has an MR rating for blackleg and average oil content for TT varieties (44.8%).

TT + CL varieties

- **Hyola Defender CT** is a mid-maturing variety suited to medium to very high rainfall zones. It was amongst the highest yielding varieties in the 2022 medium-high rainfall area NVT trials.

GT varieties

- **Pioneer PY422G** is the first Optimum Gly® hybrid variety released in Australia by Pioneer Seeds. It has an early-mid maturity and is suited to the medium rainfall zone. 2023 is the first year that Pioneer PY422G has been tested in NVTs.
- **Pioneer PY525G** is a mid-maturing variety with Optimum Gly® technology that is suited to medium-high rainfall zones. 2023 is the first year that Pioneer PY525G has been tested in NVTs.

GT + LL tolerant varieties

- **InVigor LR 4540P** is an early-mid maturing release by BASF with a blackleg rating of RMR. It combines TruFlex®, Liberty Link® and Pod Guard® technology. It had the third highest yield in low-med rainfall NVTs in 2022 and 0.7% greater oil content than the GT average of 45.7%.

CL varieties

- **Captain CL** is a long-season Graze n Grain variety with a blackleg rating of R released by AGF Seeds and Smyth Seeds. Graze n Grain varieties are not tested in NVTs.
- **Hyola Continuum CL** is an early-mid maturing variety that is suited to medium-very high rainfall areas. It has a blackleg rating of R and an oil content 1.1% higher than the CL average of 45.3%.
- **Nuseed Ceres** is an early maturing release from Nuseed. It is rated R for blackleg. 2023 is the first year that Nuseed Ceres has been tested in NVTs.
- **Pioneer PY421C** is an early-mid maturing variety with a blackleg rating of RMR. It has an oil content 1.2% above the CL average of 45.3%. 2023 is the first year that Pioneer PY421C has been tested in NVTs.

Withdrawn varieties

BASF has withdrawn InVigor R 4022P from sale.

Table 1. Herbicide tolerance, harvest maturity, oil content, blackleg rating and commercial information of current canola varieties

Herbicide tolerance[1]	Variety	Harvest maturity[2]	Oil content[3] (diff. to mean)	Blackleg resistance rating[4] (bare seed)	Blackleg group[5]	PodGuard®	EPR $/t delivered	Release year	Seed access
TT (OP)	AFP Cutubury	4	-0.9	MS	AB	-	4	2020	Agronomy for Profit
TT (OP)	ATR Bluefin	3	0.8	RMR	AB	-	5	2021	Nuseed
TT (OP)	ATR Bonito	4	0.6	MS	A	-	5	2013	Nuseed
TT (OP)	ATR Mako	4	-2.3	MRMS	A	-	5	2015	Nuseed
TT (OP)	ATR Stingray	3	0.4	MRMS	C	-	-	2011	Nuseed
TT (OP)	ATR Swordfish	4	0.6	MRMS	AB	-	5	2023	Nuseed
TT (OP)	ATR Wahoo	6	0.8	MRMS	A	-	5	2013	Nuseed
TT (OP)	Bandit TT	3	-0.8	MRMS	A	-	10	2022	AGT
TT (OP)	DG Avon TT	3	0.0	MR	AC	-	5	2023	Nutrien Ag Solutions
TT (OP)	DG Bidgee TT	4.5	-0.1	R	H	-	5	2021	Nutrien Ag Solutions
TT (OP)	DG Murray TT	6	0.6	R	H	-	5	2021	Nutrien Ag Solutions
TT (OP)	DG Torrens TT	4.5	0.7	R	H	-	5	2022	Nutrien Ag Solutions
TT	Hyola Blazer TT	4.5	0.1	R	ADF	-	-	2020	Pacific Seeds
TT	HyTTec Trident	3	0.2	R	AD	-	5	2019	Nuseed
TT	HyTTec Trifecta	5	0.2	R	ABD	-	5	2020	Nuseed
TT	HyTTec Trophy	4	-0.3	R	AD	-	5	2017	Nuseed
TT	HyTTec Velocity	3	-0.6	MR	AB	-	5	2022	Nuseed
TT	InVigor T 4510	4	-0.7	MR	BF	-	-	2016	BASF
TT	InVigor T 4511	4	0.5	R	See below[6]	-	-	2022	BASF
TT	InVigor T 6010	6	0.0	MRMS	BC	-	-	2020	BASF
TT (OP)	Renegade TT	4	-0.6	MR	A	-	10	2022	AGT
TT	RGT Baseline TT	6	0.7	MRMS	B	-	10	2022	RAGT
TT	RGT Capacity TT	4	-0.5	MRMS	B	-	10	2021	RAGT
TT	Dynatron TT	5	0.8	MRMS	BC	-	10	2020	RAGT
TT	Spark TT	3	0.9	MR	ABDS	-	10	2018	RAGT
TT (OP)	Yetna	4	-	-	AB	-	4	2015	Agronomy for Profit
TT + CL	Hyola Defender CT	6	0.2	RMR	ADF	-	-	2023	Pacific Seeds
TT + CL	Hyola Enforcer CT	5	-0.2	R	ADF	-	-	2020	Pacific Seeds
TT + CL	Pioneer PY520 TC	5	-0.2	RMR	BC	-	-	2022	Pioneer
TT + LL	InVigor LT 4530P	4.5	-0.6	RMR	BF	P	-	2021	BASF

Varieties listed in alphabetical order within herbicide tolerance groups; = new varieties are highlighted in yellow.

OP = Open pollinated

[1] Herbicide tolerance: TT =Triazine Tolerant, CL= Clearfield® (Imidazolinone tolerant), GT = glyphosate tolerant (RR = Roundup Ready type, TF = TruFlex® type, OG = OptiGly® type), LL = LibertyLink (glufosinate tolerant).

[2] Harvest maturity key: 3 = early, 4 = early-mid and mid-early, 5 = mid, 6 = mid-late, 7 = late, 8 = winter, 9 = very late winter (provided by seed companies).

[3] Oil content averages (%): TT = 44.8, GT = 45.7 and CL = 45.3 (data from 2018–2022 NVT).

[4] Blackleg resistance rating key: MS = moderately susceptible, MRMS = moderately resistant to moderately susceptible, MR = moderately resistant, RMR = resistant to moderately resistant, R = resistant.

[5] Blackleg information from GRDC Blackleg Management Guide 2023 Spring Fact Sheet, see further information at **grdc.com.au/GRDC-FS-BlacklegManagementGuide**

[6] Different blackleg resistance pattern, further testing required. Effective rotation with existing groups is currently unknown.

[Table 1. continued following page...]

Table 1. Herbicide tolerance, harvest maturity, oil content, blackleg rating and commercial information of current canola varieties (cont'd)

Herbicide tolerance[1]	Variety	Harvest maturity[2]	Oil content[3] (diff. to mean)	Blackleg resistance rating[4] (bare seed)	Blackleg group[5]	PodGuard®	EPR $/t delivered	Release year	Seed access
GT (TF)	DG Bindo TF	4.5	-0.2	MR	AB	-	-	2021	Nutrien Ag Solutions
GT (TF)	DG Hotham TF	5	-0.1	R	ABH	-	-	2022	Nutrien Ag Solutions
GT (TF)	DG Lofty TF	3	0.1	R	ABH	-	-	2021	Nutrien Ag Solutions
GT (TF)	Hyola 410XX	4.5	0.9	MR	ABD	-	-	2018	Pacific Seeds
GT (TF)	InVigor R 4520P	4.5	-1.1	MRMS	B	P	-	2020	BASF
GT (TF)	Nuseed Eagle TF	5	0.9	R	ABD	-	-	2022	Nuseed
GT (TF)	Nuseed Emu TF	3	-0.1	MR	AB	-	-	2021	Nuseed
GT (TF)	Nuseed Hunter TF	4	0.3	RMR	AB	-	-	2022	Nuseed
GT (TF)	Nuseed Raptor TF	4	-0.1	R	AD	-	-	2019	Nuseed
GT (RR)	Pioneer 44Y27 RR	4	-0.3	RMR	B	-	-	2017	Pioneer
GT (RR)	Pioneer 44Y30 RR	4	0.0	RMR	AB	-	-	2021	Pioneer
GT (RR)	Pioneer 45Y28 RR	5	1.2	RMR	BC	-	-	2018	Pioneer
GT (OG)	Pioneer PY422G	4	-	-	-	-	-	2023	Pioneer Seeds
GT (OG)	Pioneer PY525G	5	-	-	-	-	-	2023	Pioneer Seeds
GT (TF) + LL	InVigor LR 4540P	4.5	0.7	RMR	B	P	-	2023	BASF
GT (TF) + CL	Hyola Battalion XC	3.5	-0.9	R	ADF	-	-	2021	Pacific Seeds
GT (TF) + CL	Hyola Garrison XC	4	-0.1	R	ADF	-	-	2020	Pacific Seeds
GT (TF) + CL	Hyola Regiment XC	5	0.4	R	ADFH	-	-	2022	Pacific Seeds
CL	Hyola Continuum CL	4	1.1	R	ADF	-	-	2023	Pacific Seeds
CL	Hyola Equinox CL	5	0.5	R	ADF	-	-	2021	Pacific Seeds
CL	Hyola Solstice CL	5	0.4	R	AFDH	-	-	2022	Pacific Seeds
CL	Nuseed Ceres IMI	3	-	R	AD	-	-	2023	Nuseed
CL	Pioneer PY421C	4	1.2	RMR	A	-	-	2023	Pioneer Seeds
CL	Pioneer 43Y92 CL	3	-1.0	R	B	-	-	2017	Pioneer
CL	Pioneer 44Y94 CL	4	0.3	R	BC	-	-	2020	Pioneer
CL	Pioneer 45Y93 CL	5	0.3	R	BC	-	-	2018	Pioneer
CL	Pioneer 45Y95 CL	5	0.1	R	C	-	-	2021	Pioneer
CL Graze n Grain	Captain CL	8	-	R	AH	-	5	2023	AGF Seeds/Smyth Seeds
CL Graze n Grain	Hyola 970CL	9	-	R	H	-	-	2018	Pacific Seeds
CL Graze n Grain	Hyola Feast CL	8	-	R	H	-	-	2020	Pacific Seeds
CL Graze n Grain	Phoenix CL	8.5	-	R	B	-	-	2018	AGF Seeds
CL Graze n Grain	RGT Clavier CL	9	-	R	ACH	-	12	2022	RAGT
CL Graze n Grain	RGT Nizza CL	8	-	R	B	-	12	2021	RAGT
Conventional	Outlaw	3	-	RMR	A	-	10	2022	AGT

Varieties listed in alphabetical order within herbicide tolerance groups; = new varieties are highlighted in yellow.

[1] Herbicide tolerance: TT =Triazine Tolerant, CL= Clearfield® (Imidazolinone tolerant), GT = glyphosate tolerant (RR = Roundup Ready type, TF = TruFlex® type, OG = OptiGly® type), LL = LibertyLink (glufosinate tolerant).

[2] Harvest maturity key: 3 = early, 4 = early-mid and mid-early, 5 = mid, 6 = mid-late, 7 = late, 8 = winter, 9 = very late winter (provided by seed companies).

[3] Oil content averages (%): TT = 44.8, GT = 45.7 and CL = 45.3 (data from 2018–2022 NVT).

[4] Blackleg resistance rating key: MRMS = moderately resistant to moderately susceptible, MR = moderately resistant, RMR = resistant to moderately resistant, R = resistant.

[5] Blackleg information from GRDC Blackleg Management Guide 2023 Spring Fact Sheet, see further information at grdc.com.au/GRDC-FS-BlacklegManagementGuide

National Variety Trials (NVT) results 2018–2022

Data analysis

NVT results are available as single site reports or as multi-environment long term summaries (MET data). MET data establishes relationships between varieties by comparing results from similar environments. MET data considers issues that affect a single site, such as poor establishment or variable soil types and is used to generate predicted yields even when a variety is not present in a trial. This is particularly useful for canola, as new varieties are often released with limited NVT testing.

In this guide, data from the NVT Long-Term MET Yield Reporter (data accuracy ≥80% and VAF ≥25%) is presented for each NVT series for the years 2018–2022. There were 216 canola NVT trials in WA during this time. The data is presented as a table of performance values for each variety compared to the mean of all NVT sites within that rainfall series (either low-medium or medium-high, see Figure 1 for 2022 trial locations). Where a yield has been predicted, cells in Tables 2–7 appear shaded. Data should be considered more robust for varieties that have been included in trials over multiple seasons without prediction.

A five-year weighted average has been calculated from the MET data from 2018–2022 for each trial series. A weighted average is not presented where a variety has been present in only one year of NVT testing. Caution should be exercised when looking at the weighted average as it is based on the average performance of a variety over several years and across an entire rainfall zone and can mask variety-by-environment interactions. Growers should consider the relative performance of varieties within an individual season and consider how their location fits into either the low-medium or medium-high rainfall zone to help explain how a variety might perform on their farm.

Results of individual NVT trials and MET analyses are available online at nvtonline.com.au.

Medium-high rainfall NVTs

In 2022, medium-high rainfall NVTs were sown mostly from 14–30 April, except for Wagin, Williams and York, which were sown in mid-May. Trials were harvested from 25 October through to 2 December.

The hybrid varieties HyTTec Trifecta, Hyola Blazer TT, HyTTec Trident and HyTTec Trophy achieved the highest yields in the 2022 medium-high rainfall TT NVTs (11 trials, Table 2). These varieties have been consistently high performers across multiple years, as seen in the MET analysis from 2018–2022. Pioneer PY250 TC and Hyola Defender CT also yielded well in these trials, suggesting that yield can be maintained in higher rainfall environments, with the added flexibility of stacked herbicide tolerance.

DG Bidgee TT was the highest yielding OP TT variety in the 2022 medium-high rainfall zone NVTs but was still 13% lower than HyTTec Trifecta. Newer OP TT varieties are performing better in NVTs in this zone than older OP TT varieties such as ATR Bonito and ATR Stingray.

Across the 10 GT medium-high rainfall NVTs in 2022, early-mid maturing varieties tended to produce the highest yields, with Nuseed Hunter TF and InVigor R 4520P the highest yielding varieties (Table 3). Hyola Regiment XC and InVigor LR 4540P were the best of the varieties with stacked tolerance.

In 2022 there were only two trials located in the medium-high rainfall CL NVT series so variety comparisons should be considered cautiously. Some varieties have been trialled over multiple years, and data for these is more robust. In a high yielding year (average of 3.7t/ha in 2022), Pioneer varieties PY421C, 45Y93 CL, 45Y95 CL and 44Y94 CL performed the best of the CL types (Table 4).

Table 2. Grain yield of triazine tolerant canola varieties in the WA MED–HIGH RAINFALL NVT, expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five year period

Medium–High Rainfall — Triazine tolerant canola varieties								
Herbicide tolerance[1]	Variety	Year	2018	2019	2020	2021	2022	2018–2022
		Site mean yield (t/ha)	2.15	1.96	2.73	2.86	2.81	2.50
		No. trials	(10)	(12)	(8)	(11)	(11)	(52)
TT	HyTTec Trifecta	(42)	118	115	114	121	114	**116**
TT	Hyola Blazer TT	(31)	113	113	114	120	113	**115**
TT	HyTTec Trident	(28)	118	109	111	116	115	**114**
TT	HyTTec Trophy	(50)	113	111	112	116	112	**113**
TT	Dynatron TT	(34)	108	110	111	114	109	**110**
TT	InVigor T 4511	(22)	111	108	109	112	109	**110**
TT	InVigor T 4510	(52)	110	108	109	110	108	**109**
TT	HyTTec Velocity	(5)	111	108	108	108	109	-
TT	RGT Capacity TT	(33)	106	108	108	109	106	**107**
TT	RGT Baseline TT	(18)	103	107	107	112	104	**107**
TT	InVigor T 6010	(29)	105	108	106	108	104	**106**
TT (OP)	DG Bidgee TT	(22)	101	103	102	107	101	**103**
TT	Spark TT	(18)	101	100	101	102	101	**101**
TT (OP)	Renegade TT	(22)	93	102	103	99	98	**99**
TT (OP)	DG Torrens TT	(23)	98	100	99	99	97	**99**
TT (OP)	ATR Mako	(9)	91	95	98	99	96	-
TT (OP)	DG Murray TT	(23)	97	96	94	96	95	**96**
TT (OP)	Bandit TT	(11)	92	94	96	92	95	-
TT (OP)	ATR Wahoo	(5)	89	94	93	92	91	-
TT (OP)	ATR Bonito	(40)	90	93	93	89	92	**91**
TT (OP)	ATR Swordfish	(14)	85	91	92	88	90	**89**
TT (OP)	ATR Stingray	(7)	86	89	89	85	89	**88**
TT (OP)	AFP Cutubury	(16)	86	89	89	84	88	**87**
TT (OP)	ATR Bluefin	(8)	84	87	87	81	87	**85**
TT + CL	Pioneer PY520 TC	(11)	108	110	111	117	109	**111**
TT + CL	Hyola Defender CT	(11)	104	108	111	117	108	-
TT + CL	Hyola Enforcer CT	(33)	110	105	103	105	105	**106**
TT + LL	InVigor LT 4530P	(30)	105	106	105	102	104	**104**

Varieties listed in decreasing yield, within herbicide tolerance types; new varieties are highlighted in yellow.

OP = Open pollinated

[1] Herbicide tolerance: TT =Triazine Tolerant, CL= Clearfield® (Imidazolinone tolerant).

Yield data based on MET analysis from NVT Online, nvtonline.com.au

Weighted average is not presented where a variety has been present in only one year of NVT testing.

Shaded cells indicate that a variety was not included in a trial and yield has been predicted from MET analysis.

Table 3. Grain yield of glyphosate tolerant canola varieties in the WA MED–HIGH RAINFALL NVT, expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five year period

Medium–High Rainfall — Glyphosate tolerant canola varieties								
Herbicide tolerance[1]	Variety	Year	2018	2019	2020	2021	2022	2018–2022
		Site mean yield (t/ha)	2.33	2.25	2.81	3.15	2.80	2.67
		No. trials	(6)	(10)	(8)	(11)	(10)	(45)
GT (TF)	Nuseed Hunter TF	(14)	112	108	109	110	110	**110**
GT (TF)	InVigor R 4520P	(39)	107	110	108	108	107	**108**
GT (TF)	Nuseed Eagle TF	(15)	108	106	106	110	107	**107**
GT (RR)	Pioneer 44Y30 RR	(27)	105	107	107	107	107	**107**
GT (RR)	Pioneer 45Y28 RR	(31)	105	105	105	109	105	**106**
GT (TF)	Nuseed Raptor TF	(39)	108	102	104	107	106	**105**
GT (RR)	Pioneer 44Y27 RR	(39)	105	102	104	105	106	**104**
GT (TF)	Nuseed Emu TF	(7)	106	99	100	96	103	**100**
GT (TF)	DG Bindo TF	(21)	95	96	97	97	97	**97**
GT (TF)	Hyola 410XX	(27)	102	95	95	94	97	**96**
GT (TF)	DG Hotham TF	(16)	91	95	95	98	95	**95**
GT (TF)	DG Lofty TF	(9)	92	92	95	94	96	**94**
GT (TF) + CL	Hyola Regiment XC	(16)	115	105	105	108	107	**108**
GT (TF) + CL	Hyola Garrison XC	(35)	107	98	97	96	99	**99**
GT (TF) + CL	Hyola Battalion XC	(16)	106	98	97	95	98	**98**
GT (TF) + LL	InVigor LR 4540P	(10)	110	110	108	107	108	-

Varieties listed in decreasing yield, within herbicide tolerance types; = new varieties are highlighted in yellow.
[1] Herbicide tolerance: CL= Clearfield® (Imidazolinone tolerant), GT = glyphosate tolerant (RR = Roundup Ready type, TF = TruFlex® type, LL = LibertyLink (glufosinate tolerant).
Yield data based on MET analysis from NVT Online, nvtonline.com.au
Weighted average is not presented where a variety has been present in only one year of NVT testing.
Shaded cells indicate that a variety was not included in a trial and yield has been predicted from MET analysis.

Table 4. Grain yield of imidazolinone tolerant canola varieties in the WA MED–HIGH RAINFALL NVT, expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five year period

Medium-High Rainfall — Imidazolinone tolerant canola varieties								
Herbicide tolerance[1]	Variety	Year	2018	2019	2020	2021	2022	2018–2022
		Site mean yield (t/ha)	2.39	2.47	3.33	3.53	3.69	3.08
		No. trials	(6)	(5)	(3)	(3)	(2)	(19)
CL	Pioneer PY421C	(2)	116	115	116	116	116	-
CL	Pioneer 45Y95 CL	(10)	111	113	112	121	118	**114**
CL	Pioneer 44Y94 CL	(12)	108	112	111	115	113	**111**
CL	Hyola Solstice CL	(5)	119	102	107	109	105	**110**
CL	Pioneer 45Y93 CL	(14)	103	111	107	116	116	**109**
CL	Hyola Equinox CL	(6)	112	96	102	98	97	**102**
CL	Hyola Continuum CL	(2)	96	105	104	107	105	-
CL	Pioneer 43Y92 CL	(3)	102	101	103	99	99	**101**

Varieties listed in decreasing yield, within herbicide tolerance types; = new varieties are highlighted in yellow.
[1] Herbicide tolerance: CL= Clearfield® (Imidazolinone tolerant).
Yield data based on MET analysis from NVT Online, nvtonline.com.au
Weighted average is not presented where a variety has been present in only one year of NVT testing.
Shaded cells indicate that a variety was not included in a trial and yield has been predicted from MET analysis.

Low-medium rainfall NVTs

In 2022, the low-medium rainfall NVTs were sown from 4–19 May. Trials were harvested from 20 October through to 23 November.

Early- and early-mid maturing hybrid varieties achieved the highest yields in the low-medium rainfall zone TT NVT series, with HyTTec Trident and HyTTec Velocity out-yielding most other varieties (Table 5). HyTTec Trident has been a consistently strong performer in low-medium rainfall zone TT NVTs across many years and a broad range of trial yields. This, in combination with a blackleg resistance rating of R, suggests this variety has a very good fit in the WA environment. HyTTec Trident yielded 15% more than the highest OP variety, Bandit TT, in 2022.

New variety DG Avon TT yielded near the average of all varieties tested in the low-medium ranfall zone in its first year of NVTs. After several years of NVT testing, Hyola Defender CT also compares favourably to other mid-maturity TT varieties in terms of yield but has the added option of imidazolinone tolerance.

Low-medium rainfall zone GT NVTs were high yielding in 2022, achieving average yields of 2.44t/ha. Nuseed varieties Hunter TF and Emu TF and Pioneer 44Y27 RR continue to perform strongly and new variety InVigor LR 4540P achieved comparable yields to these varieties in its first year of testing.

The 2022 low-medium rainfall CL NVT series tested only five varieties across two trial locations, so variety comparisons should be treated with caution as data is limited. Pioneer 44Y94 CL had the highest yield in both 2021 and 2022.

Table 5. Grain yield of triazine tolerant canola varieties in the WA LOW–MED RAINFALL NVT, expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five year period

Low–Medium Rainfall — Triazine tolerant canola varieties								
Herbicide tolerance[1]	Variety	Year	2018	2019	2020	2021	2022	2018–2022
		Site mean yield (t/ha)	1.50	1.03	1.81	2.35	2.53	1.84
		No. trials	(7)	(8)	(9)	(12)	(12)	(48)
TT	HyTTec Trident	(43)	120	117	118	118	117	**118**
TT	HyTTec Velocity	(15)	120	112	117	114	112	**115**
TT	InVigor T 4510	(48)	112	110	106	111	111	**110**
TT	Dynatron TT	(26)	108	111	102	112	112	**109**
TT	HyTTec Trophy	(28)	109	109	108	110	110	**109**
TT	InVigor T 4511	(24)	105	108	102	107	108	**106**
TT	Hyola Blazer TT	(25)	102	106	100	108	107	**105**
TT	RGT Capacity TT	(23)	103	101	109	102	101	**103**
TT	Spark TT	(42)	105	102	104	102	102	**103**
TT (OP)	Bandit TT	(24)	103	103	102	102	102	**102**
TT	RGT Baseline TT	(3)	101	103	100	102	102	-
TT (OP)	DG Avon TT	(12)	106	97	107	98	97	-
TT (OP)	Renegade TT	(22)	100	94	101	98	97	**98**
TT (OP)	DG Bidgee TT	(2)	91	97	103	97	96	-
TT (OP)	DG Murray TT	(5)	91	94	94	93	92	-
TT (OP)	AFP Cutubury	(24)	91	90	96	91	90	**92**
TT (OP)	ATR Bonito	(43)	89	91	89	90	91	**90**
TT (OP)	ATR Swordfish	(12)	91	90	90	89	89	**90**
TT (OP)	ATR Stingray	(16)	88	86	94	84	84	**87**
TT (OP)	ATR Bluefin	(21)	86	84	87	83	83	**84**
TT + CL	Hyola Enforcer CT	(28)	97	104	97	101	103	**101**
TT + CL	Hyola Defender CT	(12)	97	100	95	102	102	-
TT + LL	InVigor LT 4530P	(32)	106	107	99	108	108	-

Varieties listed in decreasing yield, within herbicide tolerance types; = new varieties are highlighted in yellow.
OP = Open pollinated
[1] Herbicide tolerance: TT =Triazine Tolerant, CL= Clearfield® (Imidazolinone tolerant), LL = LibertyLink (glufosinate tolerant).
Yield data based on MET analysis from NVT Online, nvtonline.com.au
Weighted average is not presented where a variety has been present in only one year of NVT testing.
Shaded cells indicate that a variety was not included in a trial and yield has been predicted from MET analysis.

Table 6. Grain yield of glyphosate tolerant canola varieties in the WA LOW–MED RAINFALL NVT, expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five year period

Low–Medium Rainfall — Glyphosate tolerant canola varieties								
Herbicide tolerance[1]	Variety	Year	2018	2019	2020	2021	2022	2018–2022
		Site mean yield (t/ha)	1.76	1.06	1.8	2.66	2.44	1.94
		No. trials	(5)	(7)	(8)	(11)	(11)	(42)
GT (TF)	Nuseed Hunter TF	(18)	111	110	110	110	111	**110**
GT (TF)	Nuseed Emu TF	(28)	117	109	117	104	105	**109**
GT (RR)	Pioneer 44Y27 RR	(41)	108	106	109	107	107	**107**
GT (RR)	Pioneer 44Y30 RR	(22)	100	105	98	104	105	**103**
GT (TF)	Nuseed Raptor TF	(23)	97	105	91	104	106	**101**
GT (TF)	InVigor R 4520P	(37)	95	101	91	105	105	**100**
GT (TF)	DG Lofty TF	(22)	94	100	86	98	99	**96**
GT (TF)	Hyola 410XX	(37)	96	95	97	93	93	**94**
GT (TF)	DG Bindo TF	(16)	85	91	81	94	93	**90**
GT (TF) + LL	InVigor LR 4540P	(11)	109	107	110	108	108	-
GT (TF) + CL	Hyola Regiment XC	(11)	105	104	107	102	103	-
GT (TF) + CL	Hyola Battalion XC	(30)	102	102	100	99	100	**100**
GT (TF) + CL	Hyola Garrison XC	(26)	96	99	94	97	97	**97**

Varieties listed in decreasing yield, within herbicide tolerance types; = new varieties are highlighted in yellow.

[1] Herbicide tolerance: CL= Clearfield® (Imidazolinone tolerant), GT = glyphosate tolerant (RR = Roundup Ready type, TF = TruFlex® type, LL = LibertyLink (glufosinate tolerant).

Yield data based on MET analysis from NVT Online, nvtonline.com.au

Weighted average is not presented where a variety has been present in only one year of NVT testing.

Shaded cells indicate that a variety was not included in a trial and yield has been predicted from MET analysis.

Table 7. Grain yield of imidazolinone tolerant canola varieties in the WA LOW–MED RAINFALL NVT, expressed as a percentage of site mean yield for each trial year (2018–2022) and the weighted average over the five year period

Low–Medium Rainfall — Imidazolinone tolerant canola varieties								
Herbicide tolerance[1]	Variety	Year	2018	2019	2020	2021	2022	2018–2022
		Site mean yield (t/ha)	1.84	0.64	2.14	1.83	2.46	1.78
		No. trials	(2)	(2)	(2)	(2)	(2)	(10)
CL	Hyola Equinox CL	(2)	109	116	111	95	99	-
CL	Pioneer 44Y94 CL	(4)	99	97	98	102	102	**100**
CL	Pioneer 43Y92 CL	(10)	99	101	96	96	97	**98**
CL	Hyola Continuum CL	(2)	98	99	98	94	95	-
CL	Hyola Solstice CL	(2)	96	95	-	90	92	-

Varieties listed in decreasing yield, within herbicide tolerance types; = new varieties are highlighted in yellow.

[1] Herbicide tolerance: CL= Clearfield® (Imidazolinone tolerant).

Yield data based on MET analysis from NVT Online, nvtonline.com.au

Weighted average is not presented where a variety has been present in only one year of NVT testing.

Shaded cells indicate that a variety was not included in a trial and yield has been predicted from MET analysis.

Canola varieties grown in WA 2018–2023

The relative area sown to canola varieties with each type of herbicide tolerance in 2023 was very similar to 2022. In 2023 TT varieties accounted for 46% of the total canola area while GT varieties accounted for 45%. CL and dual-tolerant varieties accounted for much smaller percentages of the total canola area (Table 8). The most prevalent of the herbicide tolerance combinations in 2023 was GT + CL at 3.4% of the total area, mostly in the Kwinana and Geraldton port zones. In 2023, 50% of the TT area was sown to open pollinated varieties and 50% to hybrid varieties (Figure 2). This suggests the decline in TT OP area seen over recent years has stabilised.

Table 8. Proportion (% total sown area) of canola herbicide systems in WA 2018–2023

Herbicide tolerance	2018	2019	2020	2021	2022	2023
TT	72	63	62	56	47	46
GT	26	34	32	37	45	45
CL	1	2	3	3	3	3
Dual tolerance	1	1	3	4	6	6

Source: CBH Group

Note: 2022 total is 101% due to rounding

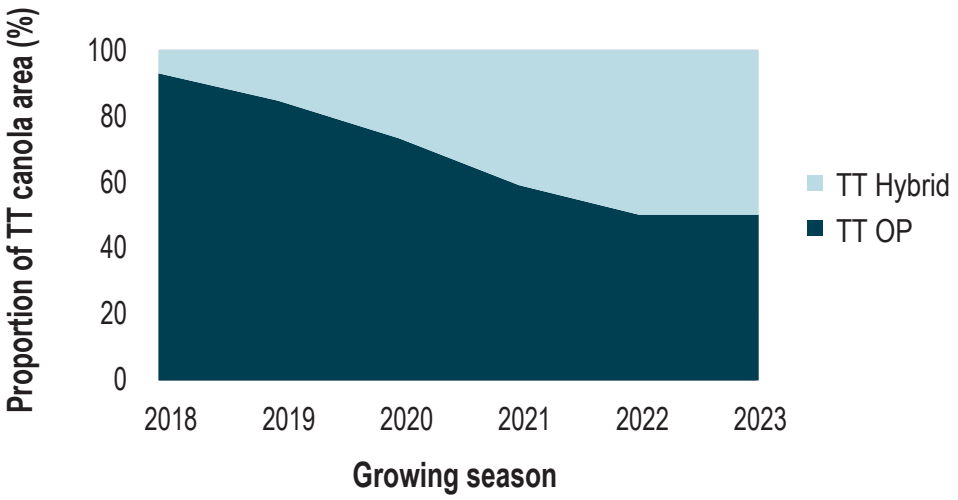

Figure 2. Relative proportion (%) of TT Hybrid vs TT OP canola area sown in WA 2018–2023

Source: CBH Group

Figure 3 shows the proportion of canola area in each port zone that was sown to each herbicide system. Farms delivering to the Geraldton port zone continue to be dominated by glyphosate tolerant canola, with over 80% of the area sown to these varieties. The Kwinana port zone has a more even mix of GT (52%) and TT (38%) canola, while the Albany and Esperance port zones have a much higher reliance on TT systems (59 and 79% respectively).

ATR Bonito was, once again, the most sown variety, with just over 18% of the canola area (Table 9). There was little change in the order of preference of varieties in 2023 compared to 2022, with Pioneer 44Y27 RR and the recently withdrawn variety, InVigor R 4022P, the most common GT varieties, and HyTTec Trident and HyTTec Trophy the most common TT hybrids. Although over 90 canola varieties have been reported as being grown in WA in 2023, the top 10 varieties account for over 70% of the total area.

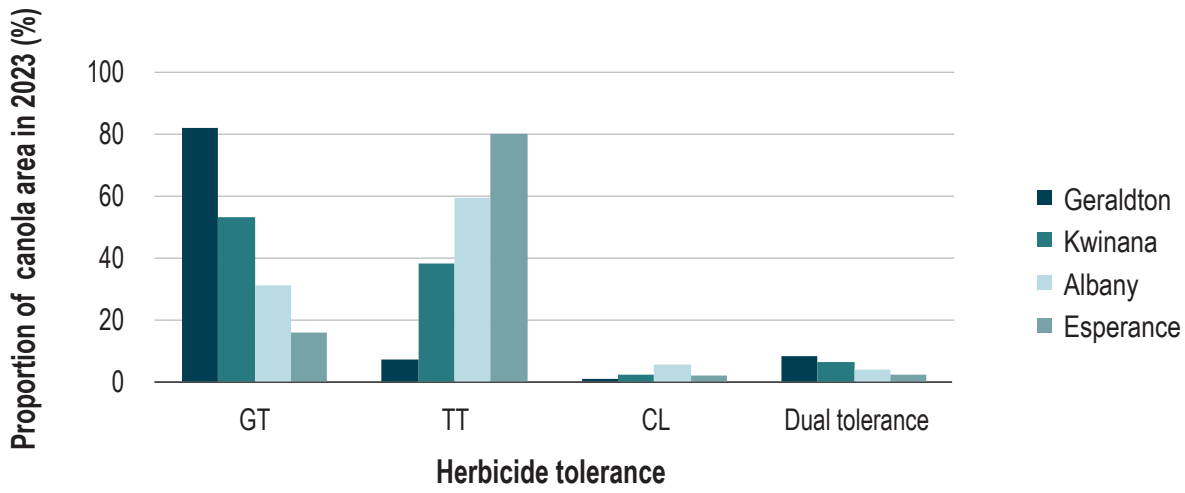

Figure 3. Relative area (%) sown to GT, TT, CL and dual tolerance canola herbicide systems in each WA port zone in 2023

Source: CBH Group

Table 5. Proportion (% of total area) of canola varieties sown in WA 2018–2023

Variety	Herbicide tolerance	2018	2019	2020	2021	2022	2023[1]
ATR Bonito	TT (OP)	53	39.1	34.6	26.4	18.4	18.4
Pioneer 44Y27 RR	GT	1.7	6.8	5.5	7.1	10.2	9.8
HyTTec Trident	TT	-	-	5.2	11.3	8	7.7
InVigor R 4022P	GT	-	-	0.8	2.7	7.3	7.3
Pioneer 44Y30 RR	GT	-	-	-	-	6.9	6.8
HyTTec Trophy	TT	0.0	2.3	5.9	5.6	6.9	6.7
HyTTec Trifecta	TT	-	-	0.3	1.2	4	4.4
Nuseed Emu TF	GT	-	-	-	-	3.8	3.9
Hyola 410XX	GT	-	1.0	2.5	2.6	3.5	3.3
Nuseed Raptor TF	GT	-	-	1.0	3.1	2.5	2.6
Pioneer 45Y28 RR	GT	-	-	1.2	2.5	2.8	2.6
Hyola Garrison XC	GT + CL	-	-	-	-	2.4	2.4
ATR Stingray	TT (OP)	6.7	6.1	5.5	3.5	1.9	2.0
Pioneer 44Y94 CL	CL	-	-	-	0.9	1.7	1.6
InVigor T 4510	TT	1.9	3.5	3.1	2.5	1.5	1.4
InVigor R 3520	GT	0.0	0.5	0.5	1.8	1.4	1.2
Hyola Enforcer CT	TT + CL	-	-	-	0.7	1.1	1.1
AFP Cutubury	TT (OP)	0.0	0.0	0.5	0.7	1.1	1.1
Pioneer 43Y23 RR	GT	7.9	7.4	4.8	3.2	0.8	0.9
InVigor R 4520P	GT	-	-	-	-	0.8	0.9
Pioneer 43Y29 RR	GT	-	3.1	3.4	3.6	0.7	0.9
InVigor R 5520P	GT	0.6	1.0	0.9	0.8	1.0	0.9
Hyola Blazer TT	TT	-	-	-	0.0	0.8	0.9
Hyola Battalion XC	GT + CL	-	-	-	-	0.9	0.9
Nuseed GT-53	GT	3.7	3.6	3.5	4.4	0.8	0.8
Hyola 404R	GT	8.4	5.4	3.6	2.8	0.5	0.6
Pioneer 44Y94 CL	CL	-	-	-	0.9	1.7	0.6
DG Bidgee TT	TT (OP)	-	-	-	-	0.6	0.6
Nuseed Condor TF	GT	-	-	-	-	0.5	0.6
InVigor LT 4530P	TT + CL	-	-	-	-	-	0.5
InVigor T 6010	TT	-	-	-	0.0	0.5	0.5
Dynatron TT	TT	-	-	-	-	0.5	0.5

Source: CBH Group
[1] Varieties are included in table only when they account for over 0.5% of the area sown in 2023.
Records of 0.0 indicate percentages below 0.5

Canola seed commercialisation companies

AGF Seeds/Smyth Seeds

agfseeds.com.au

(03) 5345 6262

Agronomy for Profit

Peter Norris 0428 850 850

AGT

agtbreeding.com.au

Alana Hartley 0417 919 299 (North)
Floyd Sullivan 0499 580 260 (South)

BASF

myseed.com.au/canola

Michael Allingame 0437 454 283
Lawrence Kirton 0427 634 965
Declan Sephton 0408 086 156

Nuseed

nuseed.com.au

Andrew Suverijn 0409 484 702
Andrew Royce 0427 466 916
Michael Hickey 0438 913 106

Nutrien Ag Solutions/Dynagro Seed

nutrienagsolutions.com.au/our-range/nutrien-exclusive-brands/dyna-gro-seed

David Clegg 0408 630 641
Kate Light 0455 159 379

Pacific Seeds

pacificseeds.com.au

Steve Lamb 0429 619 103
Andrew Heinrich 0473 520 818
Ella McDonald 0448 014 892
Mila Fotiou 0456 899 542

Pioneer Brand Seeds

pioneerseeds.com.au

Peter Bostock 0427 549 826
Erinn McCartney 0400 557 076
Tony Munns 0429 861 092
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- Blackleg information was reproduced from the GRDC Fact Sheet, 2023 Spring Blackleg Management Guide produced by Marcroft Grains Pathology.
- Variety harvest maturity was provided from company fact sheets/technical notes or directly from company representatives.
- Growers who host the NVT trials and NVT service providers, Living Farm and Kalyx.
- Canola area data was provided by CBH.

Oats

Introduction

Georgie Troup and Blakely Paynter (DPIRD)

This oat guide is designed to help growers determine which milling oat or export hay variety to grow. The guide provides variety characteristics, disease ratings and agronomic information for oat varieties that offer the best opportunity to meet market requirements (Tables 1–13; Figures 1–7).

Until the end of 2020, the National Oat Breeding Program (NOBP), led by the South Australian Research and Development Institute (SARDI) with support from the AgriFutures Export Fodder Program and the Australian Exporters Company (AEXCO) was responsible for developing and evaluating oat varieties for milling and export hay. In 2021, the breeding program at the NOBP transitioned to the commercial cereal breeding company InterGrain. InterGrain is now responsible for the national development of milling oat grain and export oaten hay varieties.

Many oat grain varieties are available for delivery into the Co-Operative Bulk Handling (CBH) system. At CBH sites accepting oats, the Grains Industry of Western Australia (GIWA) oat delivery grades available are OAT1 and OAT2, while OWAN is an exclusive segregation for Wandering oats. Each variety has its strengths and weaknesses across different growing regions. Most successful oat growers choose to grow more than one variety because no single oat variety is likely to provide optimum agronomic traits, disease resistance, yield and quality in any one year. Some grain oat varieties are suitable for export hay, but hay-only varieties may provide a better option for dedicated export hay growers. This guide summarises the suitability of oat varieties for grain (OAT1, OAT2, OWAN) and hay (Table 1). It also outlines the characteristics of seven of the most widely sown grain oat varieties (Table 2). The variety ‘snapshots’ at the end of this section summarises the strengths and weaknesses of key grain and hay varieties documented in this bulletin.

The decision on whether to grow an OAT1, OAT2 or OWAN grain oat depends on five main factors:

1. The premium paid for different OAT1, OAT2 and OWAN varieties.
2. Relative grain yield of oat varieties.
3. Differences in input costs required due to agronomic and disease characteristics.
4. Likelihood of meeting oat receival specifications.
5. Location of receival segregations for OAT1 and OAT2 varieties.

Grain oat variety choice in 2024 — what should I grow?

While there are currently no new variety options that are accredited by Grains Australia for milling oat production in 2024, new variety options with strong performance are on the horizon. These include the advanced breeding line 13008-18, which appears to be suited to lower yielding environments (<4t/ha) and Koala, which appears suited to higher yielding environments (>4t/ha).

Bannister is recommended if targeting the OAT1 market and risk of oat septoria is low-moderate. Bilby and Williams are recommended in higher rainfall areas with a low risk of drought stress during grain filling. Wandering is recommended if targeting the OWAN or OAT2 market, while Durack is a good OAT2 option with a June sowing.

Hay oat variety choice in 2024 – what should I grow?

If targeting export hay, the hay-only varieties Brusher and Forester are suitable for the far southwest of WA. Mulgara and Wintaroo are hay-only options for medium to high-yielding regions statewide. The recently released hay-only variety Koorabup and the dual-purpose variety Williams are suggested for high disease-risk areas. In other areas, the dual-purpose varieties Carrolup, Yallara and Bannister are also suitable for export hay production.

Table 1. Suitability of oat varieties for grain (OAT1, OAT2, OWAN) and hay

Variety	OAT1	OAT2	OWAN	Hay
Archer	-	-	-	✓
Bannister	✓	✓	-	✓
Bilby	✓	✓	-	-
Brusher	-	-	-	✓
Carrolup	✓	✓	-	✓
Durack	-	✓	-	✓
Forester	-	-	-	✓
Kangaroo	-	-	-	✓
Kingbale	-	-	-	✓
Koala	*	*	-	*
Kojonup	✓	✓	-	✓
Koorabup	-	-	-	✓
Kowari	✓	✓	-	-
Kultarr	-	-	-	✓
Mitika	✓	✓	-	-
Mulgara	-	-	-	✓
Swan	-	-	-	✓
Tammar	-	-	-	✓
Tungoo	-	-	-	✓
Wallaby	-	-	-	✓
Wandering	-	✓	✓	-
Williams	✓	✓	-	✓
Winjardie	-	-	-	✓
Wintaroo	-	-	-	✓
Yallara	✓	✓	-	✓

Source: GIWA and AEXCO
*Koala has not yet been considered suitable for milling or export hay.

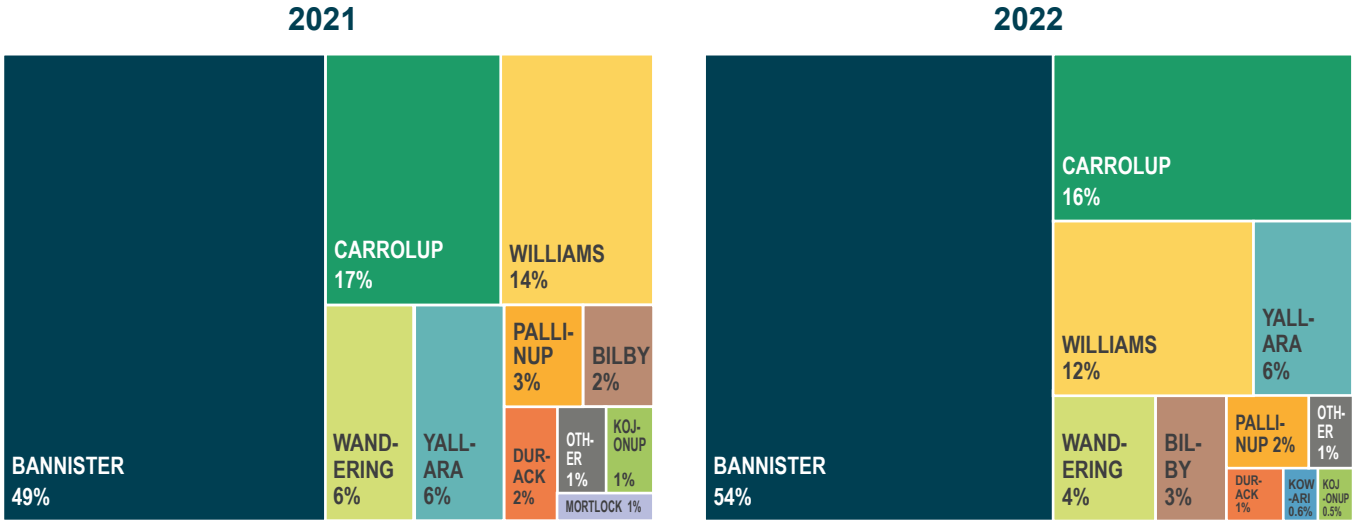

Figure 1. Relative popularity (percentage of oat area) of the top ten oat varieties plus the combined area sown to the remaining seven varieties delivered in WA in 2021 and 2022. The top ten varieties occupied 99% of the area planted to oats in both seasons, while the top five varieties occupied 92%.

Source: Grower estimates as provided to CBH for 2021 and 2022.

The hay-only varieties Archer and Kingbale may have a fit for rotations where imidazolinone (IMI) residues exist or where 'incorporated before sowing' (IBS) use of Sentry® (imazapic + imazapyr) is being considered to manage barley and brome grass, wild oats and other weeds on the label. Sentry® herbicide is now approved for IBS application in Archer and Kingbale hay, forage, seed and grain crops (domestic feed market only) (cdn.nufarm.com/wp-content/uploads/sites/22/2018/06/30133447/0512-Nufarm-Sentry-Herbicide-v2.pdf). Excess grain, seed and screenings produced from the single-gene IMI oaten hay varieties Archer and Kingbale, can now be used for domestic livestock feed. However, grain of these two varieties cannot be delivered into the Bunge and CBH bulk handling systems.

What is new in 2024?

No new milling or hay oat varieties were released in 2023. The following are notes on five varieties that might be of interest to oat growers: 13008-18, Archer, Koala, Kultarr and Wallaby.

13008-18

Key points:

- Potential milling oat with very good grain quality.
- Bannister type with improved panicle emergence.
- Medium spring maturity (3–6 days earlier to flower than Bannister).
- Very high yielding in <4t/ha environments.
- Undergoing milling evaluation post 2023 harvest.

13008-18 is a medium spring variety suited to all milling oat-growing regions in WA. 13008-18 is derived from Bannister and has the following pedigree – 02095-9/Bannister. It has been accepted for milling evaluation by Grains Australia.

13008-18 was first tested in WA oat NVT in 2021. It appears to be a yield improvement over Bannister above 2t/ha (Figure 3) with a stronger grain quality package (Figures 5 and 7). The critical quality strength of 13008-18 is its improved grain plumpness over Bannister. The disease resistance profile of 13008-18 is similar to Bannister.

Table 2. Summary of oat variety traits comparing seven grain-oat varieties

Trait	Bannister	Bilby	Carrolup	Durack	Wandering	Williams	Yallara
First year in variety trials in WA	2006	2013	1993	2010	1997	2006	2003
Statewide MET yield (% site mean)[1]	107%	102%	87%	86%	106%	103%	86%
Maturity relative to Carrolup (sown in late May)[2]	+3 days	-2 days	-	-7 days	+1 days	+2 days	-2 days
GIWA grade	OAT1	OAT1	OAT1	OAT2	OAT2	OAT1	OAT1
Suitable for export hay	Yes	No	Yes	Yes	No	Yes	Yes
Oat septoria	MSS	S	MSS	S	MSS	MSS	MSS
Oat leaf rust	MR	MRMS	VS	MRMS	VS	MR	MR
Oat stem rust	MS	SVS	S	SVS	SVS	MSS	MSS
Barley and cereal yellow dwarf	MS	S	SVS	S	S	MSS	MSS

Source: DPIRD and NVT Online nvtonline.com.au

[1] Regional differences in grain yield are masked when using a statewide average of the WA oat NVT MET data (2018–2022). Growers are directed to Tables 3 to 8 for a more precise estimate of variety performance in their region and Figures 2 and 3 to indicate relative variety performance at different site yields.

[2] Days to watery ripe from a 20 May sowing at Northam based on output from DPIRD FlowerPower v7, fp.dpird.app/

No score '-' = no rating is currently available. *Refer to page 4 for interpreting resistance classification.*

13008-18 shows promise as a hay variety. DPIRD data from 2022 suggests it has improved hay quality over Carrolup at a similar yield and Brusher at a lower hay yield.

DPIRD is evaluating 13008-18 in grain and hay trials to gather additional performance information season to InterGrain and that being generated by the WA oat NVT system before the 2024 cropping.

The NOBP bred 13008-18, and InterGrain are commercialising it. InterGrain has indicated they will release the variety if it passes milling evaluation.

Archer

Key points:

- Single gene, IMI-tolerant oat suitable for export hay.
- While modelled on Yallara oats, it has a different plant architecture and agronomic package and requires different management to optimise its performance as a hay-only variety.
- Targeted for sowing into soil with IMI residues from previous crops and for IBS use with Sentry® herbicide.
- Sentry® is approved for IBS application in crops of Archer hay, forage, seed and grain (domestic feed market only).
- Cannot be sprayed post-emergent with an IMI herbicide.
- Grain cannot be delivered to the Bunge and CBH bulk handling system but can be used in domestic feed markets for oaten grain and/or consumed on-farm.

Archer (tested as GIA1803-040) was released as a hay-only variety by InterGrain in August 2022. It was developed through mutation breeding by InterGrain's partner, GIA. According to InterGrain, Archer is a medium-maturity, medium-height and hay-only variety. In a recent DPIRD study, Archer was comparable to Yallara for yield and hay quality traits with a later cutting date (~1 week). Preliminary data from InterGrain indicates Archer produces high hay yields with suitable quality for export hay and has a useful disease profile. However, cereal cyst nematode (CCN) may require rotational management (Table 13). Archer appears to have a comparable grain yield to Carrolup, allowing for easier seed bulk-up for the following year's hay crop.

Archer seed is available from InterGrain's network of Seedclub members and resellers. As with other IMI-tolerant wheat and barley varieties, farmer-to-farmer trading of Archer seed is not allowed.

Koala

Key points:

- Currently undergoing milling evaluation.
- Suitability for export hay has not been established.
- Targeted for sowing in medium to high rainfall areas and for April planting.
- Widely tested in WA oat NVT since 2016.
- Has shown a slight yield advantage over Bannister in environments that yield more than 4.5t/ha.

Koala (tested as SV09143-35) is a late spring and tall grain-oat derived from Bannister, currently undergoing milling evaluation. Koala has the following pedigree – 02088-70/Bannister. It has similar tolerance to oat septoria and oat leaf rust (OLR) as Bannister but is improved for oat stem rust (OSR i.e. MRMS versus MS) (Table 12). Bannister and Koala have similar grain quality packages (hectolitre weight and screenings through a 2.0mm sieve) shown in Figures 4–7.

DPIRD is evaluating Koala in response to nitrogen (N) rates to gather additional agronomic, grain yield and quality information before the 2024 cropping season and complement information generated by NVT.

Koala seed will be bulked in WA in 2023 with the intent of being available for sale from Seednet partners in 2024.

Kultarr

Key points:

- Being evaluated for potential as an export hay variety.
- Suited to low to medium rainfall environments.
- Taller plant height, a benefit in more challenging years.
- Limited agronomic performance data exists for WA conditions.

According to the commercialising agent InterGrain, Kultarr (tested as 07423-18) is a quick to mid-maturing oaten hay with a tall plant height that offers excellent hay yields (Table 10). Kultarr has a higher yield potential than Brusher and Mulgara. It is slightly later to flower than Brusher and has similar flowering to Mulgara. Preliminary hay quality data indicates the variety has a suitable quality profile for export hay (Table 10). Kultarr has valuable resistance to oat septoria (MSS*p*), OLR (MR*p*) and OSR (MSS*p*) (Table 12).

Kultarr is being evaluated by DPIRD to gather additional hay yield and quality information before the 2024 cropping season and complement performance data being generated by InterGrain.

Kultarr was bred by the NOBP with support from the AgriFutures Export Fodder Program and AEXCO and is being commercialised by InterGrain. Kultarr seed will be available from InterGrain's network of Seedclub members and resellers for planting in 2024. Seed is free to trade from farmer to farmer by complying with the InterGrain seed sales declaration agreement (intergrain.com/source-seeds/ftf-trading/).

Wallaby

Key points:

- Being evaluated for potential as an export hay variety.
- Suited to medium to high rainfall environments.
- Wallaby is a dwarf type with a medium to tall plant height.
- Limited agronomic performance data exists for WA conditions.

According to the commercialising agent InterGrain, Wallaby (tested as 07079-9) is a mid-slow maturing oaten hay variety with similar hay yields to Brusher and Mulgara (Table 10). The variety has good digestibility and high water-soluble carbohydrate (WSC) levels. Provisional disease ratings suggest Wallaby has valuable resistance to oat septoria (MSS*p*), OLR (MR*p*), OSR (MS*p*) and is resistant to CCN (R) (Tables 12 and 13). Wallaby appears to have comparable grain yield to Carrolup, allowing for easier seed bulk-up for the following year's hay crop.

Wallaby is being evaluated by DPIRD to gather additional hay yield and quality information before the 2024 cropping season and complement production data being generated by InterGrain.

Wallaby was bred by the NOBP with support from the AgriFutures Export Fodder Program and AEXCO and is being commercialised by InterGrain. Wallaby seed will be available from InterGrain's network of Seedclub members and resellers for planting in 2024. Seed is free to trade from farmer to farmer by complying with the InterGrain seed sales declaration agreement (intergrain.com/source-seeds/ftf-trading/).

Other considerations for oat growers

Changes in disease pathogens

Oat growers are encouraged to look out for the red leather leaf (RLL) plant disease, which was confirmed in WA for the first time in 2021. The disease, which has been present in south-eastern Australia for many years, can cause yield and quality impacts in oaten hay and grain crops. DPIRD detected the disease in samples collected from Narrogin, Piesseville and Pingelly as part of its general crop surveillance program. The geographic spread suggests the disease has likely been present for more than one season.

In eastern Australia, RLL is commonly found in areas with high rainfall, mild weather and high humidity. Epidemiology of the disease is not well understood and no detailed study of the pathogen's life cycle has been done. RLL survives on crop residue and infection will likely arise from spores produced in the infested residue and secondary spread from infected plants. If you suspect you have RLL in your crops, please get in touch with Geoff Thomas via email at geoff.j.thomas@dpird.wa.gov.au or by phone at (08) 9368 3262 or Kylie Chambers at kylie.chambers@dpird.wa.gov.au or by phone (08) 9690 2151.

Early sowing reduces the risk of screenings in milling oats

A screening limit introduced in 2019–2020 for the receival of milling oat in the OAT2 grade has increased delivery risk for milling oat growers in WA. The new limit means grain with more than 15% screenings through a 2.0mm slotted sieve is not deliverable into the bulk handling system.

Research conducted by DPIRD with GRDC support (project DAW1901-002RTX) over two seasons (2019 and 2020) demonstrated that growers of milling oats could reduce screenings risk by sowing earlier. Oats sown in early April had a higher hectolitre weight (up 3kg/hL) and lower screenings (down 9% through a 2.0mm sieve) while yielding 0.65t/ha more than when sown after the first week of May. Grain staining, if present, was below the reportable levels for downgrading and did not influence the risk from earlier sowing in the trials. Early sowing and choosing the best variety reduced screenings more than reducing high rates of applied N. Early April sowing and variety selection are critical to meeting the recently introduced OAT2 delivery standards for milling oats.

Tips for nitrogen fertiliser – grain and hay

Nitrogen strategies differ for grain and hay oats, but high rates of applied N can be detrimental to both grain and hay quality.

If growing oats to deliver milling oat grain, the recommended N strategy is to apply one-third of the total required N fertiliser at seeding and two-thirds at six to ten weeks after seeding. While there is some flexibility around this recommended strategy, applying all N upfront carries the most risk.

The grain quality of Carrolup and Williams is more sensitive to increasing N than Bannister. The risk of high screenings and low hectolitre weight increases as more N is applied to grain crops. The dangers of higher N rates can be offset by sowing in April and planting varieties with high grain plumpness and high hectolitre weight.

If growing oats for hay delivery, the recommended N strategy is to apply two-thirds at seeding and one-third at six to ten weeks after seeding. To maximise quality, late N should be applied before stem elongation.

Research in the National Hay Agronomy (NHA) project, a four-year study supported by AgriFutures (project number PRJ-011029) with trials sites in WA, SA, Vic and NSW found that:

- Nitrogen application results in more biomass and taller and greener plants with an increased risk of lodging (especially in susceptible varieties). Peak hay yield was achieved with 90kg N/ha when averaged across varieties and locations. In some locations, target N was lower due to below-average rainfall during critical periods of the season.
- Nitrogen was not a major driver of hay quality defects such as thick stem diameter, high acid detergent fibre (ADF), high neutral detergent fibre (NDF) and high lignin, but did increase crude protein and decrease WSC.
- Applying more than 90kg N/ha increased the risk of not meeting the industry WSC limit of 22% for premium hay.
- Hay quality traits of varieties responded similarly to increasing N. When seeking high levels of WSC, more N can be applied to varieties with higher genetic levels of WSC before dropping a quality grade, with potentially more hay grown at the same quality grade. For example, more N can be applied to Yallara hay crops than Koorabup hay crops due to their inherent genetic differences in WSC, with Yallara one of the higher WSC varieties evaluated.
- Planting date was not a significant driver of N response when averaged across varieties and locations. While there were differences between planting dates in agronomic traits such as hay yield and hay quality parameters (except hay greenness, ADF and NDF), for most traits the response to N was similar across planting dates, albeit at a different level.
- Across the three years of research (2019–2021), season and variety had a greater influence on hay quality than rate of applied N.

Target plant density

Target plant density for oats depends on end-use (grain or hay) and rainfall zone.

When determining seeding rate, it is essential to consider target plant density (plants per square metre) rather than using a set machinery seeding rate (kg/ha). Using a fixed seeding rate can result in variable plant density across seasons due to variations in seed size (variety and seed source), seed viability and establishment conditions.

A target density of 160 plants/m^2 is appropriate for grain oats in lower rainfall areas, while 240 plants/m^2 is recommended in higher rainfall areas.

For hay oats, a target density of 240 plants/m^2 is appropriate in lower rainfall areas, while 320 plants/m^2 is recommended in higher rainfall areas.

The target density in plants/m^2 determines the seeding rate in kg/ha and is calculated using the following formula:

$$\text{Seed rate (kg/ha)} = \frac{\text{1000 kernel weight (g) x target density (plants/m}^2\text{)}}{\text{germination \% x establishment \% x 100}}$$

For example, if sowing Bannister oats with a kernel weight of 35g per 1000 kernels at a target density of 240 plants/m^2 with a germination of 96% and an expected establishment of 80%, then the seed rate in kg/ha required to establish 240 plants/m^2 is:

$$\text{seed rate in kg/ha} = 109 \text{ kg/ha} = \frac{35 \text{ x } 240}{0.96 \text{ x } 0.80 \text{ x } 100}$$

Lodging management in hay oats

Lodging poses a logistical issue for producers of export fodder, especially in high rainfall environments and when high soil nutrition results in big canopies early in the season. Crop lodging costs hay yield, causes uneven crop ripening, makes it difficult to cut the crop at a consistent height and affects curing time.

One way to reduce lodging in hay crops is to use the gibberellin biosynthesis inhibitor Moddus® Evo (250g/L trinexypac-ethyl), which increases stem strength and reduces plant height while potentially delaying flowering. The label rate for Moddus® Evo use in oats is 300–400mL/ha, with application restricted to Z30–Z32 (beginning of stem elongation). Another option is to graze the paddock before stem elongation.

Spraying a label rate application of Moddus® Evo at stem elongation (Z31–Z32) affected yield of hay oats in a four-year NHA project supported by AgriFutures (project number PRJ-011029). While Moddus® Evo improved straw strength and reduced lodging risk, 400mL/ha of Moddus® Evo also caused a yield decline in some seasons. The yield decline was not associated with any adverse change in hay quality. As the likelihood of lodging cannot be predicted when spraying the crop at the beginning of stem elongation, careful consideration should be given before applying Moddus® Evo at the label rate for export hay.

Research has shown that applying Moddus® Evo at 200mL/ha (below the label rate) is safer for hay oat crops, resulting in less risk of yield loss while improving straw strength and lowering lodging risk. The hay industry should consider applying for a label extension to allow a lower application rate of Moddus® Evo to reduce application cost and risk of yield loss.

Gibberellic acid and stuck panicles in export hay

In dry seasons, with specific varieties and generally in low rainfall environments, oat panicles can be slow to emerge from the leaf sheath, often only partially emerging before the watery ripe growth stage of the top florets. This results in growers either delaying hay cutting until the panicles have fully emerged or cutting at the correct growth stage but enduring a longer curing time. Both these scenarios can result in reduced hay quality due to a decline in WSC, increased fibre due to the later growth stages and increased environmental exposure as the hay cures. By increasing curing time, stuck panicles also increase the risk of saprophytic colonisation.

In the four-year NHA project supported by AgriFutures (project number PRJ-011029), gibberellic acid as ProGibb® SG was evaluated at four locations when sprayed at either stem elongation (Z31–32), flag leaf emergence (Z37–39) or both growth stages. While the gibberellic acid elongated the nodes, it elongated all nodes, not just the peduncle, and resulted in taller plants. While there was no adverse effect of applying gibberellic acid as ProGibb® SG on hay yield or quality, later applications (i.e. after flag leaf emergence) may be required so that the effect is only seen on the peduncle. The risk of stuck panicles is best managed through breeding of varieties capable of peduncle elongation, which in turn allows panicle emergence under most conditions. Further work is required to better understand the best time to apply gibberellic acid and other growth regulators so that only the peduncle is elongated and the risk of stuck panicles is reduced.

Using fungicides to protect hay quality in the swath

Rainfall during windrow curing encourages growth of saprophytic fungi, which usually consist of cosmopolitan fungi such as *Alternaria* spp. and *Cladosporium* spp. that colonise senescing or dead tissue and cause dark discolouration or spots. Curing hay provides an ideal environment for colonisation, especially when it coincides with or follows rainfall. Hay discolouration due to

growth of weather-induced saprophytic fungi is a significant issue for producers of export oaten hay as it reduces visual quality, suitability for export markets and economic returns.

Late-season fungicide options to minimise saprophytic colonisation of curing hay were evaluated by DPIRD and Agriculture Victoria plant pathologists in a NHA project supported by AgriFutures (project number PRJ011029). The research found foliar fungicides should be applied as needed for in-crop disease control and that effective disease control could improve hay quality through retained green leaf area.

While fungicides, specifically strobilurin-based products, can reduce saprophytic fungal growth and improve visual hay quality, exceeding fungicide MRLs is a potential risk, particularly with late-season strobilurin applications. However, oaten hay downgraded from biological damage and saprophyte staining can cost the grower about $150/t.

The NHA project established the weather conditions that favour saprophytic fungi development on windrows. As the research was preliminary, concrete recommendations to industry on the use of strobilurin fungicides could not be provided. The recommendation to date is that fungicides should be applied to manage in-crop disease with any additional saprophyte suppression an off-target bonus rather than the sole purpose of the application. Applying late-season fungicide can reduce the impact of fungal staining on visual quality. Applying fungicides (strobilurin and demethylation inhibitor, DMI based products) can have an off-target effect of reducing saprophytic fungal colonisation of bleached (senescent) leaf material in the windrow. However, these fungicides had no impact on green leaf retention or the nutritional quality of hay post-weathering. Strobilurin chemistries had a greater and more consistent effect on reducing saprophytic growth than DMIs.

Growers applying late-season fungicides to reduce fungal staining on visual quality should apply them well before the withholding period (i.e. 28 rather than 21 days before cutting). Applying fungicides before the withholding period is just as effective at reducing saprophytic growth and provides growers with a wider cutting window while reducing chemical residue levels. Further work is required to provide growers and industry with fungicide and non-fungicide options to reduce or avoid saprophytic fungal growth while maintaining and protecting export markets.

Please note: to avoid exceeding chemical MRLs in hay and jeapordising export hay markets, it is vital that unnecessary fungicide applications are avoided and that label recommendations for rates and withholding periods are followed precisely.

Management of grain staining in grain oats

Fungicide strategies can reduce but not eliminate the risk of grain staining in oats. Variety selection is the key in high-risk environments. DPIRD research found that the level of septoria-stained grain in untreated varieties with partial septoria resistance was lower than highly susceptible varieties with multiple fungicide applications.

Bannister is the most widely sown oat variety in WA for grain due to its yield advantage over Carrolup and its higher grain quality than Williams. However, despite sharing the same septoria resistance rating with Carrolup and Williams, Bannister is more susceptible to septoria grain staining. There is a greater risk of grain staining and subsequent receival downgrading for Bannister in higher rainfall areas than for Carrolup and Williams.

In situations of high disease pressure, such as growing a susceptible variety, oat-on-oat rotations and regions of high rainfall, Consult Ag and DPIRD research suggests that if oat septoria becomes evident at stem elongation (>5% of leaf area affected), a two-spray regime at stem elongation and again at flag emergence will achieve the greatest control and reduce the risk of grain staining at harvest. When disease pressure is lower, or if the disease enters the canopy later in the season, a single application at flag leaf emergence is the best strategy. Rainfall between grain-fill and harvest can also result in grain staining of Bannister but applying late fungicides (applied at Z55–59) is an unreliable control measure.

Harvest timing for grain oats

Harvest timing is critical to maximising oat yield.

To reduce shedding, oats must be harvested as soon as the crop is ripe. Non-dwarf and other varieties likely to shed or lodge should be harvested earlier than varieties less likely to shed or lodge. Grain can be directly harvested at a moisture content above 12% and then placed under aeration or through a grain dryer to reduce harvesting delays. Direct harvesting is the most economical way to harvest oats for grain if the

crop ripens and dries evenly (to less than 12% moisture). If the oat crop has an uneven maturity or the climate does not allow for rapid grain drying, swathing should be considered as it is illegal to desiccate oat crops in Australia for delivery.

DPIRD research in 2019 examined the effect of delayed harvesting on 12 milling oat varieties. Grain yield and quality of all 12 varieties responded similarly to delayed harvest. Delaying harvest by three weeks reduced grain yield by 10%. Delaying harvest by six weeks reduced grain yield by 25%.

Grain – yield and quality

Georgie Troup and Blakely Paynter (DPIRD)

Grain yield

National Variety Trials (NVT) are managed by the Grains Research and Development Corporation (GRDC) to provide a nationally independent means of assessing varietal performance and enable growers to select the best variety for their environment. The results of NVT trials are available as individual site reports or multi-environment (MET) long-term summaries. The MET analysis generates a table of performance values for each variety compared to the mean of the NVT site. Growers and consultants can select the specific state, region, location, or group of locations of their choice to choose the best variety for their environment. Both the single-site and multi-year MET analyses are available at nvtonline.com.au.

Tables 3 to 8 present data extracted from the Long-Term MET Yield Reporter available at nvtonline.com.au. MET data (accuracy ≥0.8 and VAF ≥25%) are presented for each year (2018–2022) for each of the Agzones in WA except Agzone 1 and then combined across Agzones to provide a statewide MET. If there are four or more observations, a five-year weighted average has been calculated from the MET data. Caution should be exercised when examining the weighted average as it masks varietal performance over seasons within an Agzone.

Table 9 uses single-site MET data to highlight the probability of one variety yielding less, the same or more than another variety when grown in the same trial with the same agronomy. Grain yields are compared using the least significant difference (p=0.05) calculated from the single-site MET analysis standard error. Only oat NVT trials where both varieties have been sown and harvested are compared.

It is important to note that the single-site MET analyses only represent varietal performance under one specific set of seasonal and site conditions. Growers should not use the single-site MET analysis as their sole data source when comparing the performance of a new variety.

MET analyses based on the average varietal performance of Agzones can mask variety by environment (GxE) interactions across the locations (and seasons) within the Agzone. For this reason, the relative performance of varieties in each year from 2018 to 2022 helps explain the variability in relative varietal performance across seasons. While Agzones are a simple way to group trials across environments, they may not accurately reflect a specific location in every season.

Differences in comparative grain yield performance between varieties can depend on the yield potential of the site. To help assess relative varietal performance at different site yields, NVT Online (through the Long-Term MET Yield Reporter) presents data at half-tonne yield intervals (called 'yield groups') based on trials that match the yield range. This guide presents an alternative method of viewing yield performance at different site yields using data extracted from the 'Statewide tables of yield and grain quality' available at nvtonline.com.au. Figures 2 and 3 use linear regression to compare varieties at different yield potentials and present varietal trends as the site mean yield increases (the average yield of the varieties compared).

The graphs were developed by calculating differences between the grain yield of a variety relative to the site mean yield (the 'deviation'), with the deviation assessed for quadratic or linear trends. If the quadratic trend is significant ($p<0.05$), a quadratic polynomial has been fitted to the data. If the linear trend (but not the quadratic trend) is significant ($p<0.05$), a linear polynomial has been fitted to the data. If neither the quadratic nor the linear trend is significant, the grain yield response of a variety has been deemed to run parallel to the site mean yield at the average deviation for that variety. It is worth noting that relative performance may differ depending on the years and locations analysed. This highlights the importance of examining more than one dataset and comparing the performance of new varieties over at least three seasons.

Table 3. Grain yield of oat varieties in AGZONE 2 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		4.38	2.90	2.82	4.01	4.21	3.63
Variety	(No. trials)	(3)	(4)	(4)	(4)	(4)	(19)
Deliverable as OAT1							
Bannister	(19)	110	103	101	106	105	**105**
Bilby	(19)	100	102	104	103	102	**102**
Carrolup	(19)	84	93	84	84	85	**86**
Kojonup	(19)	89	84	85	101	100	**92**
Kowari	(19)	94	99	102	98	98	**98**
Mitika	(11)	90	97	97	-	-	**95**
Williams	(19)	107	105	96	100	99	**101**
Yallara	(19)	89	98	88	80	82	**87**
Deliverable as OAT2							
Durack	(19)	83	96	94	84	85	**89**
Wandering	(19)	108	105	101	105	104	**104**
Not yet evaluated for milling							
13008-18	(8)	-	-	-	110	109	**111**
Koala	(19)	112	97	93	106	107	**103**

Source: based on MET analysis from NVT Online, nvtonline.com.au

Table 4. Grain yield of oat varieties in AGZONE 3 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		4.27	3.41	3.07	4.55	4.92	4.12
Variety	(No. trials)	(2)	(2)	(2)	(2)	(3)	(11)
Deliverable as OAT1							
Bannister	(11)	108	111	105	104	110	**108**
Bilby	(11)	102	97	101	102	100	**100**
Carrolup	(11)	91	95	84	87	92	**90**
Kojonup	(11)	101	110	88	97	106	**101**
Kowari	(11)	96	92	97	99	94	**95**
Mitika	(6)	94	91	94	-	-	**93**
Williams	(11)	107	109	100	99	109	**105**
Yallara	(11)	86	92	90	86	87	**88**
Deliverable as OAT2							
Durack	(11)	85	83	89	89	83	**86**
Wandering	(11)	109	108	102	103	110	**107**
Not yet evaluated for milling							
13008-18	(5)	-	-	-	108	108	**108**
Koala	(11)	109	122	105	104	115	**111**

Source: based on MET analysis from NVT Online, nvtonline.com.au

Table 5. Grain yield of oat varieties in AGZONE 4 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		2.11	1.11	1.30	3.63	4.62	2.55
Variety	(No. trials)	(1)	(1)	(1)	(1)	(1)	(5)
Deliverable as OAT1							
Bannister	(5)	105	106	83	107	109	**102**
Bilby	(5)	105	102	123	97	105	**106**
Carrolup	(5)	90	96	69	82	74	**82**
Kojonup	(5)	83	73	56	91	103	**81**
Kowari	(5)	99	97	123	94	98	**102**
Mitika	(3)	96	96	110	-	-	**97**
Williams	(5)	109	117	80	97	97	**100**
Yallara	(5)	89	104	62	94	66	**83**
Deliverable as OAT2							
Durack	(5)	90	96	105	87	75	**91**
Wandering	(5)	111	113	101	98	107	**106**
Not yet evaluated for milling							
13008-18	(2)	-	-	-	108	115	**-**
Koala	(5)	95	96	35	114	110	**90**

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

Table 6. Grain yield of oat varieties in AGZONE 5 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		3.08	1.81	2.16	2.48	4.49	2.77
Variety	(No. trials)	(1)	(2)	(2)	(2)	(2)	(9)
Deliverable as OAT1							
Bannister	(9)	108	99	108	108	107	**106**
Bilby	(9)	101	103	103	99	102	**102**
Carrolup	(9)	91	89	86	90	88	**89**
Kojonup	(9)	90	78	92	98	104	**93**
Kowari	(9)	96	102	97	94	97	**97**
Mitika	(5)	93	99	93	-	-	**94**
Williams	(9)	109	98	106	104	103	**103**
Yallara	(9)	93	97	86	93	82	**90**
Deliverable as OAT2							
Durack	(9)	88	100	85	87	84	**89**
Wandering	(9)	109	100	109	104	107	**105**
Not yet evaluated for milling							
13008-18	(4)	-	-	-	107	109	**110**
Koala	(9)	107	89	106	114	109	**105**

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

Table 7. Grain yield of oat varieties in AGZONE 6 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		4.82	4.52	3.63	4.91	5.42	4.66
Variety	(No. trials)	(1)	(1)	(1)	(1)	(1)	(5)
Deliverable as OAT1							
Bannister	(5)	117	109	115	107	109	**111**
Bilby	(5)	95	102	105	102	100	**101**
Carrolup	(5)	92	91	85	84	88	**88**
Kojonup	(5)	112	107	118	110	107	**111**
Kowari	(5)	87	96	94	97	95	**94**
Mitika	(3)	86	93	88	-	-	**90**
Williams	(5)	114	106	111	98	104	**107**
Yallara	(5)	91	83	64	76	83	**79**
Deliverable as OAT2							
Durack	(5)	76	83	68	81	81	**78**
Wandering	(5)	111	109	119	105	107	**110**
Not yet evaluated for milling							
13008-18	(2)	-	-	-	107	108	**-**
Koala	(5)	135	112	120	112	116	**119**

Source: based on MET analysis from NVT Online, nvtonline.com.au

Table 8. Grain yield of oat varieties averaged across AGZONES 2–6 expressed as a percentage of the site mean yield for each trial year (2018–2022) and the weighted average over the five-year period (where there are four or more observations)

Year		2018	2019	2020	2021	2022	2018–2022
Site mean yield (t/ha)		3.96	2.77	2.67	3.87	4.60	3.58
Variety	(No. trials)	(8)	(10)	(10)	(10)	(11)	(49)
Deliverable as OAT1							
Bannister	(49)	110	106	104	106	108	**107**
Bilby	(49)	100	101	104	102	102	**102**
Carrolup	(49)	88	93	84	85	87	**87**
Kojonup	(49)	96	93	90	100	104	**97**
Kowari	(49)	94	97	100	97	96	**97**
Mitika	(28)	91	95	95	-	-	**94**
Williams	(49)	108	106	100	100	103	**103**
Yallara	(49)	89	94	84	84	82	**86**
Deliverable as OAT2							
Durack	(49)	83	91	88	86	83	**86**
Wandering	(49)	109	106	105	104	107	**106**
Not yet evaluated for milling							
13008-18	(21)	-	-	-	108	109	**110**
Koala	(49)	113	105	98	108	111	**107**

Source: based on MET analysis from NVT Online, nvtonline.com.au

Table 9. Direct comparisons between two varieties (yield difference compared using least significant difference, p=0.05, calculated using standard errors from single-site MET) – how many times (as a per cent) was variety A (comparator variety) lower-yielding, the same yield or higher-yielding than variety B (base variety) when sown together in WA oat NVT?

Variety A	Percentage of trials			Number of trials	Comparison years	Comparison
	Variety A is lower yielding than Variety B	Variety A and B yield the same	Variety A is higher yielding than Variety B			
Variety B: Bannister						
13008-18	14%	59%	27%	22	2021–2022	13008-18 = Bannister
Bilby	46%	40%	14%	50	2018–2022	Bilby ≤ Bannister
Carrolup	94%	6%	0%	50	2018–2022	Carrolup < Bannister
Durack	90%	4%	6%	50	2018–2022	Durack < Bannister
Koala	30%	44%	26%	50	2018–2022	Koala = Bannister
Kojonup	60%	38%	2%	50	2018–2022	Kojonup ≤ Bannister
Kowari	70%	22%	8%	50	2018–2022	Kowari < Bannister
Mitika	75%	18%	7%	28	2018–2020	Mitika < Bannister
Wandering	12%	80%	8%	50	2018–2022	Wandering = Bannister
Williams	32%	60%	8%	50	2018–2022	Williams = Bannister
Yallara	88%	8%	4%	50	2018–2022	Yallara < Bannister
Variety B: Carrolup						
13008-18	0%	9%	91%	22	2021–2022	13008-18 > Carrolup
Bannister	0%	6%	94%	50	2018–2022	Bannister > Carrolup
Bilby	2%	16%	82%	50	2018–2022	Bilby > Carrolup
Durack	28%	44%	28%	50	2018–2022	Durack = Carrolup
Koala	6%	16%	78%	50	2018–2022	Koala > Carrolup
Kojonup	18%	22%	60%	50	2018–2022	Kojonup ≥ Carrolup
Kowari	8%	18%	74%	50	2018–2022	Kowari > Carrolup
Mitika	11%	36%	54%	28	2018–2020	Mitika ≥ Carrolup
Wandering	0%	6%	94%	50	2018–2022	Wandering > Carrolup
Williams	0%	8%	92%	50	2018–2022	Williams > Carrolup
Yallara	26%	52%	22%	50	2018–2022	Yallara = Carrolup

Source: based on single-site MET data from NVT Online, **nvtonline.com.au**

The highest yielding oat varieties sown in WA oat NVT are Bannister, Koala, Wandering and Williams, with the advanced breeding line 13008-18 also one of the highest performers in those Agzones where MET data was available (Tables 3 to 8). However, Wandering cannot be delivered into the OAT1 grade and Koala is not yet accredited as a milling oat variety nor deliverable into the Bunge or CBH bulk handling system. Bannister and Williams have an advantage over Wandering above 3.5t/ha, while Wandering has an advantage below 1.5t/ha (data not shown). Since 2017, Bannister has outperformed Williams in environments above 3t/ha but performed the same in environments below 3t/ha (Figure 2).

Carrolup (Figures 2–3), Durack (data not shown) and Yallara (Figures 2–3) are inferior to Bannister, Wandering and Williams at most levels of yield potential. However, Durack (data not shown) becomes competitive with Bannister and Williams in environments with a yield potential below 1.5t/ha, particularly with a June sowing. Bilby is as good or better than Bannister below 2t/ha but inferior above 3t/ha and has matched Williams since 2018 (Figure 2).

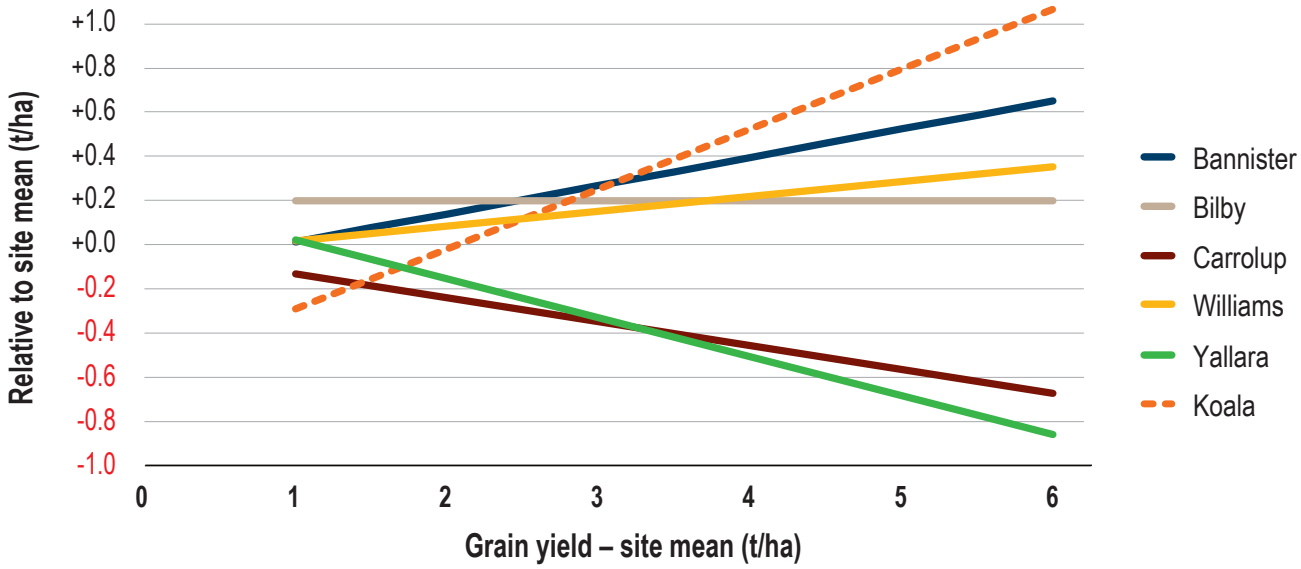

Figure 2. Fitted grain yield of Bannister, Bilby, Carrolup, Koala, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2017–2022). Each variety sown in all 62 trial-years of data, NVT Online nvtonline.com.au

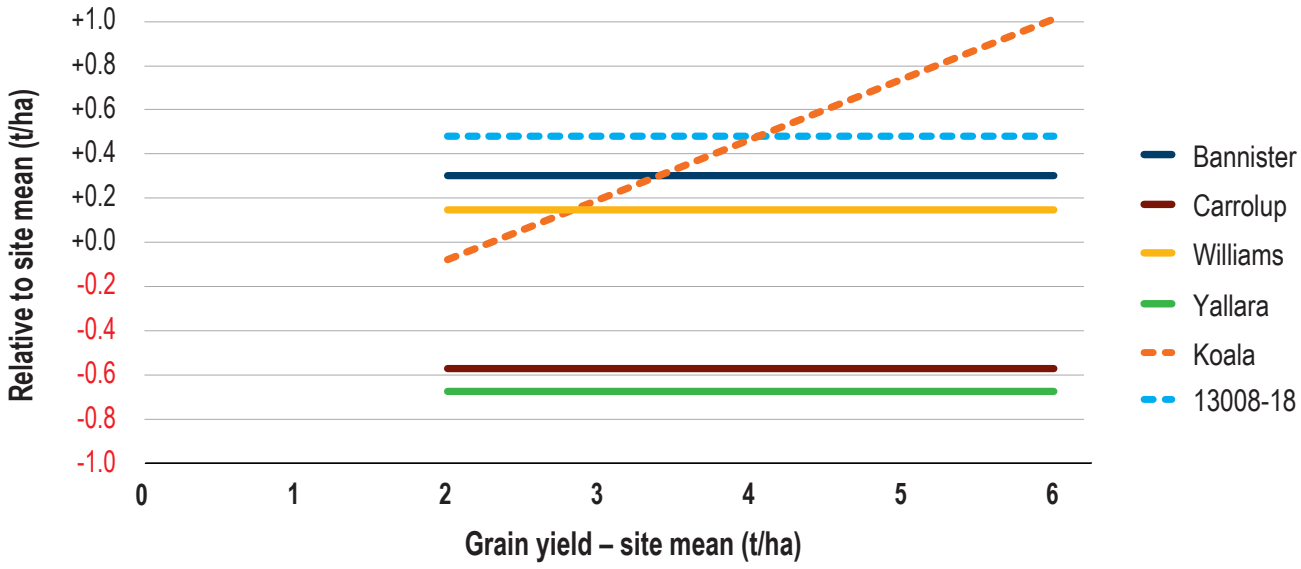

Figure 3. Fitted grain yield of 13008-18, Bannister, Carrolup, Koala, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2021–2022). Each variety sown in all 22 trial-years of data, NVT Online nvtonline.com.au

Grain quality

Grain quality is an essential trait of milling oat varieties. In Figures 4 to 7 physical grain quality (hectolitre weight and screenings through a 2.0mm slotted sieve) of popular milling oat varieties has been plotted relative to the site mean. The deviation from the site mean has then been assessed for quadratic and linear trends. If neither the quadratic nor the linear trend is significant, the grain quality response of a variety has been deemed to run parallel to the site mean quality at the average deviation for that variety. Data for this analysis was extracted from the NVT' Statewide yield and grain quality' tables available at nvtonline.com.au.

None of the current milling oat varieties combine a high hectolitre weight with high grain plumpness (low screenings). The closest is Yallara, but this variety is not competitive with Bannister for grain yield (Figure 2). In WA oat NVT, the yield of Yallara was below Bannister in 88% of trials (Table 9).

Carrolup is the benchmark variety for hectolitre weight among milling oat varieties, followed by Durack (not shown) and Yallara (Figure 4 and 5). Hectolitre weight is a receival weakness of Bannister, Wandering and Williams, although Bannister is slightly better than Williams (Figures 4 and 5). Like Bannister, Bilby has inferior hectolitre

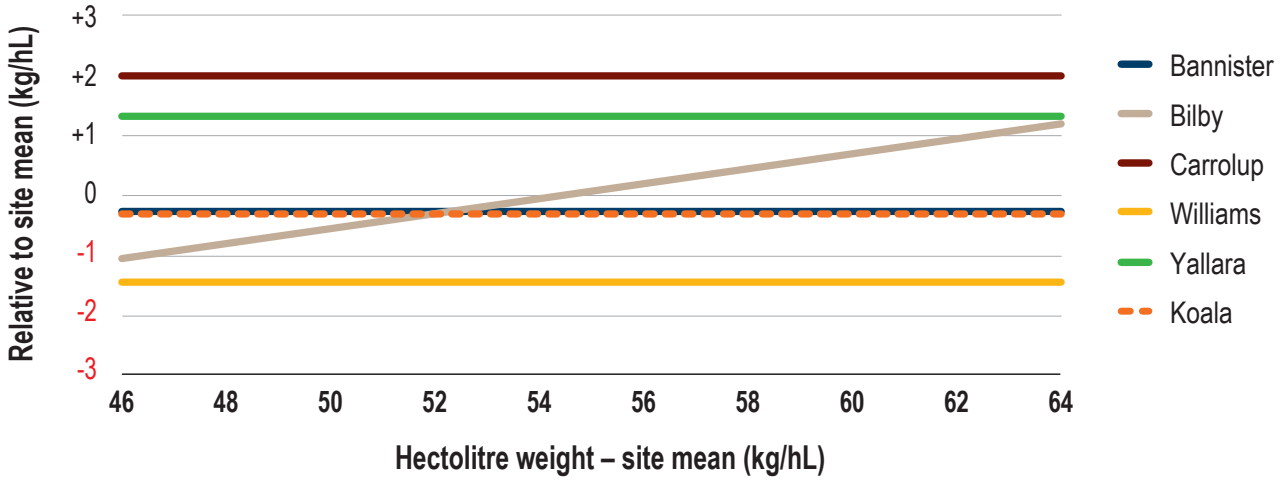

Figure 4. Fitted hectolitre weight of Bannister, Bilby, Carrolup, Koala, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2017–2022). Each variety sown in all 62 trial-years of data, NVT Online nvtonline.com.au

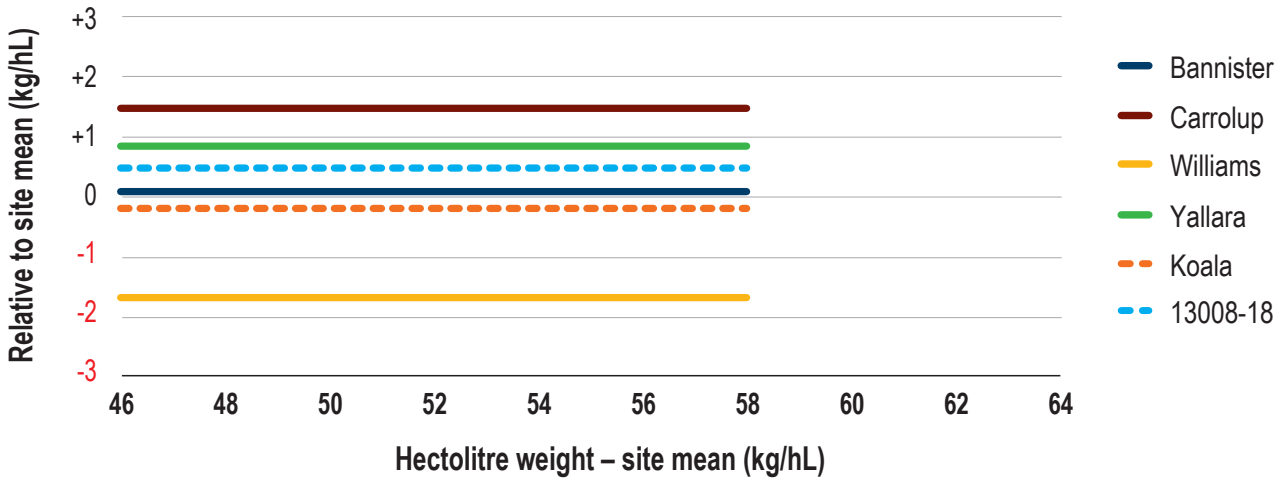

Figure 5. Fitted hectolitre weight of 13008-18, Bannister, Carrolup, Koala, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2021–2021). Each variety sown in all 22 trial-years of data, NVT Online nvtonline.com.au

weight relative to Carrolup (Figures 4 and 5). The hectolitre weight of Koala is the same as Bannister and a general improvement over Williams. The hectolitre weight of 13008-18 appears to be a slight improvement over Bannister.

The benchmark varieties for grain plumpness are Kowari (data not shown), Mitika (data not shown) and possibly Yallara (Figures 6 and 7). Grain plumpness is a weakness of Carrolup and Williams, with these two varieties having the lowest grain plumpness (highest screenings) and the greatest risk of not meeting the receival standards of current milling varieties. Bannister is an improvement over Williams but is not as plump as Kowari (data not shown), Mitika (data not shown) or Yallara. Koala has grain plumpness like Bannister and is an improvement over Williams. Bilby, Durack and Wandering have a slight plumpness advantage over Bannister and an advantage over Williams (data not shown). 13008-18 has superior grain plumpness to Bannister and may be a general improvement over Yallara, one of the plumper milling varieties.

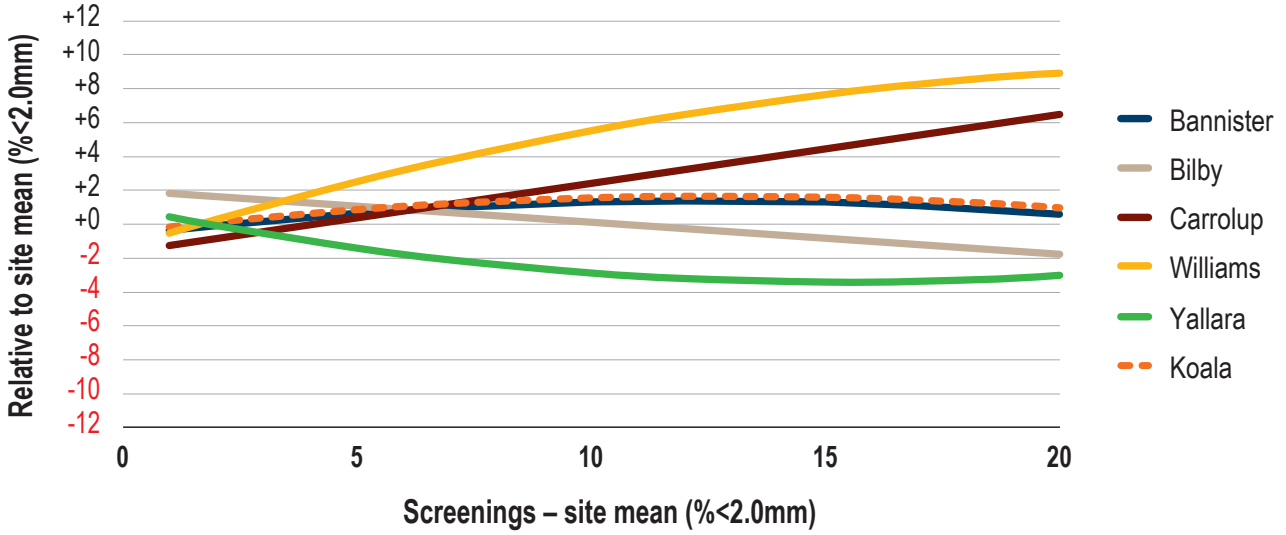

Figure 6. Fitted grain plumpness of Bannister, Bilby, Carrolup, Koala, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2017–2022). Each variety sown in all 59 trial-years of data, NVT Online nvtonline.com.au

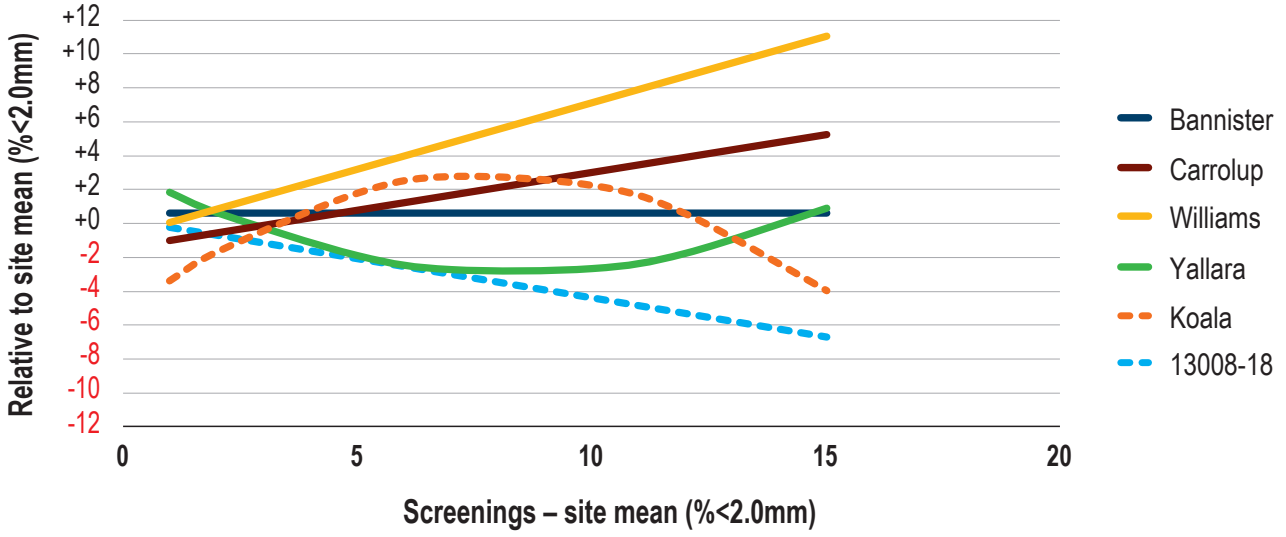

Figure 7. Fitted grain plumpness of 13008-18, Bannister, Carrolup, Koala, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2021–2022). Each variety sown in all 22 trial-years of data, NVT Online nvtonline.com.au

Hay – yield and quality

Georgie Troup, Blakely Paynter and Bronte Wackett (DPIRD)

Variety performance in breeder hay variety trials

Breeder hay variety trials are conducted nationally, with several sites in WA annually. Table 10 compares hay yield and quality of dual-purpose and hay-only varieties from the WA sites. Quality measures present in Table 10, as predicted by near-infrared analysis (NIR), include digestibility, crude protein (CP), water-soluble carbohydrates (WSC), acid detergent fibre (ADF) and neutral detergent fibre (NDF).

The difference in hay yield between varieties was 1t/ha, with Brusher at the higher end and Koorabup and Winjardie at the lower end of the hay yield range (Table 10). In datasets tabulated by the NOBP and included in previous sowing guides, Forester achieved good hay quality however it is not widely sown in WA due to its very late maturity, and there is no data available in the current dataset. Of the varieties listed in Table 10 with hay yield and quality data, Wallaby has the best overall hay quality (high digestibility, high WSC, low fibre and moderate rates of rumen digestibility), and Koorabup has the poorest quality (low digestibility, low WSC, higher fibre levels and moderate rumen digestibility).

Table 10. Average hay yield and quality (predicted by NIR) in NOBP and InterGrain trials in WA from 2017 to 2022

Variety	Hay yield (t/ha)	Digestibility (% dm)	WSC (% dm)	ADF (% dm)	NDF (% dm)	CP (% dm)
(No. trials)	(46)	(46)	(46)	(46)	(46)	(46)
Deliverable as OAT1						
Bannister	10.4	65.5	26.8	32.5	52.6	5.9
Bilby	-	-	-	-	-	-
Carrolup	10.3	63.2	27.1	33.3	52.2	5.9
Kojonup	-	-	-	-	-	-
Kowari	-	-	-	-	-	-
Mitika	-	-	-	-	-	-
Williams	-	-	-	-	-	-
Yallara	10.6	63.2	26.9	32.9	51.6	5.8
Deliverable as OAT2						
Durack	10.5	62.7	25.9	33.2	52.1	5.7
Wandering	-	-	-	-	-	-
Not yet evaluated for milling						
13008-18	-	-	-	-	-	-
Koala	-	-	-	-	-	-
Hay-only variety						
Archer	10.8	63.3	25.4	33.1	52.4	6.1
Brusher	11.1	64.5	26.9	32.9	52.1	6.0
Kingbale	10.8	63.5	27.0	34.5	52.8	5.6
Koorabup	10.1	63.3	26.5	33.9	52.7	5.8
Kultarr	10.8	63.7	26.5	33.6	52.4	5.6
Mulgara	10.6	64.7	27.6	33.3	52.4	5.7
Wallaby	10.7	66.0	28.5	32.6	52.5	5.7
Winjardie	10.1	63.3	25.9	33.2	52.5	5.8
Wintaroo	10.7	63.3	26.7	34.8	52.8	5.7

Source: InterGrain

CP = crude protein, WSC = water soluble carbohydrates, ADF = acid detergent fibre, NDF = neutral detergent fibre. No score '-' = no rating is currently available.

Bannister was the best of the dual-purpose hay varieties, with improved digestibility, moderate levels of WSC, moderate fibre levels and higher rumen digestibility than Carrolup, Durack and Yallara. The susceptibility of Bannister to oat septoria may affect the visual grading of its hay more than other dual-purpose varieties, where the disease in not adequately controlled. Of the dual-purpose varieties, Carrolup, Williams and Yallara are the preferred varieties for export hay.

Hay quality trait performance

The following comments relate to hay quality traits in the breeder hay variety trials (Table 10):

- **Digestibility** – Bannister and Wallaby were more digestible than other varieties tested.
- **Crude protein** – little difference was noted between varieties, with the range only 0.5%. Archer and Brusher were at the higher end, with Kingbale and Kultarr at the lower end of the range.
- **Water soluble carbohydrates** – Brusher, Carrolup, Mulgara, Wallaby and Yallara had higher WSC.
- **Acid detergent fibre** – Bannister, Brusher, Wallaby and Yallara had lower ADF levels.
- **Neutral detergent fibre** – Yallara had the lowest NDF.

Variety performance in NHA agronomy trials

NHA research supported by AgriFutures (project number PRJ-011029) assessed hay yield and quality of four dual-purpose (Carrolup, Durack, Williams and Yallara) and four hay-only varieties (Brusher, Koorabup, Mulgara and Wintaroo) over three consecutive years in WA, SA, Vic and NSW. The varieties were assessed at two seeding dates, typically three to four weeks apart. Data were averaged over three rates of applied N due to the lack of a variety by N interaction for the twelve datasets.

The NHA hay yields ranged from 2 to 18t/ha, with 50% of the hay cuts yielding between 4.5 to 10.5t/ha. The difference in mean hay yield between the highest (Wintaroo) and lowest (Durack) yielding varieties averaged over sowing dates was 0.7t/ha, which was similar to the range observed in the breeder hay trials (Table 10).

Brusher and Wintaroo were the leading varieties for hay yield at the first sowing date, while Wintaroo had the highest yield of the second sowing date. Varietal differences (lowest to highest) at the first sowing date were 1.0t/ha and 0.6t/ha at the second sowing date. Brusher lost the most yield with delayed sowing (1.8t/ha), while Carrolup and Durack were the least affected with only a 1.0t/ha reduction in yield.

Brusher and Wintaroo had the poorest overall straw strength, followed by Mulgara. Varieties differed in stem diameter, with Carrolup, Durack and Koorabup averaging 0.5mm narrower stems than Mulgara, Williams and Wintaroo. Mulgara, Williams and Wintaroo were the most likely to produce hay with a stem diameter wider than 6mm, the upper limit for premium hay.

Brusher was more variable in its hay greenness than the other seven varieties as measured by a Soil Plant Analysis Development (SPAD) chlorophyll meter. Durack hay was the greenest, averaging 5 SPAD units darker than Carrolup, Mulgara and Wintaroo, which were the lightest green. Williams varied the least in the greenness of all the varieties.

The following comments relate to hay quality traits of varieties in the NHA trials (data not shown):

- **Digestibility** – Brusher, Mulgara and Yallara were more digestible than Durack.
- **Crude protein** – Williams had the highest CP and Wintaroo the lowest.
- **Water soluble carbohydrates** – Yallara had the highest WSC and Koorabup and Williams the lowest.
- **Acid detergent fibre** – Koorabup and Wintaroo had the highest average ADF, with Brusher and Yallara the lowest.
- **Neutral detergent fibre** – Koorabup and Wintaroo had the highest average NDF and Yallara had the lowest.
- **NDFDom30** – Brusher, Mulgara and Yallara hay had higher levels of rumen digestibility after 30 hours than Carrolup and Durack hay.

Of the eight varieties evaluated, Yallara had the best overall hay quality nationally, with the highest WSC and lowest fibre levels (ADF and NDF) combined with thin stems (data not shown). Yallara hay yield was comparable to the specialist hay varieties Brusher and Wintaroo, with a lower lodging risk and similar hay colour.

The new hay variety Koorabup was uninspiring with hay yield 0.5t/ha behind Brusher, a higher ADF and NDF risk, lower WSC and a similar hay greenness and stem diameter. These poor results for Koorabup in NHA trials mimic the observations of this variety in the breeder hay trials (Table 10). Koorabup was the only variety that did not store WSC when sown early compared to late.

While the hay variety Mulgara yielded 0.5t/ha more than Carrolup, it had lower WSC and thicker stems. Hay colour and fibre (ADF, NDF and lignin) were similar.

Variety response to sowing date varied and was not easily predicted before the season or when the crop was planted. While earlier sowing increased the opportunity to maximise hay yield, it did not do so consistently. Further evaluation of variety responses to seeding date is warranted, especially with the suite of new oaten hay options currently being evaluated by the industry and the breeding company InterGrain.

General comments on hay quality

Before growing oats for export hay, arranging a contract with an exporter is essential. Cutting at or just before watery ripe (Z71) will achieve optimum yield and quality. Cutting the crop before Z71 can maximise hay quality if the panicles are not stuck in the boot. However, there is a window of five to seven days after Z71 before hay quality falls. This window provides room to cut hay on time. Rainfall events of 10mm or more post-cutting can drastically reduce quality.

Good colour, aroma, sweet taste and fine texture are essential to export hay buyers. Hay processing companies in WA also grade based on nutritional value. Number of grades (and even grading systems) differ between hay processors. Some companies have five grades, others have four and some grade hay based on a 100-point system. Unlike grain, there is no common standard on which hay is received. Hay should have a maximum bale moisture of 14% at delivery to ensure that it does not degrade or spoil during storage. Some export standards are as low as 12% moisture. High moisture hay (>18%) is at risk of self-combustion during storage and spoilage from mould.

Typical quality standards to meet WA export hay requirements are outlined in Table 11. Premium Grade-1 hay will generally have more than 4% crude protein, be more than 60% digestible with WSC above 22%, ADF less than 32%, NDF below 55% and a stem thickness below 6mm. Most processors have a limit of 1% by weight of broadleaf plants and 5% of other cereals/ryegrass/wild oats. Zero-tolerance exists for the presence of toxic plants, doublegee and foreign material such as dirt, stones, sticks, insects, wool, wire and carcases.

Most processors allow a maximum of 10% disease-affected leaves. Check withholding periods on labels of all fungicides before use and do not apply fungicide if the likely cutting date is within the withholding period. For best control, plant disease-resistant varieties. Export markets expect a clean and green product from Australia and are checking for breaches of MRLs for a range of herbicide, insecticide and fungicide products. Growers should follow label registrations for any product applied.

Livestock deaths caused by annual ryegrass toxicity poisoning from Australian hay or straw exports into an importing country could devastate the Australian hay and straw export industry. All export hay must be sampled and tested for the bacterium (*Rathayibacter toxicus*), the cause of annual ryegrass toxicity. If contamination by this bacterium is a potential problem, it is important to implement an annual ryegrass toxicity management program.

Table 11. Quality standards to meet export hay requirements

Parameter	Grade 1	Grade 2	Grade 3	Grade 4
Crude protein (% dm)	4–10	<4	<4	<4
Est. metabolisable energy (MJ/kg DM)	>9.5	<9.5	<9.5	<9.5
In-vitro digestibility (% dm)	>60	>58	>56	>53
Water soluble carbohydrates (% dm)	>22	>18	>14	>14
Acid detergent fibre (% dm)	<30–32	>32–35	>35–37	>37–40
Neutral detergent fibre (% dm)	≤55	≤55–59	≤57–60	≤60–64
Stem thickness (mm)	<6	<8	<9	>9

Source: DPIRD

Disease and pest resistance

Manisha Shankar, Kylie Chambers, Geoff Thomas, Blakely Paynter, Carla Wilkinson and Daniel Huberli (DPIRD)

Foliar disease abbreviations:

- **BB** = bacterial blight
- **OCR** = oat crown (leaf) rust.
- **OSR** = oat stem rust.
- **RLL** = red leather leaf.

Disease resistance abbreviations:

- **VS** = very susceptible.
- **SVS** = susceptible to very susceptible.
- **S** = susceptible.
- **MSS** = moderately susceptible to susceptible.
- **MS** = moderately susceptible.
- **MRMS** = moderately resistant to moderately susceptible.
- **MR** = moderately resistant.
- **RMR** = resistant to moderately resistant.
- **R** = resistant.
- *p* = provisional rating.

Refer to page 4 for interpreting resistance classification.

Adult resistance

Information about disease and virus resistance of oat and hay varieties are presented in Tables 12 and 13 and the variety snapshots. Leaf disease ratings in this guide are for the adult-stage. While adult-stage ratings are applicable after flag leaf emergence, they can be relevant as early as late tillering to stem elongation in some varieties and for some diseases. DPIRD is now screening oat varieties under contract for NVT. The foliar resistance data for milling oat varieties in Table 12 is from disease screening trials in WA. Koorabup was the only hay variety screened by DPIRD in 2020 and 2021; limited data is available for the other hay-only varieties. In 2021, DPIRD began screening several hay-only varieties for NVT, including Brusher, Kingbale, Mulgara, Tungoo and Wintaroo. Some of the data presented has been sourced from InterGrain.

Variety disease ratings vary over time due to seasonal changes in disease pressure, regional disease spread, climatic conditions, stubble retention and the development of new pathotypes/races. As a result, minor changes in resistance scores of varieties can occur between sowing guides. In this 2024 guide, there have been no significant changes in resistance scores due to a new pathotype.

Pathotype surveillance and fungicide resistance

Any oat varieties rated as MRMS, MR or R carrying significantly higher levels of disease than expected should be sent for pathotype identification and fungicide resistance testing. Collect leaf samples before spraying the crop with a fungicide to ensure sample viability.

Place infected septoria, oat crown (leaf) rust (OCR) and oat stem rust (OSR) in paper envelopes marked with the location, variety, disease and date collected. Fold the leaf in half so the infected area is on the inside. Please do not wrap leaf material in plastic or send it in plastic-lined envelopes.

Send septoria-infected leaf material in paper envelopes to DPIRD, Locked Bag 4, Bentley Delivery Centre WA 6983 and marked attention, Manisha Shankar. For more information, contact Manisha Shankar via email at manisha.shankar@dpird.wa.gov.au or by phone (08) 9368 3533.

Send OCR and OSR samples in paper envelopes directly to the University of Sydney, Australian Rust Survey, Reply Paid 88076 Narellan NSW 2567. For more information on sample collection and submission, contact Matthew Williams (ACRCP Operations and Technical Officer) via email at matthew.williams@sydney.edu.au or by phone (02) 9351 8808.

Samples suspected of infection with RLL can be sent to DPIRD Diagnostic Laboratory Services (DDLS) to be included in the DPIRD surveillance project supported by GRDC (project number DAW2104-003RTX). For more information about plant disease testing, sample submission forms and sampling techniques, contact DDLS via email at DDLS@dpird.wa.gov.au or by phone at (08) 9368 3533.

Oat Septoria

Septoria (*Phaeosphaeria avenaria* f.sp. *avenaria* (asexual stage: *Stagonospora* (formerly *septoria*) *avenae* f.sp. *avenaria*), also known as *Septoria avenae* blotch, is the most common oat disease in WA. Oat septoria was found in 90% of paddocks surveyed through the AgriFutures-supported NHA project (project number PRJ-011029) and GRDC disease surveillance projects (project numbers DAW1907-002RTX and DAW2104-003RTX). The disease severity of oat septoria was generally low, with the percentage of leaf area affected under 10%. Oat septoria does not infect wheat and wheat septoria does not infect oats.

Septoria occurs throughout the cereal growing areas and is most severe in the high rainfall areas. It begins as small dark brown-to-purple, oval or elongated spots on leaves. Spots grow into larger light or dark-brown blotches with a lighter yellow/brown border that can cover and kill the entire leaf. Dark-brown blotches can also occur on the panicle. Infection can spread to leaf sheaths and through these to stems, where greyish-brown or shiny black lesions can cause lodging. In some varieties, the fungus can sometimes cause a dark discolouration of the grain when unseasonably late rain occurs.

In extreme cases, septoria can cause up to 20% grain yield loss and crop lodging but losses of about 10% are more common in high rainfall areas. The disease can also affect grain quality by reducing grain weight and increasing screenings. Tall or slow-maturing oats are less likely to be affected by the disease than short (dwarf) or fast-maturing varieties. Septoria can also reduce hay yield, quality and appearance and is a significant constraint to hay production.

Most oat varieties are rated as MSS or below to septoria. Mitika and Winjardie are particularly susceptible and rated as SVS. No milling variety has acceptable resistance to oat septoria, while the hay-only varieties Koorabup (MRMS) and Tungoo (MRMS) have good resistance.

Oat crown (leaf) rust (OCR)

Oat crown rust (OCR, *Puccinia coronata* var. *avenae*), also known as leaf rust, appears on leaves as small, circular-to-oval pustules containing orange to yellow powdery spores. The word ‘crown’ refers to the shape of spores produced by the fungus, not the disease symptoms. Pustules are found predominantly on the leaf tissue, but pustules can also occur on stems and panicles under heavy infection. As the crop matures, the pustules darken and produce black spores embedded in leaf tissue. The spore masses in the pustules are readily dislodged. Leaf rust develops most rapidly at 15–22°C under moist conditions. OCR does not infect wheat and wheat leaf rust does not infect oats.

OCR can cause losses of up to 50% in forage, hay and grain yield. It can also reduce forage and hay quality (both physical and nutritional) and palatability. OCR can also reduce grain quality, impacting grain weight and screenings.

Most milling oat varieties have good resistance to OCR except Carrolup (VS), Kojonup (SVS) and Wandering (VS). Winjardie (SVS), Kingbale (S) and Wintaroo (S) have the weakest resistance of the hay-only varieties.

Oat stem rust (OSR)

Oat stem rust (OSR, *Puccinia graminis* f.sp. *avenae*) is a fungal foliar disease of oats. It appears as elongated pustules containing reddish-brown powdery spores, mainly on stems and potentially on the leaves and head in heavy infections. Spore masses in the pustules can dislodge readily. Stem rust development and spread are favoured by warm (18–30°C) humid conditions and an epidemic is more likely if the spring is suitably wet. The latent period (the approximate time taken for an infection to result in new spores) of OSR is 7–10 days under these optimal temperature conditions. Disease severity can increase extremely rapidly once a crop is uniformly infected. OSR does not infect wheat and wheat stem rust does not infect oats.

OSR can cause up to 90% yield loss and reduce grain quality in susceptible varieties. It also reduces hay yield, quality and appearance. Widespread outbreaks are rare but very damaging. Regional outbreaks are more common, causing losses over limited areas.

Milling oat and most hay-only varieties are rated as MS or below to OSR, with Bilby, Durack and Wandering the most sensitive (SVS). The unclassified variety Koala has good resistance to OSR being rated as MRMS, while the hay-only variety Mulgara is rated as MR.

Red leather leaf (RLL)

Red leather leaf (RLL, *Neospermospora avenae*) typically occurs during the tillering stages and first appears as small light (grey-pale blue) coloured lesions with a red/red-brown edge. During the stem elongation to head emergence stages, symptoms appear as red, irregular-shaped lesions spread across leaves. Later in the season, affected leaves take on a 'leathery' appearance, turning red, brown and maybe slightly rolled.

RLL was first detected in WA oat crops in 2021, although it has likely been present for more than one season. The impact of RLL on the yield and quality of hay and grain in WA is currently unknown. In the eastern states, RLL has caused at least 10% yield loss in hay and grain in susceptible varieties in favourable seasons.

How and where this disease will impact WA oat production is speculative. However, it is most likely to be a concern for oat growers in the cooler high-medium rainfall zones of the Great Southern region, where oats are more common and seasonal conditions, particularly in winter, are more favourable.

If you suspect you have RLL in your crops, please get in touch with Geoff Thomas via email at geoff.j.thomas@dpird.wa.gov.au or by phone at (08) 9368 3262 or Kylie Chambers at kylie.chambers@dpird.wa.gov.au or by phone (08) 9690 2151.

Crown rot

Crown rot (*Fusarium pseudograminearum*) is a fungal, stubble-borne disease most common in continuous cereal rotations. It affects the sub-crown internode, crown and lower stems and is not usually noticed until after heading when whiteheads are visible in wheat and sometimes barley. The browning at the base of infected tillers is the most reliable indicator of crown rot in oats. Whiteheads are not observed in oats.

Varietal resistance and tolerance to crown rot are limited. Seed dressings are registered to suppress crown rot. However, no fungicide options exist to control crown rot once the crop has been established. Inoculum levels can be reduced by including non-cereals in the rotation (such as pulses, oilseed, lupin and grass-free pasture). Inter-row seeding and maintaining reasonable grass weed control in break crops and between crops are also effective measures.

Research in WA suggests that oats are more resistant to crown rot than wheat and barley. Research at Merredin and Wongan Hills has demonstrated that high levels of crown rot can cause average yield losses of 19% in wheat and 18% in barley. Trials with milling oats observed an average yield loss to crown rot of 4%. No differences in tolerance were observed among the oat varieties evaluated.

Bacterial blight (BB)

In the AgriFutures-supported NHA project (project number PRJ-011029), BB was present in 41% of paddocks surveyed over the three years, generally at low severity. BB development is moisture driven. Periods of low rainfall or reduced canopy humidity limit disease impact, while increased temperature and reduced humidity in spring lessen disease development in the upper canopy. The dominance of BB-susceptible variety Bannister and the general practice of sowing oats over oats increases the risk of BB. Despite this, BB was rarely observed at damaging levels at any location.

Stripe blight (*Pseudomonas syringae* pv. *striafaciens*) is the predominant form of BB observed in WA. While common, it only reached damaging levels in a few paddocks when conditions were favourable. Halo blight (*Pseudomonas syringae* pv. *corofaciens*) is less common but has been observed more frequently in WA throughout the 2023 growing season.

Stripe blight symptoms are found predominantly on leaves. They resemble water-soaked spots without the presence of a halo. The spots lengthen and form patches that can then form red-brown stripes, which distort leaf growth in young leaves. Stripes can develop yellow and red margins. The lesions can merge, forming irregular blotches that cause the leaf to senesce prematurely. Florets inside can appear rotten and stained if the stripe blight occurs on the boot. Emerged florets appear mottled brown-to-white and can be sterile.

Halo blight causes oval water-soaked spots that are pale green or yellow. The centre of the spots becomes yellow-brown, surrounded by a yellow-green halo. As the disease develops, the lesions turn brown and join to form irregular blotches. Severe infection can lead to premature senescence of leaves.

There are no registered products available for the control of BB.

Barley and cereal yellow dwarf (BYD/CYD)

Both BYD and CYD viruses occur in WA. As screening for varietal resistance to BYD and CYD occurs in the field, resistance scores reflect the rating for the presence of both viruses. However, BYD is more frequent than CYD at a ratio of about 2:1. BYD can reduce grain yield by up to 80% with seedling infection and up to 20% with later infection. Oat plants primarily become infected from infected oat (*Rhopalosiphum padi*) or corn leaf (*Rhopalosiphum maidis*) aphids.

Varietal resistance reduces the impact of the virus but not the effect of aphid feeding on plant growth. Therefore, varietal resistance to BYD and CYD does not reduce the need to spray for aphids to prevent yield loss from feeding damage once aphids reach threshold levels in the crop (50% of tillers with 15 or more aphids).

Most oat varieties are rated as MS or below to BYD and CYD.

Root lesion nematode (RLN)

Root lesion nematodes (RLN, *Pratylenchus* species) are microscopic, worm-like animals that feed on plant roots causing yield loss in susceptible crops, including wheat, barley and canola. Growing susceptible crops and varieties will increase RLN population numbers and increase the risk of yield losses. RLN can be found across about 6.25 million hectares (nearly 74% of the winter cropping area of WA). *Pratylenchus neglectus* is the dominant species, followed by *Pratylenchus quasitereoides* (formerly *P. teres*). Nematode populations potentially limit the yield of barley and wheat in more than 50% of infested paddocks. Yield loss in oat crops has not been investigated in WA.

The key to managing RLN is identifying paddocks with high nematode numbers and incorporating resistant crops and varieties or a fallow to reduce nematodes. Wheat, barley, canola and oats are all susceptible crops and can increase nematode levels. Resistance is the ability of the crop to prevent nematode multiplication and tolerance is the ability of the crop to yield in the presence of nematodes. Oats are generally more resistant than wheat to *P. neglectus* and more susceptible than wheat to *P. quasitereoides*. Lupins, field peas, faba beans and serradella are resistant and should lower the numbers of the two RLN species.

The *P. neglectus* and *P. quasitereoides* resistance scores in this guide are from WA-based glasshouse and field trials. Varieties with fewer than five observations, or where there has been no field trial verification of the glasshouse rating, receive provisional ratings. All oat varieties tested caused RLN nematodes to increase over the growing season, with Williams the most resistant milling variety and Mulgara the most resistant hay-only variety to both *P. neglectus* and *P. quasitereoides*.

Cereal cyst nematode (CCN)

Cereal cyst nematode (CCN, *Heterodea avenae*) is present in cropping regions around Geraldton, Esperance and the Avon Valley, but the pest can occur sporadically across the WA wheatbelt. Oat varieties are not as tolerant as barley to CCN, and yield loss can be expected when infection occurs. Choose a more resistant and tolerant variety if growing oats in a paddock infested with CCN. This should limit nematode multiplication for future crops and yield loss in the current oat crop. CCN resistance and tolerance ratings for milling oat varieties sourced from NVT online and SARDI indicate that Bannister and Durack have the best tolerance to CCN. At the same time, Mulgara, Tammar, Tungoo and Wintaroo are moderately tolerant among the hay-only varieties (Table 13).

Planting CCN-resistant oat varieties slows nematode development, leading to lower nematode levels in the soil for subsequent crops. The milling oat varieties, Bannister, Durack and Yallara, slow CCN numbers. Among the hay-only varieties, Brusher, Mulgara, Tammar, Tungoo and Wintaroo slow CCN numbers.

Further reading

In Australia, a range of fungal, bacterial and viral pathogens infect oats, impacting the yield and quality of grain and hay crops. The overall impact of these diseases on oaten hay production is not well researched or understood, especially compared to other cereal crops.

How individual diseases impact the nutritional quality of hay is less well understood than physical qualities. Export hay is evaluated on physical qualities such as stem thickness, greenness and nutritional attributes, including WSC, ADF, NDF and dry matter digestibility. The colour/greenness of oaten hay can be reduced by disease lesions, chlorosis and saprophytic fungi growing on dead tissue, all of which can cause export hay to be downgraded.

A 22-page review outlining the significant diseases of oaten hay crops in Australia was published in September 2020 by DPIRD as a milestone of the NHA project supported by AgriFutures (project number PRJ-011029). The review summarises disease symptoms, epidemiology and current control strategies. The review also contains a list of registered (as of August 2020) seed dressings, in-furrow treatments and foliar fungicides, and the withholding period following foliar fungicide application for grazing and harvesting. The review can be found online at: agrifutures.com.au/product/plant-diseases-impacting-oaten-hay-production-in-australia-a-review/.

Fact sheets on oat septoria, rusts (both OLR and OSR) and RLL published by the National Hay Agronomy Project are available on the AgriFutures website agrifutures.com.au/knowledge-hub.

Table 12. Oat leaf disease resistance profiles when grown in WA

Disease[1]	Oat septoria	Oat leaf rust	Oat stem rust	Barley and cereal yellow dwarf[4]
Pathotype[2]	Mixed	0001-2 [4,7]	94-1,2,4	–
Growth stage[3]	Adult	Adult	Adult	Seedling and Adult
Deliverable as OAT1				
Bannister	MSS	MR	MS	MS
Bilby	S	MRMS	SVS	S
Carrolup	MSS	VS	S	SVS
Kojonup	MSS	SVS	MSS	MSS
Kowari	S	MR	S	S
Mitika	SVS	MRMS	S	SVS
Williams	MSS	MR	MSS	MSS
Yallara	MSS	MR	MSS	MSS
Deliverable as OAT2				
Durack	S	MRMS	SVS	S
Wandering	MSS	VS	SVS	S
Not yet evaluated for milling				
13008-18	MS	MR	MSS	MS
Koala	MSS	MR	MRMS	S
Hay-only variety				
Archer	MSS	MR	MS	MS
Brusher	MSS	MR	S	MSS
Forester	S	-	-	-
Kingbale	MSS	S	S	MS*p*
Koorabup	MRMS	MRMS	MSS	MSS
Kultarr	MSS*p*	MR*p*	MSS*p*	MSS*p*
Mulgara	S	MR	MR	MS
Swan	-	-	-	-
Tammar	-	-	-	-
Tungoo	MRMS	RMR	MS	MSS
Wallaby	MSS*p*	MR*p*	MS*p*	MSS*p*
Winjardie	SVS	SVS	-	MS
Wintaroo	MSS	S	MS	MS

Source: Manisha Shanker, InterGrain and NVT Online, nvtonline.com.au

[1] Resistance rating: VS = very susceptible, SVS = susceptible to very susceptible, S = susceptible, MSS = moderately susceptible to susceptible, MS = moderately susceptible, MRMS = moderately resistant to moderately susceptible, MR = moderately resistant, RMR = resistant to moderately resistant, R = resistant, *p* = provisional rating. No score '-' = no rating is currently available. *Refer to page 4 for interpreting resistance classification.*

[2] Pathotype: the strain of the pathogen used in evaluating the disease reaction of the different oat varieties, which represents the most common pathotype present in WA. Therefore, on-farm reactions of varieties may differ if the pathotype present differs from the pathotype used in testing.

[3] Growth stage: the seedling resistance score reflects resistance at the two to the three-leaf stage and the adult resistance score reflects resistance after flag leaf emergence.

[4] Barley and cereal yellow dwarf: plants become infected from infected oat and corn leaf aphids. Varietal resistance reduces the effect of the virus on plant growth but does not reduce the impact of aphid feeding on plant growth.

Table 13. Oat nematode resistance profiles

Disease[1]	Root lesion nematode[3]	Root lesion nematode[3]	CCN resistance[4]	CCN tolerance[4]
Species	***Pratylenchus neglectus***	***Pratylenchus quasitereoides***	***Heterodera avenae***	***Heterodera avenae***
Growth stage[2]	**Seedling and Adult**	**Seedling and Adult**	**Seedling and Adult**	**Seedling and Adult**
Deliverable as OAT1				
Bannister	MSS	S*p*	MR	MI
Bilby	MS*p*	VS*p*	VS	-
Carrolup	S	S*p*	S	I
Kojonup	MSS	SVS*p*	VS	I
Kowari	-	-	VS	-
Mitika	-	-	VS	I
Williams	MRMS	MSS*p*	S	I
Yallara	-	-	R	I
Deliverable as OAT2				
Durack	MS	S*p*	RMR	MI
Wandering	-	-	VS	I
Not yet evaluated for milling				
13008-18	-	-	-	-
Koala	-	-	-	-
Hay-only variety				
Archer	-	-	S*p*	-
Brusher	MS	SVS*p*	MR	MI
Forester	-	-	MS	MI
Kingbale	MS*p*	VS*p*	R	-
Koorabup	MS*p*	VS*p*	S	-
Kultarr	-	-	MR*p*	-
Mulgara	MS	MSS*p*	R	MT
Swan	-	-	MR	I
Tammar	-	-	MR	MT
Tungoo	-	-	R	MT
Wallaby	-	-	R	-
Winjardie	MSS*p*	-	S	I
Wintaroo	-	-	R	MT

Source: Carla Wilkinson, InterGrain and NVT Online, **nvtonline.com.au**

[1] Resistance rating: VS = very susceptible, SVS = susceptible to very susceptible, S = susceptible, MSS = moderately susceptible to susceptible, MS = moderately susceptible, MRMS = moderately resistant to moderately susceptible, MR = moderately resistant, RMR = resistant to moderately resistant, R = resistant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, *p* = provisional rating. No score '-' = no rating is currently available. *Refer to page 4 for interpreting resistance classification.*

[2] Growth stage: the seedling resistance score reflects resistance at the two to the three-leaf stage and the adult resistance score reflects resistance after flag leaf emergence.

[3] Root lesion nematode: oat varieties vary in the impact of root-lesion nematode on their growth. A resistant variety retards nematode development, leading to lower nematode levels in the soil for subsequent crops. *Pratylenchus teres* has been renamed *Pratylenchus quasitereoides*. Ratings are based on data collected in WA.

[4] CCN: oat varieties differ in their resistance (a resistant variety retards nematode development) and tolerance (tolerant varieties yield better in the presence of nematodes). CCN resistance and tolerance data are based on variety responses in SA.

Variety snapshots

Georgie Troup and Blakely Paynter (DPIRD)

Variety snapshots are presented for:

- seven dual-purpose varieties (Bannister, Carrolup, Durack, Kojonup, Wandering, Williams and Yallara) deliverable into milling oat segregations in WA are also suitable for export hay.
- three grain-only varieties (Bilby, Kowari and Mitika) that are deliverable into milling oat segregations in WA but are not suitable for export hay.
- two grain varieties that have not yet been classified (13008-18 and Koala).
- ten hay-only varieties (Archer, Brusher, Kingbale, Koorabup, Kultarr, Mulgara, Swan, Winjardie and Wintaroo) that can be cut for export hay but cannot be delivered into milling oat segregations in WA.

The comment section in each snapshot describes essential characteristics of a variety, including yield relative to another variety and key weaknesses and strengths.

Grain yield data extracted from the Long Term MET Yield Reporter (available at NVT online, nvtonline.com.au) are presented relative to a control variety (typically Bannister) rather than the site mean yield (as shown in Tables 3 to 8) for each year from 2018 to 2022. Single-site MET data from Table 9 has been used in the comments section to highlight the probability of one variety yielding less, the same, or more than another variety when grown under the same agronomy (in the same trial).

DPIRD collects disease resistance data for grain varieties under a service agreement with GRDC for the NVT system. InterGrain supplies hay disease data (except Koorabup). Disease and nematode resistance ratings are sourced from Tables 12 and 13 and presented for the plant's adult growth stages (if known).

Phenology information is an output of the new flowering date predictive program, "FlowerPower" oat (available at fp.dpird.app/), developed by DPIRD. "FlowerPower" oat is a statistical model that predicts the date of the watery ripe (Z71) growth stage for oats in two WA environments (Northam and Katanning). Model predictions use historical temperature data from 2011, sourced from the SILO database hosted by the Queensland Department of Environment and Science (longpaddock.qld.gov.au/silo/point-data/). Data presented relative to a control variety (typically the dual-purpose variety Carrolup and the hay variety Brusher) for two model environments (Northam and Katanning) for five sowing dates (10-April, 20-April, 10-May, 20-May and 10-June). The phenology data presented in the snapshots is the median predicted date to Z71 (date expected for 50% of seasons) based on "FlowerPower" oat version v7.0.10.

Agronomic traits are tabulated based on published data generated by NOBP in their annual newsletters (pir.sa.gov.au/research/research_specialties/crop_sciences/crop_improvement), data collected by DPIRD, research findings from the DPIRD-GRDC co-funded projects DAW00107, DAW00227 and DAW1901-002RTX and in some cases, directly from the breeder. Data presented includes:

- Plant type is based on the genetic background of the variety. Data sourced from NOBP.
- Coleoptile and coleoptile + mesocotyl length. Short = 40–60mm, medium = 60–80mm, long = 80–100mm, very long = 100–120mm and extremely long = >120mm. Oat seedlings emerge by elongating the mesocotyl and coleoptile (in wheat and barley, it is only through coleoptile elongation), so oats can safely be sown deeper than wheat and barley. The coleoptile and mesocotyl lengths were measured after germinating seeds in rolled, moistened filter paper for 15 days at 15°C in the dark. DPIRD collected data.
- Hull lignin is an empirical phloroglucinol test where colour either develops or does not. Hull lignin ratings are based on data published by NOBP. There is a 0–5 scale where 0 is no hull lignin. Hull lignin is also measurable by near-infrared spectroscopy (NIR). Data sourced from NOBP.

- Stem diameter ratings based on data published by NOBP where fine = <4mm, moderate = 4–6mm, thick = 7–8mm and very thick = >8mm. Data sourced from NOBP.

Variety information, including pedigree, the seed licensee, seed trading restrictions and the EPR payable sourced from breeding companies, Variety Central (varietycentral.com.au/) and IP Australia Plant Breeders Rights database (pericles.ipaustralia.gov.au/pbr_db/search.cfm).

Bannister(Þ)

OAT1 grain and hay variety

Comments

Bannister (tested as WAOAT2354) is a medium spring, tall milling oat variety suitable for export hay. Bannister is susceptible to grain staining. Growers should avoid sowing Bannister in high risk, grain staining scenarios, oat-on-oat rotations and where pre-harvest rain is a high risk. Carrolup has been the dominant dual-purpose variety cut for export hay, but the popularity of Bannister amongst export hay growers is growing. Bannister hay has better quality and increased hay yield than Carrolup in trials. While hay yields are lower than Brusher, hay quality in breeder trials was comparable. Bannister is the most widely sown oat variety in WA, occupying half the area sown to oats in 2022.

Grain yield (% Carrolup)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	131	111	120	126	124
Agzone 3	119	117	125	120	120
Agzone 4	117	110	120	130	147
Agzone 5	119	111	126	120	122
Agzone 6	127	120	135	127	124
Statewide	125	114	124	125	124

Disease resistance	Rating
Septoria	MSS
Leaf rust	MR
Stem rust	MS
BYD and CYD	MS
RLN (*P. neglectus*)	MSS
RLN (*P. quasitereoides*)	S*p*
CCN (resistance)	MR

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+3	+3	+3	+3	+3
Katanning	+3	+3	+3	+3	+3

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+1	+1	+1	+1	+1
Katanning	+1	+1	+1	+1	+0

Agronomic traits	
Plant type	Dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Extremely long
Hull lignin	High
Stem diameter	Moderate

Variety information	
Pedigree	93Q440-44-12/95Q624-30
Breeder / Seed licensee	DPIRD / Seednet
Access to seed	Seednet Partners
EPR ($/t, excl GST) (grain / hay)	$2.30 / $2.00

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Carrolup

OAT1 grain and hay variety

Comments

Carrolup (tested as 81Q:346) is a medium spring, mid-tall milling oat variety suitable for export hay. Carrolup has a significantly lower grain yield than the new milling varieties Bannister and Williams. Carrolup grain has the best hectolitre weight of current milling varieties, but screenings tend to be high similar to Williams. Hay quality of Carrolup is comparable to many of the specialist hay varieties but at a lower hay yield. Carrolup is the second most widely grown oat variety in WA after Bannister, occupying 16% of the oat area in 2022.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	76	90	83	79	81
Agzone 3	84	86	80	84	84
Agzone 4	86	91	83	77	68
Agzone 5	84	90	80	83	82
Agzone 6	79	83	74	79	81
Statewide	80	88	81	80	81
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	VS				
Stem rust	S				
BYD and CYD	SVS				
RLN (*P. neglectus*)	S				
RLN (*P. quasitereoides*)	S*p*				
CCN (resistance)	MR				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Bannister**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-3	-3	-3	-3	-3
Katanning	-3	-3	-3	-3	-3
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-2	-2	-2	-2	-2
Katanning	-2	-2	-2	-2	-3
Agronomic traits					
Plant type	Dwarf				
Coleoptile length	Medium				
Coleoptile + mesocotyl length	Extremely long				
Hull lignin	High				
Stem diameter	Moderate				
Variety information					
Pedigree	Mortlock/80Q256				
Breeder / Seed licensee	DPIRD				
Access to seed	Free to trade				
EPR ($/t, excl GST) (grain / hay)	No EPR payable				

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Kojonup

OAT1 grain and hay variety

Comments

Kojonup (tested as 91Q291-23-23) is a medium spring, medium height, milling oat variety suitable for export hay. Grain yield is between Carrolup and Bannister. It has good grain quality, large seed size, high hectolitre weight and low screenings. Kojonup is susceptible to oat Septoria and OLR. Kojonup is not recommended for lower rainfall regions (e.g. less than 200mm growing season rainfall). While Kojonup is suitable for export hay, hay yields are generally lower than Carrolup. Kojonup is a minor variety and occupied about 0.5% of the planted area to oats in 2022.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	81	82	84	95	95
Agzone 3	94	99	84	93	96
Agzone 4	79	69	67	85	94
Agzone 5	83	79	85	91	97
Agzone 6	96	98	103	103	98
Statewide	87	88	87	94	96
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	SVS				
Stem rust	MSS				
BYD and CYD	MSS				
RLN (*P. neglectus*)	MSS				
RLN (*P. quasitereoides*)	SVS*p*				
CCN (resistance)	VS				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Carrolup**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-	-	-	-	-
Katanning	-	-	-	-	-
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-	-	-	-	-
Katanning	-	-	-	-	-
Agronomic traits					
Plant type	Dwarf				
Coleoptile length	Medium				
Coleoptile + mesocotyl length	Extremely long				
Hull lignin	High				
Stem diameter	-				
Variety information					
Pedigree	83Q:384/Coomallo				
Breeder / Seed licensee	DPIRD				
Access to seed	Free to trade				
EPR ($/t, excl GST) (grain / hay)	$ 2.25 / -				

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Williams(Þ)

OAT1 grain and hay variety

Comments

Williams (tested as WAOAT2332) is a medium spring, mid-tall milling oat variety suitable for export hay. Williams has a similar grain yield to Bannister and Wandering but may lodge in high yielding environments. Williams grain has lower hectolitre weight and higher screenings than Bannister and Yallara, especially in lower rainfall regions. Williams has a higher level of grain β-glucan. Hay yields are around 0.5–1.0t/ha less than specialist hay varieties like Brusher, Mulgara and Winjardie at a comparable hay quality. Hay quality is similar to Wintaroo, with slightly lower WSC and slightly higher crude protein. The main issue with Williams hay is stem thickness, so a target density of 320 plants/m2 is required when grown for export hay. Williams is the third most widely sown oat variety, occupying 12% of the oat planted area in 2022.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	97	102	95	94	94
Agzone 3	99	98	95	95	99
Agzone 4	104	110	96	91	89
Agzone 5	101	99	98	96	96
Agzone 6	97	97	97	92	95
Statewide	98	100	96	94	95
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	MR				
Stem rust	MSS				
BYD and CYD	MSS				
RLN (*P. neglectus*)	MRMS				
RLN (*P. quasitereoides*)	MSS*p*				
CCN (resistance)	S				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Carrolup**				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+3	+2	+2	+2	+2
Katanning	+3	+2	+2	+2	+3
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+1	+0	+0	+0	+0
Katanning	+1	+0	+0	+0	+0
Agronomic traits					
Plant type	Non-dwarf				
Coleoptile length	Medium				
Coleoptile + mesocotyl length	Very long				
Hull lignin	Moderately high				
Stem diameter	Moderately thick				
Variety information					
Pedigree	85Q845-59/Carrolup//93Q496-13/Carrolup				
Breeder / Seed licensee	SARDI / Barenbrug				
Access to seed	Free to trade				
EPR ($/t, excl GST) (grain / hay)	$2.30 / $2.00				

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Yallara(Þ)

OAT1 grain and hay variety

Comments

Yallara (tested as SV97001-13-4) is a medium spring, mid-tall milling oat variety suitable for export hay. Grain yields are similar to Carrolup, with improved disease resistance. Yallara grain has a slightly lower hectolitre weight than Carrolup grain but improved grain plumpness (lower screenings). Yallara has bright grain and high grain digestibility, making it suitable for the horse racing industry. Hay yields are slightly higher than Williams and comparable to the specialist hay variety Brusher. Yallara can produce high-quality hay with moderately fine stems and is replacing Winjardie as a hay variety in the northern half of Agzone 2. Yallara has some tolerance to oat septoria and OSR, with good resistance to OLR. Yallara is the fourth most popular oat variety in WA in 2022, occupying about 6% of the area sown to oats.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	81	95	87	75	78
Agzone 3	80	83	86	83	79
Agzone 4	85	98	75	88	61
Agzone 5	86	98	80	86	77
Agzone 6	78	76	56	71	76
Statewide	81	89	81	79	76
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	MR				
Stem rust	MSS				
BYD and CYD	MSS				
RLN (*P. neglectus*)	–				
RLN (*P. quasitereoides*)	–				
CCN (resistance)	R				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Carrolup**				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-1	-2	-1	-2	-2
Katanning	-1	-2	-1	-2	-1
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-3	-4	-3	-4	-4
Katanning	-3	-4	-3	-4	-4
Agronomic traits					
Plant type	Non-dwarf				
Coleoptile length	Medium				
Coleoptile + mesocotyl length	Extremely long				
Hull lignin	High				
Stem diameter	Moderately fine				
Variety information					
Pedigree	Euro/ND931075//Euro				
Breeder / Seed licensee	SARDI / Seednet				
Access to seed	Seednet Partners				
EPR ($/t, excl GST) (grain / hay)	$2.00 / $2.00				

Refer to page 4 for interpreting resistance classification.

Durack(Þ)

OAT1 grain and hay variety

Comments

Durack (tested as WA02Q302-9) is an early spring, mid-tall, milling variety suitable for export hay. Durack is only deliverable as an OAT2 variety. When evaluated, Durack was not granted OAT1 status as it failed to meet the target grain β-glucan target of 4%. It is similar in height and grain yield to Carrolup and Yallara with comparable hectolitre weight but improved grain plumpness relative to Carrolup. Grain plumpness (or screenings) is similar to Yallara. Durack is the earliest maturing oat variety of any current milling or hay variety. While earlier flowering helps produce large grains, it may also increase the risk of frost during flowering, so growers are encouraged to sow between May and mid-June when sowing in frost-prone areas. Hay yields are generally lower than Carrolup and Williams. Durack is susceptible to oat septoria and OSR. Durack was the eighth most popular oat variety in 2022 but occupying only 1% of the area sown to oats.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	75	93	93	79	81
Agzone 3	79	75	85	86	75
Agzone 4	86	91	127	81	69
Agzone 5	81	101	79	81	79
Agzone 6	65	76	59	76	74
Statewide	75	86	85	81	77
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	MRMS				
Stem rust	SVS				
BYD and CYD	S				
RLN (*P. neglectus*)	MS				
RLN (*P. quasitereoides*)	Sp				
CCN (resistance)	RMR				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Carrolup**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-6	-7	-7	-7	-7
Katanning	-7	-7	-7	-7	-6
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-8	-9	-9	-9	-9
Katanning	-9	-9	-9	-9	-9
Agronomic traits					
Plant type	Non-dwarf				
Coleoptile length	Medium				
Coleoptile + mesocotyl length	Extremely long				
Hull lignin	High				
Stem diameter	Moderate				
Variety information					
Pedigree	01Q211/94Q601-45-28				
Breeder / Seed licensee	SARDI / Barenbrug				
Access to seed	Barenbrug				
EPR ($/t, excl GST) (grain / hay)	$2.30 / $2.00				

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Wandering

OAT2/OWAN grain and hay variety

Comments

Wandering (tested as WAOAT2052) is a medium spring, medium height feed variety received as OAT2 and OWAN only. Wandering has comparable grain yield to Bannister and Williams but is less competitive at sites with a yield potential above 3t/ha. Wandering is suitable for cutting for hay but is not preferred by the export industry. Hay yields are generally higher than Carrolup, with improved digestibility and WSC. Wandering is very susceptible to OLR and OSR. Wandering was the fifth most popular oat variety, occupying 4.4% of the area sown to oats in 2022.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	98	102	100	99	99
Agzone 3	101	97	97	99	100
Agzone 4	106	107	122	92	98
Agzone 5	101	101	101	96	100
Agzone 6	95	100	103	98	98
Statewide	99	100	101	98	99
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	VS				
Stem rust	SVS				
BYD and CYD	S				
RLN (*P. neglectus*)	–				
RLN (*P. quasitereoides*)	–				
CCN (resistance)	VS				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Carrolup**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	+2	+1	+1	+1	+1
Katanning	+2	+1	+1	+1	+2
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	+0	-1	-1	-1	-1
Katanning	+0	-1	-1	-1	-1
Agronomic traits					
Plant type	Dwarf				
Coleoptile length	Medium				
Coleoptile + mesocotyl length	Extremely long				
Hull lignin	High				
Stem diameter	Moderate				
Variety information					
Pedigree	SA Seln 41/75Q36-144-31				
Breeder / Seed licensee	DPIRD				
Access to seed	Free to trade				
EPR ($/t, excl GST) (grain / hay)	No EPR payable				

Refer to page 4 for interpreting resistance classification.

Bilby(b)

OAT1 grain variety

Comments

Bilby (tested as 06204-16) is an early-medium spring, short milling oat variety not suitable for export hay. The grain quality of Bilby is comparable to Bannister but with a lower grain yield above 3t/ha. Grain yields are between Kojonup and Wandering. Since 2017, grain yields of Bilby have been similar to Williams with a higher hectolitre weight and lower screenings. Bilby has higher grain β-glucan and lower oil than other dwarf varieties with bright grain. Bilby is very susceptible to oat septoria and OSR. The Bilby area has grown, and it occupied just under 3% of the area sown to oats in 2022.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	91	99	103	97	97
Agzone 3	94	87	96	98	91
Agzone 4	100	96	148	91	96
Agzone 5	94	104	95	92	95
Agzone 6	81	94	91	95	92
Statewide	91	95	100	96	94
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	MRMS				
Stem rust	SVS				
BYD and CYD	S				
RLN (*P. neglectus*)	MS*p*				
RLN (*P. quasitereoides*)	S*p*				
CCN (resistance)	MR				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Carrolup**				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-2	-2	-2	-2	-2
Katanning	-2	-2	-2	-2	-1
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-4	-4	-4	-4	-4
Katanning	-4	-4	-4	-4	-4
Agronomic traits					
Plant type	Dwarf				
Coleoptile length	Medium				
Coleoptile + mesocotyl length	Extremely long				
Hull lignin	High				
Stem diameter	–				
Variety information					
Pedigree	98011-6/98240-19				
Breeder / Seed licensee	SARDI / Barenbrug				
Access to seed	Barenbrug				
EPR ($/t, excl GST) (grain / hay)	$2.50 / -				

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Kowari(b)

OAT1 grain variety

Comments

Kowari (tested as SV03198-18) is a medium spring, medium height milling oat variety not suitable for export hay. Kowari is an alternate to Bilby, but with lower yield potential, similar hectolitre weight and improved grain plumpness (lower screenings). Kowari has slightly longer straw and higher grain yield than Mitika at comparable grain quality. Kowari grain is attractive to millers seeking health claims for their products as it has a higher level of grain β-glucan. Kowari is susceptible to oat septoria and OSR. Kowari grain has low hull lignin, which improves feed grain quality. Kowari occupied 0.6% of the area sown to oats in 2022.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	85	96	101	92	93
Agzone 3	89	83	92	95	85
Agzone 4	94	92	148	88	90
Agzone 5	89	103	90	87	91
Agzone 6	74	88	82	91	87
Statewide	85	92	96	92	89
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	MR				
Stem rust	S				
BYD and CYD	S				
RLN (*P. neglectus*)	–				
RLN (*P. quasitereoides*)	–				
CCN (resistance)	VS				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Carrolup**				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-8	-9	-9	-9	-9
Katanning	-8	-9	-9	-9	-8
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-10	-11	-11	-11	-11
Katanning	-10	-11	-11	-11	-11
Agronomic traits					
Plant type	Dwarf				
Coleoptile length	Medium				
Coleoptile + mesocotyl length	Extremely long				
Hull lignin	Low				
Stem diameter	–				
Variety information					
Pedigree	Mitika/WAOAT2099				
Breeder / Seed licensee	SARDI / Barenbrug				
Access to seed	Barenbrug				
EPR ($/t, excl GST) (grain / hay)	$2.50 / -				

Refer to page 4 for interpreting resistance classification.

Mitika(Þ)

OAT1 grain variety

Comments

Mitika (tested as SV94046-57) is a medium spring, short height milling oat variety not suitable for export hay. The grain yield of Mitika is an improvement on Carrolup, but is significantly lower than Bannister and Williams. Mitika grain is comparable to Kowari for hectolitre weight and grain plumpness, but is lower yielding. Mitika, like Kowari, has higher levels of β-glucan than current milling and dual-purpose varieties. Mitika is susceptible to oat septoria and OSR. Mitika has improved feed quality due to low husk lignin and high grain digestibility. Mitika is a minor variety occupying less than 0.5% of the area planted to oats in 2022.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	82	94	96	-	-
Agzone 3	87	82	90	-	-
Agzone 4	91	91	133	-	-
Agzone 5	86	100	86	-	-
Agzone 6	74	85	77	-	-
Statewide	83	90	91	-	-
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	MRMS				
Stem rust	S				
BYD and CYD	SVS				
RLN (*P. neglectus*)	–				
RLN (*P. quasitereoides*)	–				
CCN (resistance)	VS				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Carrolup**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-	-	-	-	-
Katanning	-	-	-	-	-
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-	-	-	-	-
Katanning	-	-	-	-	-
Agronomic traits					
Plant type	Dwarf				
Coleoptile length	Medium				
Coleoptile + mesocotyl length	Extremely long				
Hull lignin	Low				
Stem diameter	–				
Variety information					
Pedigree	OX87;072-13/OX87;080-1//OX88;045-12				
Breeder / Seed licensee	SARDI / Barenbrug				
Access to seed	Free to trade				
EPR ($/t, excl GST) (grain / hay)	$2.00 / -				

Refer to page 4 for interpreting resistance classification.

13008-18

Not yet evaluated for milling

Comments

13008-18 is a medium spring variety suited to all milling oat-growing regions in WA. 13008-18 is derived from Bannister and has the following pedigree – 02095-9/Bannister. It has been accepted for milling evaluation by Grains Australia.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	-	-	-	104	104
Agzone 3	-	-	-	104	98
Agzone 4	-	-	-	101	106
Agzone 5	-	-	-	99	102
Agzone 6	-	-	-	100	99
Statewide	-	-	-	102	101
Disease resistance	**Rating**				
Septoria	MS				
Leaf rust	MR				
Stem rust	MSS				
BYD and CYD	MS				
RLN (*P. neglectus*)	-				
RLN (*P. quasitereoides*)	-				
CCN (resistance)	-				
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Carrolup**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-	-	-	-	-
Katanning	-	-	-	-	-
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	**20-Apr**	**10-May**	**20-May**	**10-Jun**
Northam	-	-	-	-	-
Katanning	-	-	-	-	-
Agronomic traits					
Plant type	-				
Coleoptile length	-				
Coleoptile + mesocotyl length	-				
Hull lignin	-				
Stem diameter	-				
Variety information					
Pedigree	02095-9/Bannister				
Breeder / Seed licensee	SARDI / InterGrain				
Access to seed	to be advised				
EPR ($/t, excl GST) (grain / hay)	to be advised				

Refer to page 4 for interpreting resistance classification.

Koala(Þ)

Not yet evaluated for milling

Comments

Koala (tested as SV09143-35) is late spring, tall grain oat derived from Bannister that is yet to be evaluated for its milling potential. Suitability for export hay has not been established. Koala has a similar tolerance to oat septoria and OLR as Bannister but is improved for OSR. Grain quality packages (hectolitre weight and screenings through a 2.0mm sieve) for Koala and Bannister are similar. Koala seed will be bulked in WA in 2023 and is planned for release as a feed oat in 2024 for on-farm and domestic use, with Seednet indicating it will submit the variety for milling accreditation in 2023.

Grain yield (% Bannister)	2018	2019	2020	2021	2022
Agzone 1	-	-	-	-	-
Agzone 2	102	94	92	100	102
Agzone 3	101	110	100	100	105
Agzone 4	90	91	42	107	101
Agzone 5	99	90	98	106	102
Agzone 6	115	103	104	105	106
Statewide	103	99	94	102	103

Disease resistance	Rating
Septoria	MSS
Leaf rust	MR
Stem rust	MRMS
BYD and CYD	S
RLN (*P. neglectus*)	–
RLN (*P. quasitereoides*)	–
CCN (resistance)	–

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

Agronomic traits	
Plant type	Dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Extremely long
Hull lignin	Moderately low
Stem diameter	–

Variety information	
Pedigree	02088-70/Bannister
Breeder / Seed licensee	SARDI / Seednet
Access to seed	Seednet Partners
EPR ($/t, excl GST) (grain / hay)	$2.50 / -

Refer to page 4 for interpreting resistance classification.

Archer(Þ)

Hay variety

Comments

Archer (GIA1803-040) is a single gene, imidazolinone (IMI) tolerant, mid-maturity and mid-height hay-only variety. Preliminary data indicates Archer has high hay yields with suitable quality for export hay, and a useful disease profile, although CCN may require rotational management. Archer was developed through mutation breeding by GIA and is being commercialised by InterGrain. Archer appears to have a comparable grain yield to Carrolup, allowing for easier seed bulk-up for the following year's hay crop. Archer has improved tolerance to soil residual IMI herbicides as a plant back option. The APMVA have registered the Sentry® herbicide with Archer for pre-plant IBS application for forage, seed, and grain (domestic feed market only). Archer cannot be sprayed post-emergent with an IMI herbicide. Farmer-to-farmer trading of Archer seed will not be allowed, as with IMI tolerant wheat and barley varieties. Suggested alternative to Brusher, Carrolup, Mulgara, and Yallara.

Hay yield and quality	Archer	Carrolup
Hay yield (t/ha)	10.8	10.3
Digestibility (% dm)	63.3	63.2
CP (% dm)	6.1	5.9
WSC (% dm)	25.4	27.1
ADF (% dm)	33.1	33.3
NDF (% dm)	52.4	52.2

Disease resistance	Rating
Septoria	MSS
Leaf rust	MR
Stem rust	MS
BYD and CYD	MS
RLN (*P. neglectus*)	–
RLN (*P. quasitereoides*)	–
CCN (resistance)	S*p*

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Wintaroo				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Extremely long
Hull lignin	–
Stem diameter	–

Variety information	
Pedigree	Euro/ND931075//Euro
Breeder / Seed licensee	GIA / Intergrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl GST) (grain / hay)	$3.65 / $3.65

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Brusher(b)

Hay variety

Comments

Brusher (tested as SV87103-109) is a tall, medium spring hay-only oat variety. Brusher reaches watery ripe about five days earlier than Wintaroo and two days later than Carrolup across a range of sowing dates. Brusher hay is similar in height to Mulgara and Wintaroo with thinner stems and lower fibre levels. It also has improved digestibility, metabolisable energy and WSC than Wintaroo. Brusher has improved hay yield and quality relative to Carrolup and is the most widely sown hay-only variety cut for export hay. Brusher is susceptible to oat septoria and OSR, and is suitable for sowing in lower rainfall areas.

Hay yield and quality	Brusher	Carrolup
Hay yield (t/ha)	11.1	10.3
Digestibility (% dm)	64.5	63.2
CP (% dm)	6.0	5.9
WSC (% dm)	26.9	27.1
ADF (% dm)	32.9	33.3
NDF (% dm)	52.1	52.2

Disease resistance	Rating
Septoria	MSS
Leaf rust	MR
Stem rust	S
BYD and CYD	MSS
RLN (*P. neglectus*)	MSS
RLN (*P. quasitereoides*)	SVS*p*
CCN (resistance)	MR

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+2	+2	+2	+2	+2
Katanning	+2	+2	+2	+2	+3

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Wintaroo				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-5	-5	-5	-5	-4
Katanning	-5	-5	-5	-4	-4

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Extremely long
Hull lignin	Low
Stem diameter	Moderate

Variety information	
Pedigree	Dumont/Wallaroo//Bandicoot
Breeder / Seed licensee	SARDI / AEXCO
Access to seed	AEXCO seed distributor
EPR ($/t, excl GST) (grain / hay)	$2.00 / $2.00

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Kingbale(b)

Hay variety

Comments

Kingbale (tested as GIA1701O-I) is a single gene, imidazolinone (IMI) tolerant, hay-only oat variety. Kingbale has a similar agronomic and disease profile to Wintaroo. Kingbale was developed through mutation breeding from Wintaroo by GIA and is being commercialised by InterGrain. The breeding process was similar to the development of Scope CL from Buloke barley. Kingbale has improved tolerance to soil residual IMI herbicides as a plant back option. The APMVA have registered the Sentry® herbicide with Kingbale for pre-plant IBS application for forage, seed and grain (domestic feed market only). Kingbale cannot be sprayed post-emergent with an IMI herbicide. Farmer-to-farmer trading of Kingbale seed will not be allowed, as with IMI tolerant wheat and barley varieties. Suggested alternative to Carrolup, Koorabup, Winjardie, and Wintaroo.

Hay yield and quality	Kingbale	Carrolup
Hay yield (t/ha)	10.8	10.3
Digestibility (% dm)	63.5	63.2
CP (% dm)	5.6	5.9
WSC (% dm)	27.0	27.1
ADF (% dm)	34.5	33.3
NDF (% dm)	52.8	52.2

Disease resistance	Rating
Septoria	MSS
Leaf rust	S
Stem rust	S
BYD and CYD	MS*p*
RLN (*P. neglectus*)	MS*p*
RLN (*P. quasitereoides*)	VS*p*
CCN (resistance)	R

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Extremely long
Hull lignin	-
Stem diameter	-

Variety information	
Pedigree	MIOLRP-86-3/Echidna//Wallaroo
Breeder / Seed licensee	GIA / Intergrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl GST) (grain / hay)	$3.65 / $3.65

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Koorabup(b)

Hay variety

Comments

Koorabup (tested as 05096-32) is a new medium spring, hay-only oat variety developed for WA. Relative to Carrolup, it is about a week later to cut, with a similar plant height and hay yield but improved oat Septoria resistance. Koorabup has comparable grain yield to Carrolup, allowing ease of seed bulk-up for the following year's hay crop. Koorabup hay yields are lower than Archer and Brusher and close to Carrolup. It has better lodging and shattering resistance than Wintaroo and Brusher and similar to Mulgara. Koorabup hay has quality tested poorly in breeder variety trials since 2017 and in National Hay Agronomy trials.

Hay yield and quality	Koorabup	Carrolup
Hay yield (t/ha)	10.1	10.3
Digestibility (% dm)	63.3	63.2
CP (% dm)	5.8	5.9
WSC (% dm)	26.5	27.1
ADF (% dm)	33.9	33.3
NDF (% dm)	52.7	52.2

Disease resistance	Rating
Septoria	MRMS
Leaf rust	MRMS
Stem rust	MSS
BYD and CYD	MSS
RLN (*P. neglectus*)	MS*p*
RLN (*P. quasitereoides*)	VS*p*
CCN (resistance)	S

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+6	+6	+6	+6	+6
Katanning	+6	+6	+6	+6	+6

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+4	+4	+4	+4	+4
Katanning	+4	+4	+4	+4	+3

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Extremely long
Hull lignin	High
Stem diameter	Moderately fine

Variety information	
Pedigree	WAOAT2282/WAOAT2236
Breeder / Seed licensee	SARDI / AEXCO
Access to seed	AEXCO seed distributor
EPR ($/t, excl GST) (grain / hay)	$2.00 / $2.00

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Kultarr(b)

Hay variety

Comments

Kultarr (tested as 07423-18), according to the commercialising agent InterGrain, is a quick-mid maturing oaten hay with a tall plant height and offers excellent hay yields. Kultarr has a higher yield potential than Brusher and Mulgara. It is slightly later to flower than Brusher, and similar to Mulgara. Preliminary hay quality data indicates the variety has a suitable quality profile for export hay. Kultarr has useful resistance to oat septoria and OLR. Kultarr was bred by SARDI with support from AgriFutures and AEXCO, and is being commercialised by InterGrain. Kultarr is an option where Brusher, Carrolup, Mulgara, or Yallara are currently planted.

Hay yield and quality	Kultarr	Carrolup
Hay yield (t/ha)	10.8	10.3
Digestibility (% dm)	63.7	63.2
CP (% dm)	5.6	5.9
WSC (% dm)	26.5	27.1
ADF (% dm)	33.6	33.3
NDF (% dm)	52.4	52.2

Disease resistance	Rating
Septoria	MSS*p*
Leaf rust	MR*p*
Stem rust	MSS*p*
BYD and CYD	MSS*p*
RLN (*P. neglectus*)	–
RLN (*P. quasitereoides*)	–
CCN (resistance)	MR*p*

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Wintaroo				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Long
Coleoptile + mesocotyl length	Extremely long
Hull lignin	–
Stem diameter	–

Variety information	
Pedigree	IL3587/Mulgara
Breeder / Seed licensee	SARDI / Intergrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl GST) (grain / hay)	$3.00 / $3.00

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Mulgara(Þ)

Hay variety

Comments

Mulgara (tested as SV96025-7) is a tall, medium spring hay-only oat variety. Mulgara reaches watery ripe at a similar time to Brusher and about three days later than Carrolup across a range of sowing dates. Mulgara has excellent resistance to OLR and OSR, but is rated as S to oat septoria. It is an improvement compared to Wintaroo for lodging, shattering resistance and early vigour. Hay yield in breeder's trials was an improvement over Carrolup and comparable to Brusher. Hay digestibility and WSC is better than Carrolup but similar for fibre. Mulgara has excellent hay colour and resists brown leaf tipping. Mulgara is al alternative to Kingbale and Wintaroo where OLR, OSR, or lodging are problematic year in, year out. Mulgara seed is large and care must be taken to compensate for this at sowing to ensure a target density of 320 plants/m^2 is acheived in medium to higher rainfall areas.

Hay yield and quality	Mulgara	Carrolup
Hay yield (t/ha)	10.6	10.3
Digestibility (% dm)	64.7	63.2
CP (% dm)	5.7	5.9
WSC (% dm)	27.6	27.1
ADF (% dm)	33.3	33.3
NDF (% dm)	52.4	52.2

Disease resistance	Rating
Septoria	S
Leaf rust	MR
Stem rust	MR
BYD and CYD	MS
RLN (*P. neglectus*)	MS
RLN (*P. quasitereoides*)	MS*p*
CCN (resistance)	R

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+3	+3	+3	+3	+3
Katanning	+3	+3	+3	+3	+4

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+1	+1	+1	+1	+1
Katanning	+1	+1	+1	+1	+1

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Long
Coleoptile + mesocotyl length	Extremely long
Hull lignin	High
Stem diameter	Moderate

Variety information	
Pedigree	OX89;030-26/93-112
Breeder / Seed licensee	SARDI / AEXCO
Access to seed	AEXCO seed distributor
EPR ($/t, excl GST) (grain / hay)	$2.00 / $2.00

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Swan

Hay variety

Comments

Swan (tested as Oat 3) is a tall, medium spring, hay-only oat variety. Relative to Carrolup, it is ready for cutting at a similar time, with taller hay of higher yield that is susceptible to lodging. It also has comparable hay quality and a similar disease resistance profile to Carrolup. Older hay varieties such as Swan (first registered in 1967) are not widely accepted by export due to their thicker stems. Swan is best suited to lower rainfall environments e.g. eastern wheatbelt. Swan grain has low hull lignin, which improves feed grain quality.

Hay yield and quality	Swan	Carrolup
Hay yield (t/ha)	-	10.3
Digestibility (% dm)	-	63.2
CP (% dm)	-	5.9
WSC (% dm)	-	27.1
ADF (% dm)	-	33.3
NDF (% dm)	-	52.2

Disease resistance	Rating
Septoria	–
Leaf rust	–
Stem rust	–
BYD and CYD	–
RLN (*P. neglectus*)	–
RLN (*P. quasitereoides*)	–
CCN (resistance)	MR

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Extremely long
Hull lignin	Low
Stem diameter	Moderately thick

Variety information	
Pedigree	Kent/Ballidu
Breeder / Seed licensee	DPIRD
Access to seed	Free to trade
EPR ($/t, excl GST) (grain / hay)	No EPR payable

Refer to page 4 for interpreting resistance classification.

Wallaby(b)

Hay variety

Comments

Wallaby (tested as 07079-9), according to the commercialising agent InterGrain, is a mid-slow maturing oaten hay variety with similar hay yields to Brusher and Mulgara. The variety has excellent quality attributes including good digestibility and high WSC levels. Wallaby has a medium to tall plant height and is likely suited to medium and high rainfall zones and resistant to CCN. Provisional ratings suggest Wallaby has useful resistance to oat septoria, OLR and OSR. Wallaby appears to have a comparable grain yield to Carrolup, allowing for easier seed bulk-up for the following year's hay crop. Wallaby was bred by SARDI with support from AgriFutures and AEXCO, and is being commercialised by InterGrain. Wallaby is an option where Brusher, Carrolup, Koorabup, Mulgara or Wintaroo are currently planted.

Hay yield and quality	Wallaby	Carrolup
Hay yield (t/ha)	10.7	10.3
Digestibility (% dm)	66.0	63.2
CP (% dm)	5.7	5.9
WSC (% dm)	28.5	27.1
ADF (% dm)	32.6	33.3
NDF (% dm)	52.5	52.2

Disease resistance	Rating
Septoria	MS*p*
Leaf rust	MR*p*
Stem rust	MS*p*
BYD and CYD	MS*p*
RLN (*P. neglectus*)	–
RLN (*P. quasitereoides*)	–
CCN (resistance)	R

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Wintaroo				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Long
Coleoptile + mesocotyl length	Very long
Hull lignin	–
Stem diameter	–

Variety information	
Pedigree	98228-3/00167-14
Breeder / Seed licensee	SARDI / Intergrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl GST) (grain / hay)	$3.00 / $3.00

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Winjardie

Hay variety

Comments

Winjardie (tested as Oat 146) is a tall, medium spring hay oat variety. A low disease resistance profile makes it unsuitable for disease-prone locations. However, Winjardie can produce quality export hay when grown in the northern half of Agzone 2 where disease pressure is reduced. Winjardie grain has low hull lignin, which improves feed grain quality.

Hay yield and quality	Winjardie	Carrolup
Hay yield (t/ha)	10.1	10.3
Digestibility (% dm)	63.3	63.2
CP (% dm)	5.8	5.9
WSC (% dm)	25.9	27.1
ADF (% dm)	33.2	33.3
NDF (% dm)	52.5	52.2

Disease resistance	Rating
Septoria	SVS
Leaf rust	SVS
Stem rust	–
BYD and CYD	MS
RLN (*P. neglectus*)	MS*p*
RLN (*P. quasitereoides*)	–
CCN (resistance)	S

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	-	-	-	-	-
Katanning	-	-	-	-	-

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Very long
Hull lignin	Low
Stem diameter	Moderate

Variety information	
Pedigree	66Q01-44/XBVT183
Breeder / Seed licensee	DPIRD
Access to seed	Free to trade
EPR ($/t, excl GST) (grain / hay)	No EPR payable

p = provisional rating. *Refer to page 4 for interpreting resistance classification.*

Wintaroo(b)

Hay variety

Comments

Wintaroo (tested as SV88083-4) is a tall, medium-late spring, hay oat variety. Wintaroo reaches watery ripe about five days later than Brusher and seven days later than Carrolup across a range of sowing dates. Susceptible to OLR. It resists brown leaf tipping by hot winds and maintains good colour longer than most varieties. Care must be taken to monitor the stems as they tend to turn white while the top remains green. Wintaroo hay is sought after by export hay houses. Experienced hay growers with cutting, conditioning and bailing equipment or access to a contractor will have an advantage in achieving the maximum potential from Wintaroo. Wintaroo grain has low hull lignin, which improves feed grain quality, but its grain yield is not as high as other hay or grain varieties.

Hay yield and quality	Wintaroo	Carrolup
Hay yield (t/ha)	10.7	10.3
Digestibility (% dm)	63.3	63.2
CP (% dm)	5.7	5.9
WSC (% dm)	26.7	27.1
ADF (% dm)	34.8	33.3
NDF (% dm)	52.8	52.2

Disease resistance	Rating
Septoria	MSS
Leaf rust	S
Stem rust	MSS
BYD and CYD	MSS
RLN (*P. neglectus*)	–
RLN (*P. quasitereoides*)	–
CCN (resistance)	R

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+7	+6	+7	+7	+6
Katanning	+7	+7	+7	+7	+7

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Wintaroo				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+5	+4	+5	+5	+4
Katanning	+5	+5	+5	+5	+4

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Extremely long
Hull lignin	Low
Stem diameter	Moderate

Variety information	
Pedigree	MIOLRP-86-3/Echidna//Wallaroo
Breeder / Seed licensee	SARDI / AEXCO
Access to seed	AEXCO seed distributor
EPR ($/t, excl GST) (grain / hay)	$2.00 / $2.00

Refer to page 4 for interpreting resistance classification.

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Pulse guide

By Mark Seymour, Stacey Power, Harmohinder Dhammu, Martin Harries, Geoff Thomas, Jean Galloway and Ciara Beard (DPIRD) with contributions and edits from Stuart Nagel (SARDI), Jason Brand and Joshua Fanning (DEECA – Agriculture Victoria), Sam Catt and Jeff Paull (University of Adelaide) and Kristy Hobson (NSW DPI)

Introduction

Pulses can be useful break crops to grow in rotation with cereals and canola. A well-managed pulse crop can reduce disease in following crops, control grass weed populations and fix nitrogen. Cereal yields and grain protein are usually maximised following a pulse, lupin or pasture legume. After peaking in the 1990s, pulse crop areas declined due to an expansion of canola and difficulties with in-crop control of broadleaf weeds and diseases.

New varieties with improved herbicide tolerance and resistance to key pathogens are now available to address these challenges.

Relative yield of crops in WA

Table 1. Crop yields in NVT experiments conducted in the last 5 years in WA (Source NVT 2018 to 2022) and break-even yield (PIRSA Farm gross margin guide 2022).

Crop	Agzone						Break even yield (t/ha)		
	1	2	3	4	5	6	Low rainfall	Medium rainfall	High rainfall
Barley	3.5	3.9	5.0	3.8	3.2	4.6	1.3	2.1	1.7
Canola	1.7	2.2	3.3	1.8	2.0	2.6	0.7	1.0	1.2
Chickpea	1.4	1.0	-	1.1	1.1	-	0.5	0.6	0.8
Faba Bean	-	-	2.4	-	2.2	-	0.6	0.9	1.2
Field Pea	2.0	1.7	1.7	1.5	1.2	-	0.8	0.9	1.2
Lentil	1.6	1.7	2.1	0.5	1.1	-	0.5	0.7	0.8
Lupin	2.2	2.2	-	1.9	1.9	1.7	0.8	1.1	1.3
Oat	-	3.6	4.1	2.6	2.8	4.7	1.1	1.8	2.5
Wheat	3.3	3.7	4.2	3.0	2.9	4.1	0.9	1.7	2.7

Source: NVTonline. PIRSA Farm Gross Margin Guide 2022.
Lentil 2020-2022, Agzone mean data presented if more than 1 trial conducted since 2020.
Break even yields – based off forecast prices; Grades = malting barley, milling oats, red lentil, APW wheat, TT canola.

LEFT: DPIRD Plant Pathology group.

Picking a pulse

Inoculation of pulse crops

One of the key benefits of growing pulses is their ability to fix atmospheric nitrogen, resulting in high protein content in both the pulse grain and the stubble remaining in the paddock. To nodulate roots and fix nitrogen, pulses need to be inoculated with a specific species of rhizobia bacteria. Due to environmental factors limiting bacteria survival, it is recommended that inoculation of pulses happens each season, particularly where soil is acidic or a pulse in the same inoculation group hasn't been grown in several years. Previously, group E (field pea, lentil, and vetch) and group F (faba bean and broad bean) inoculants have been sold in combination. From 2024, these groups will now be sold separately, as new high-performing rhizobia strains for each species have become available. The new strains retain the ability of the old strains to nodulate roots in paddocks where acidity is not an issue and they can effectively nodulate crop roots at lower pHs than previous strains, giving farmers more confidence in achieving optimal nodulation at the lower end of the suitable pH range.

India Warren- Hicks (DPIRD) and Soniamol Johnston (RAIN).

Table 2. Adaptation of broadleaf crops to some soil factors

Crop	pH	Inoculant group	Soil texture	Salinity tolerance rank	Boron tolerance rank	Comments
Canola	4–9		All			
Chickpea	5.5–9	N	Sandy loamy to clay	5	2 (Kabuli varieties) 5 (Desi varieties)	
Faba bean	5.2–9	F	Loam-clay	1	1	Lower pH ok in higher rainfall areas
Field pea	5–9	E	Loamy sand to clay	2	2 (Dun varieties) 4 (White varieties)	
Lentil	5.2–9	E	Loam-clay	4	5	Herbicide damage an issue on sandier soils
Lupin: narrow-leaf	4 –7	G	Sand to sandy loam	3	-	
Lupin: albus	6–7.5	G	Loamy sand to loam	4	-	Higher pH than narrow-leaf lupins
Vetch	5–9	E	Loamy sand to clay	2	1	

1 = least sensitive, 5 = most sensitive

Table 3. Recent experiences and comments on broadleaf crops in WA

Crop	Comments
Canola	• Hard to beat in WA. Well-adapted to WA soils and climate – plus excellent weed control. • Appears to be more sensitive to delayed sowing and patchy emergence than most pulse crops. • Consider alternative breaks to canola if root lesion nematodes are an issue.
Chickpea	• Due to lack of cold tolerance, best results in warmer areas – but high prices make them an option throughout WA. • Low weed burdens and a wider range of chemical options have improved weed control – but no viable crop-topping option = sow in relatively weed free paddocks.
Faba bean	• Lower pH ok in higher rainfall areas. • Recent varieties x agronomy = lower disease risk.
Field pea	• Robust varieties and agronomy package – best weed control package of the pulses. • Lack of early sowing option and higher forecast prices for other pulses may put peas under pressure in the rotation.
Lentil	• Seek advice before growing lentils. • Wide range of farmer experiences from very good yields to very poor results. • Herbicide damage an issue on sandier soils. • Can be sown in April in frost free areas.
Lupin: narrow-leaf	• Early sowing of canola has reduced the pressure on lupin as a break crop. • Sclerotinia stem and pod rot are an increasing risk for lupin crops with denser canopies in regions and seasons with known disease risk. All current lupin varieties appear to be susceptible.
Lupin: albus	• Best suited to medium rainfall areas of the northern wheatbelt. • Adapted to loams with pH 6.0 or above. • Early sowing critical to ensure ok flowering window. • Avoid paddocks with blue lupins due to anthracnose. • Niche market so investigate marketing options.
Vetch	• Particularly suited to farmers with livestock. • Species available that can be sown very early and grazed multiple times. • Grain vetch growers need to talk to marketers as the demand for grain can be variable.

Table 4. Foliar fungicides for pulse crops in WA

Active ingredient		azoxystrobin (200g/L)+ cyproconazole (80g/L)	carbendazim (500g/L)	chlorothalonil (720g/L)	chlorothalonil (900g/kg)	mancozeb (750g/kg)	pydiflumetofen (100g/L)+ fludioxonil (150g/L)	procymidone (500g/L)	prothioconazole (150g/L)+ bixafen (75g/L)	tebuconazole (430g/L)	tebuconazole (370g/L)+ azoxystrobin (222g/L)
Example product		Amistar® Xtra	Spin Flo® – Nufarm	Bravo® Weather Stik® Barrack Betterstick® Nufarm Unite® 720	Sipcam Echo® 900 WDG	Dithane® Rainshield® Neo Tec®	Miravis® Star	Fortress® 500, Sumisclex® 500	Aviator® Xpro®	Orius® 430 SC	Veritas® Opti
Crop	**Disease**										
Chickpea	Ascochyta blight	400–800mL		1.0–2.0L	0.8–1.6kg	1.0–2.2kg	250–500mL		400–600mL		400–540mL
	Botrytis grey mould	400–800mL	500mL			1.0–2.2kg	750–1000mL				400–540mL
	Sclerotinia						750–1000mL				
Field pea	Blackspot			1.1–1.8L		1.0–2.2kg			600mL		400–540mL
	Downy mildew or BGM	400–800mL		1.1–1.8L	0.9–1.5kg	1.0–2.2kg	750–1000mL				400 to 540mL
	Powdery mildew									145mL	
Faba bean	Ascochyta	400–800mL				1.0–2.2kg	250–500mL	500mL	400–600mL		400–540mL
	Cercospora	400–800mL				1.0–2.2kg	750–1000mL	500mL	400–600mL	145mL#	160mL
	Chocolate spot	400–800mL (suppression)	500mL	1.4–2.3L	1.2–1.9kg	1.0–2.2kg	750–1000mL	500mL	600mL		400–540mL
	Rust	400–800mL		1.4–2.3L	1.2–1.9kg	1.0–2.2kg			600mL	145mL#	160mL
Lentil	Ascochyta blight	400–600mL		1.4–2.3L	0.8–1.6kg	1.0–2.2kg	250–500mL		400–600mL		400–540mL
	Botrytis grey mould	400–600mL	500mL	1.4–2.3L	0.8–1.6kg	1.0–2.2kg	750–1000mL	500mL	400–600mL		400–540mL
	Sclerotinia						750–1000mL				
Lupin@	Anthracnose					1.0–2.2kg					
	Botrytis grey mould	400–800mL				1.0–2.2kg	750–1000mL				400–540mL
	Sclerotinia						750–1000mL				
Vetch	Ascochyta blight	400–800mL				1.0–2.2kg	250–500mL				
	Botrytis grey mould	400–800mL	500mL			1.0–2.2kg	750–1000mL				400–540mL
	Rust	400–800mL				1.0–2.2kg					

refer to permit PER13752
@ There are extra active ingredients registered by permit for anthracnose and sclerotinia, see registration page on https://www.agric.wa.gov.au/lupins/registered-foliar-fungicides-lupin-and-other-pulse-crops-western-australia

[Table 4. continued following page...]

Table 4. Foliar fungicides for pulse crops in WA (cont'd)

Active ingredient		azoxystrobin (200g/L)+ cyproconazole (80g/L)	carbendazim (500g/L)	chlorothalonil (720g/L)	chlorothalonil (900g/kg)	mancozeb (750g/kg)	pydiflumetofen (100g/L)+ fludioxonil (150g/L)	procymidone (500g/L)	prothioconazole (150g/L)+ bixafen (75g/L)	tebuconazole (430g/L)	tebuconazole (370g/L)+ azoxystrobin (222g/L)
Example product		Amistar® Xtra	Spin Flo® – Nufarm	Bravo® Weather Stik® Barrack Betterstick® Nufarm Unite® 720	Sipcam Echo® 900 WDG	Dithane® Rainshield® Neo Tec®	Miravis® Star	Fortress® 500, Sumisclex® 500	Aviator® Xpro®	Orius® 430 SC	Veritas® Opti
Withholding period – harvest		8 weeks	28 days	14 days	14 days	28 days	Not required when used as directed	Faba bean 9 days, lentil 21 days	Not required	3 days	28 days
Withholding period – graze		4 weeks	28 days	14 days	14 days	14 days	6 weeks	Lentil 21 days	35 days	3 days	28 days
Group		Group 3 and 11	Group 1	Group M5	Group M5	Group M3	Group 7 and 12	Group 2	Group 3 and 7	Group 3	Group 3 and 11
Special comments		DO NOT apply after development of pods				Less effective on botrytis grey mould and chocolate spot than alternative products	DO NOT apply more than two applications per crop. Apply up to the end of flowering.		DO NOT apply after early flowering in faba, field pea and lentil or after late flowering in chickpea		DO NOT apply more than 1.08L/ha of VERITAS® OPTI per season in pulses

Lupin

Introduction

Narrow-leafed lupins are uniquely suited to the acid and sandy soils found across large tracts of the Western Australian grainbelt and play an important role in breaking cereal disease cycles and adding fixed nitrogen to cropping systems.

Increased use of canola as a break crop in recent years has seen lupin production in WA decline from a high of more than one million hectares in the late 1990s to about 300,000 to 400,000 hectares with a current gross value of production of about $200 million.

Recent release

AGT released two new narrow-leaf lupin varieties in September 2023, with an end point royalty (EPR) of $4.50 per tonne (GST exclusive). Very limited amounts of seed will be available to growers in 2024. Both varieties have improved lodging tolerance compared to PBA Jurien, with good tolerance to metribuzin.

Gidgee has a short-medium plant height and a provisional rating of MR to both stem phomopsis and anthracnose and S for pod phomopsis. Since 2021, Gidgee has been in 27 NVTs across Agzones 1, 2, 4, 5 and 6. It has a similar maturity and adaptation to PBA Jurien, and has had comparable yields in most agzones, with both varieties amongst the top of the pack in two high-yielding seasons.

Rosemont has excellent early vigour, with taller plant height and better lodging resistance than PBA Jurien. It is a slower maturing variety that is broadly adapted to all WA regions, including the south. It has a white flower and seed coat. Rosemont has had good yields in NVTs, particularly in Agzones 1 and 2, although it has only been trialed in 2022.

What variety should I grow?

Besides stable high yields, growers generally choose varieties with sufficient metribuzin tolerance for broadleaf weed control as well as anthracnose tolerance and low pod shatter. In recent years the most widely grown variety has been PBA Jurien.

In September 2019, a new variety of narrow-leaf lupin was released called Coyote. It is early maturing (similar to PBA Jurien), with metribuzin tolerance similar to Mandelup. Coyote is susceptible to phomopsis stem infection, so lupin stubbles should be grazed with care in high-risk environments.

Table 1. Grain yield of narrow-leaf lupin varieties in AGZONE 1 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	2.64	1.03	1.39	3.52	2.65
No. of trials	(3)	(2)	(1)	(1)	(1)
Coromup	96	101	90	92	101
Coyote	106	107	107	108	120
Gidgee	-	-	-	104	115
Jenabillup	100	-	-	-	-
Mandelup	-	94	97	106	110
PBA Barlock	-	86	93	107	104
PBA Bateman	102	103	106	105	107
PBA Gunyidi	-	104	106	98	92
PBA Jurien	-	95	103	-	117
PBA Leeman	98	100	85	91	103
Rosemont	-	-	-	-	122
Wonga	-	69	71	92	75

Source: NVT Online, **nvtonline.com.au**

NOTE: For all Agzones in 2018, Mandelup, PBA Barlock, PBA Gunyidi and PBA Jurien establishment was poor, and these varieties were not included in the analysis. Use 2018 data with caution. For all Agzones in 2021, PBA Jurien was not included due to seed source issues.

Table 2. Grain yield of narrow-leaf lupin varieties in AGZONE 2 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	2.04	1.64	2.00	2.98	2.29
No. of trials	(5)	(7)	(5)	(5)	(6)
Coromup	97	98	90	91	97
Coyote	108	108	111	110	113
Gidgee	-	-	-	106	109
Jenabillup	98	-	-	-	-
Mandelup	-	99	101	108	105
PBA Barlock	-	94	97	108	105
PBA Bateman	103	104	107	106	105
PBA Gunyidi	-	102	103	97	95
PBA Jurien	-	102	108	-	114
PBA Leeman	99	97	86	90	98
Rosemont	-	-	-	-	115
Wonga	-	77	71	89	85

Source: NVT Online, **nvtonline.com.au**

NOTE: For all Agzones in 2018, Mandelup, PBA Barlock, PBA Gunyidi and PBA Jurien establishment was poor, and these varieties were not included in the analysis. Use 2018 data with caution. For all Agzones in 2021, PBA Jurien was not included due to seed source issues.

Table 3. Grain yield of narrow-leaf lupin varieties in AGZONE 4 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	2.26	0.65	1.43	2.03	2.70
No. of trials	(3)	(3)	(3)	(5)	(5)
Coromup	100	98	91	94	99
Coyote	109	113	108	109	109
Gidgee	-	-	-	105	110
Jenabillup	97	-	-	-	-
Mandelup	-	102	100	106	102
PBA Barlock	-	97	97	106	99
PBA Bateman	102	106	106	105	103
PBA Gunyidi	-	99	103	97	98
PBA Jurien	-	108	106	-	106
PBA Leeman	103	97	88	94	99
Rosemont	-	-	-	-	112
Wonga	-	73	76	90	84

Source: NVT Online, **nvtonline.com.au**

NOTE: For all Agzones in 2018, Mandelup, PBA Barlock, PBA Gunyidi and PBA Jurien establishment was poor, and these varieties were not included in the analysis. Use 2018 data with caution. For all Agzones in 2021, PBA Jurien was not included due to seed source issues.

Table 4. Grain yield of narrow-leaf lupin varieties in AGZONE 5 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	1.71	1.21	1.54	2.59	2.20
No. of trials	(1)	(1)	(2)	(2)	(2)
Coromup	93	94	93	94	92
Coyote	114	104	108	109	107
Gidgee	-	-	-	109	109
Jenabillup	94	-	-	-	-
Mandelup	-	103	101	104	102
PBA Barlock	-	104	99	102	101
PBA Bateman	107	103	105	105	105
PBA Gunyidi	-	100	101	99	101
PBA Jurien	-	107	106	-	107
PBA Leeman	-	92	91	92	90
Rosemont	-	-	-	-	112
Wonga	-	94	81	84	85

Source: NVT Online, **nvtonline.com.au**

NOTE: For all Agzones in 2018, Mandelup, PBA Barlock, PBA Gunyidi and PBA Jurien establishment was poor, and these varieties were not included in the analysis. Use 2018 data with caution. For all Agzones in 2021, PBA Jurien was not included due to seed source issues.

Table 5. Grain yield of narrow leaf lupin varieties in AGZONE 6 expressed as percentage of site mean yield for each trial year (2018–2021)

Year	2018	2019	2020	2021
Site mean yield (t/ha)	1.10	1.82	2.00	1.70
No. of trials	(1)	(1)	(1)	(1)
Coromup	50	95	97	95
Coyote	135	121	120	108
Jenabillup	105	-	-	-
Mandelup	-	116	108	103
PBA Barlock	-	115	101	101
PBA Bateman	123	108	108	105
PBA Gunyidi	-	89	95	100
PBA Jurien	-	127	117	-
PBA Leeman	-	97	98	93
Wonga	-	84	67	84

Source: NVT Online, **nvtonline.com.au**

NOTE: For all Agzones in 2018, Mandelup, PBA Barlock, PBA Gunyidi and PBA Jurien establishment was poor, and these varieties were not included in the analysis. Use 2018 data with caution. For all Agzones in 2021, PBA Jurien was not included due to seed source issues. There was no narrow leaf lupin NVT in Agzone 6 in 2022.

Table 6. Lupin variety NVT disease ratings

Variety	Anthracnose	Brown leaf spot	Cucumber mosaic virus	Phomopsis (pod infection)	Phomopsis (stem infection)
Coromup	MR	MS	MR	MS	MR
Gidgee	MR*p*	MS*p*	MRMS*p*	S*p*	MR*p*
Coyote	MRMS	MS*p*	MRMS	MRMS	S
Jenabillup	MS	MRMS	MRMS	MR	MS
Mandelup	MRMS	MS	MRMS	S	RMR
PBA Barlock	RMR	MS	MR	MR	MR
PBA Bateman	MRMS	MS	MR	MS	RMR
PBA Gunyidi	MRMS	MS	MRMS	MRMS	RMR
PBA Jurien	RMR	MS	MS	MR	RMR
PBA Leeman	MRMS	MS	MRMS	MRMS	MR
Rosemont	MRMS*p*	MS*p*	MR*p*	MS*p*	MR*p*

Source: NVT Online, nvtonline.com.au, AGT and DPIRD
S = Susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, RMR = Resistant to moderately resistant. *p* = provisional rating

Table 7. Lodging, disease and insect ratings for narrow-leaf lupins in WA

Variety	Lodging (high rainfall)	Grey spot	BYMV	Aphid
Coromup	MRMS	R	S	R
Coyote	-	R	MR	-
Jenabillup	MRMS	R	MR	R
Mandelup	MS	R	S	R
PBA Barlock	MR	R	MS	R
PBA Bateman	MRMS	R	MR	R
PBA Gunyidi	MR	S	MS	R
PBA Jurien	MRMS	R	MRMS	R
PBA Leeman	MRMS	R	S	R

Source: DPIRD
S = Susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, R = Resistant.

Table 8. Seed quality of narrow-leafed lupin varieties as a percentage of Mandelup

Variety	100-seed weight (g)*	Protein as % of Mandelup#	Alkaloid as % of Mandelup#
Mandelup	**15.8**	**100 (32%)**	**100 (0.017%)**
Coromup	15.7	-	-
Coyote	15.1	Similar to Mandelup^	Similar to Mandelup and PBA Jurien^
Jenabillup	16.0	103	67
PBA Barlock	14.9	97	115
PBA Bateman	16.3	-	-
PBA Gunyidi	14.3	102	100
PBA Jurien	157	102	105
PBA Leeman	15.7	-	-

Source: *NVT data (2018-2022); # PBA variety release documents summarising protein and alkaloid percent (whole seed, six sites, 2010-2014); ^AGT data.

Lupin agronomy guide

Paddock selection

- Sandy textured soils with pH 4.5–7.0 (calcium chloride – $CaCl_2$) and good depth.
- Avoid saline soils, those subject to waterlogging, alkaline and shallow duplex soils.
- A relatively low weed burden.
- Avoid paddocks with large areas of WA blue lupins, particularly in northern areas.
- Ideally paddocks with reasonably heavy stubble from previous year (i.e. cereal) to reduce brown spot risk.
- The interval between lupin crops is determined by several factors including the level of brown spot and weed burden.
- Soils must be free of sulfonylurea herbicide residues (e.g. Glean®, Logran®).

Rotation

- Growing lupins following a cereal crop minimises disease risk.
- Lupins should never be grown following lupins.

Sowing window

Agzone	Rainfall	Suggested sowing date
Agzone 1	High	Late April to early June
	Medium	Late April to mid-May
Agzone 2	High	Late April to early June
	Medium	Late April to mid-May
Agzone 3	High	Early May to early June
Agzone 4	Low	Late April to mid-May
Agzone 5	Low-Medium	Late April to mid-May
Agzone 6	High	Late April to early June

Sowing depth

- Sow seeds 3–5cm below the soil surface.

Seed dressing and inoculation

- Seed should be treated with either iprodione (e.g. Rovral®) or procymidone (e.g. Sumisclex®) to reduce the risk of brown spot and pleiochaeta root rot on old lupin country.
- In high-risk areas, thiram seed dressing should be applied to reduce the transmission of seed-borne anthracnose at the rate of 100g active ingredient per 100kg of seed. Thiram is not compatible with rhizobium inoculums.
- Apply Group G (or S) inoculum to seed or as dry granule where lupins have not been grown during the past five years. On neutral and alkaline soils inoculate every time a lupin crop is grown.

Fertiliser

- Use soil tests and paddock history to determine rates.
- Deep-band phosphate at seeding for maximum efficiency and to minimise salt toxicity to seedlings.
- On soils with potential manganese deficiency, manganese can be drilled with compound fertiliser or alternatively applied as a foliar spray. This is especially important for paddocks growing the next year's lupin seed.

Target density

- 40–45 plants/m².
- Yields can decline below 40 plants/m².

Seeding rate

- Between 90–120kg/ha — adjust for germination rate and seed size.

Seed source

- Use high quality seed from paddocks with good fertiliser history.
- Check the seed for germination percentage, seed size, freedom from cucumber mosaic virus (CMV) and anthracnose. Use seed that has less than 0.5% CMV-infected seed.
- In areas where manganese deficiency is a problem, also test for manganese levels. Replace seed if manganese is below 20mg/kg.

Row spacing

- In the warm dry environments of the medium- and low-rainfall northern wheatbelt, wider rows (50cm or more) are likely to yield better than narrower rows (18–25cm).
- Narrower rows are most likely to yield better in cooler, longer season environments where terminal drought is not severe and yield potential is very high.
- Narrow rows and/or high density can help reduce infection of bean yellow mosaic virus in high-risk paddocks.

Herbicide options

The following herbicides are registered on lupins in WA. It is advisable to check labels of specific herbicide products for rates, crop and weed growth-stages for application, recommended surfactants and oils, withholding and plant-back periods, etc.

Pre-seeding and incorporated by sowing (IBS) herbicides

- Atrazine 900g/kg, Group 5/C, e.g. Atradex® WG at 280–560g/ha. Apply atrazine in mixture with simazine 900 (e.g. Simagranz®) at 280–560g/ha. Use a maximum of 930g/ha of atrazine and simazine mixture on yellow sands and 1.12kg/ha on all other soil types.
- Carbetamide 900g/kg, Group 23/E, e.g. Ultro® 900 WG at 1.1–2.3kg/ha. Apply the lower rate on sandy soils and where lower weed densities are expected. However, use the higher rate on heavier soils and where the weed densities are expected to be moderate to high. Do not apply carbetamide pre-sowing if planting with disc seeder as increased contact between the germinating seed and herbicide may reduce crop safety.
- Dimethenamid-P 720g/L, Group 15/K, e.g. Outlook® at 1L/ha. Annual ryegrass suppression only at higher density.
- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 1.1kg/ha. Do not use on white or grey sands.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.5L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.
- Metribuzin 750g/kg®, Group 5/C, e.g. Titan Metribuzin at 200g/ha. A permit (PER89566) with validity up to 30 April 2024 is in place for this use pattern. Apply to metribuzin tolerant varieties only including Mandelup, PBA Barlock, PBA Jurien and PBA Leeman. The permit is expected to be renewed by the start of 2024 season.
- Pendimethalin 440g/L, Group 3/D, e.g. Stomp® at 1.5–2.25L/ha. Apply 1.5L/ha in mixture with simazine 900 at 0.55kg/ha up to 24 hours prior to lupin sowing.
- Propyzamide 900g/kg, Group 3/D, e.g. Edge® 900 WG at 0.56–1.11kg/ha. Use higher rates on heavy soils under sub-optimal conditions or where a heavy grass population is expected.
- Prosulfocarb 800g/L (Group 15/J) + s-metolachlor 120g/L (Group 15/K), e.g. Boxer Gold® at 2.5L/ha.
- Pyroxasulfone 850g/kg, Group 15/K, e.g. Sakura® at 118g/ha.
- Simazine 900g/kg, Group 5/C, e.g. Simagranz® at 0.55–1.6kg/ha. Apply 0.55–1.1kg/ha on light soils and 1.1–1.6kg/ha on heavy soils. Do not use on whitish or grey sands.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.86–1.2kg/ha. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40–60%). Sow 3cm and preferably 5cm deep. Do not use rates higher than 0.86kg/ha on soils with pH 8.0 and above as unacceptable crop damage may occur.
- Terbuthylazine 600g/kg (Group 5/C) + Propyzamide 300g/kg (Group 3/D), e.g. Effigy® 900 WG at 1.25–1.75kg/ha. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40–60%). Sow at least 5cm deep. The rates higher than 1.25kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage. Heavy, intense rainfall following application may cause crop damage.
- Tri-allate 500g/L, Group 15/J, e.g. Avadex® Xtra at 1.6L/ha.
- Trifluralin 480g/L, Group 3/D, e.g. TriflurX® at 1.2–1.7L/ha. The rate depends upon the soil type, refer to label.
- Trifluralin 350g/L (Group 3/D) + Tri-allate 550g/L (Group 15/J), e.g. Jetti Duo® at 1.45–1.8L/ha. For best results apply within 12 hours of crop sowing. Use it with knife/blade point sowing system.

Post-sowing pre-emergent (PSPE) herbicides

- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 1.1kg/ha. Do not use on white or grey sands and must be applied before crop emergence.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.25L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.
- Simazine 900g/kg, Group 5/C, e.g. Simagranz® at 0.55–1.6kg/ha. Apply 0.55–1.1kg/ha on light soils and 1.1–1.6kg/ha on heavy soils. Do not use on whitish or grey sands.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.6–0.86kg/ha. Apply within two days of sowing. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40-60%). Sow crop 3cm and preferably 5cm deep. Do not use rates higher than 0.86kg/ha on soils with pH 8.0 and above as unacceptable crop damage may occur. Heavy, intense rainfall following application may cause crop damage.

Important points to consider when using pre-emergent herbicides

- Soil type will influence the maximum rate of pre-emergent herbicides that can be applied; so check the herbicide labels for details. For example, in WA, simazine (900g a.i./kg) at 0.55–1.1kg/ha (Group 5/C) is registered on light soils, whereas the rate registered for gravelly-loam soils is 1.1–1.6kg/ha.
- Due to a different sub-group within Group 5/C herbicides, adding 0.55–1.1kg/ha of diuron (900g a.i./kg) will help manage wild radish resistant to simazine/atrazine. It will also improve control of capeweed and doublegee. Crop damage can occur if diuron is added to high rates of simazine and/or atrazine or terbuthylazine. For improved crop safety, reduce the rate of triazines (e.g. simazine).
- If grass weed populations are high, add grass herbicides such as trifluralin, propyzamide, pyroxasulfone, etc, to the recommended rates of simazine/atrazine/terbuthylazine.
- Use of soil-applied residual herbicides on mouldboard ploughed/renovated soils could cause crop damage, especially when lupins are sown shallower than the recommended depth of 3–5cm.

Post-emergent herbicides for broadleaf weed control

- Diflufenican 500g/L, Group 12/F, e.g. Brodal® Options or Bonanza® Elite at 100–200mL/ha. Apply from 2nd-leaf stage to big bud stage of lupins (before start of main stem flowers). Apply diflufenican 500g/L at 100mL,150mL and 200mL/ha for control of up to 2, 4 and 6-leaf stage weeds (wild radish, hedge mustard, Indian hedge mustard and wild turnip), respectively. Suppression of capeweed up to 4 leaf stage at 200mL/ha rate.
- Metosulam 100g/L, Group 2/B, e.g. Eclipse® at 50–70mL/ha. Use 50mL/ha when wild radish population is low (less than 100 plants/m^2) and growing conditions are optimal. Apply 70mL/ha where wild radish density is high, or crop competition is poor. Application window is between 8-leaf stage of crop to the appearance of flower bud/big bud for control of up to 8-leaf wild radish. Do not use wetting agents, spray oils and surfactants with this herbicide.
- Metosulam 100g/L, Group 2/B, e.g. Eclipse® at 50mL/ha + diflufenican 500g/L, Group 12/F, e.g. Brodal® Options at 100mL/ha. Application window is between 8-leaf stage of crop to pre-big bud stage (main stem flowering) for control of up to 8-leaf wild radish and suppression of up to 6-leaf capeweed.
- Metribuzin 750g/kg, Group 5/C, e.g. Stacato® or Mentor® WG at 100–150g/ha plus 100mL/ha Brodal® Options (diflufenican 500g/L), Group 12/F. Apply to actively growing lupins from 3–4 leaves until bud emergence stage for control of wild radish up to 250mm diameter in size and suppression of capeweed, doublegee and larger wild radish. Use higher rates for heavy weed burden and larger weed size. Do not use wetting agents and spray oils with this herbicide mixture.

- Picolinafen 750g/kg, Group 12/F, e.g. Glocker® 750 WG at 33–50g/ha. Apply at 2–6 leaf stage of lupins. Use the lower rate on 2–4 leaf and higher rate on 6–8 leaf wild radish and good spray coverage of the weeds is essential. Suppression of capeweed only at the higher rate.
- Simazine 900g/kg, Group 5/C, e.g. Simagranz® at 0.4–1.1kg/ha as a top-up application within four weeks of sowing following a pre-emergence application of simazine at label rates.

Post-emergent herbicides for grass weed control

- Butroxydim 250g/kg, Group 1/A, e.g. Factor® WG at 80–180g/ha + Supercharge® Elite® at 1% (v/v) to control 2-leaf to early tillering weeds. The lower rates are for younger weeds growing actively under ideal conditions. The higher rates for the weeds that are at early tillering stage, or in dense populations, or growing in poor growing conditions. For improved control of ryegrass and other grass weeds, it must be combined with clethodim or fop herbicide containing fluazifop-p, haloxyfop-R, propaquizafop or quizalofop. Do not apply at flowering stage of crop.
- Clethodim 240g/L, Group 1/A, e.g. Select® or Status® at 150–500mL/ha + D-C-Trate® at 2% or Hasten® at 1% or Kwickin® at 1% or Uptake® oil at 0.5% (v/v) for control of 2-leaf to fully tillered grass weeds, refer to label. The lower rates will provide effective control if applied under ideal conditions to weeds that are smaller, actively growing, and free from temperature or water stress. Do not apply after 80% of lupin flowers have opened.
- Diclofop-methyl 375g/L, Group 1/A, e.g. Di-Grass or Sirofop® at 1–2L/ha + wetting agent (e.g. Wetspray® 1000) at 0.25% (v/v) to control 2–4 leaf stage weeds. The rate selection depends upon the weed species and their size, refer to label. Do not spray when temperatures are higher than 25°C.
- Fluazifop-p 128g/L, Group 1/A, e.g. Fusilade® Forte at 410–820mL/ha. Lower rate for 2–5 leaf stage weeds and higher rate for 5-leaf to early tillering weeds. Apply up until 17 weeks before crop harvest.
- Haloxyfop-R 520g/L, Group 1/A, e.g. Verdict® at 50–100mL/ha + Uptake® oil at 0.5% or non-ionic wetting agent (e.g. BS1000®) at 0.2% (v/v). Application rate depends on weed size, adjuvant type and mix partner, refer to label. Apply from 2-leaf to pre-flowering crop growth stages. Do not apply in mixture with diflufenican (e.g. Brodal® Options), Group 12/F, or simazine, Group 5/C, as crop yellowing may occur and separate applications are recommended. Withholding periods are not required when used as directed.
- Propaquizafop 100g/L, Group 1/A, e.g. Shogun® at 200–450mL/ha + Hasten® or Kwickin® at 0.5% or non-ionic wetting agent (e.g. BS1000®) at 0.2% (v/v) to control 3-leaf to mid tillering weeds. Use 300mL/ha where ryegrass is not the dominant weed. Use higher rate for ryegrass control and for best results wait until 75% of ryegrass have begun tillering. Apply up until 15 weeks before crop harvest.
- Quizalofop-p-ethyl 200g/L, Group 1/A, e.g. Elantra® Xtreme® or Leopard® 200 at 65–190mL/ha + Hasten®/Plantocrop™ at 1% or non-ionic surfactant (e.g. BS1000®, Wetspray®) at 0.2% or non-ionic surfactant (1000g a.i./L) at 0.1% plus a mineral spray oil at 1% (v/v) to control 3-leaf to early tillering weeds. The selection of rate depends upon the weed species and their size, refer to label. Use higher rate under heavy weed pressure, and/or when weeds have commenced tillering. Apply up until six weeks before crop harvest.

v/v = volume by volume of final spray solution

Post-emergent herbicides – timing for weeds

- Spray small weeds early.
- Apply top-up simazine, Group 5/C, diflufenican and picinolinafen, Group 12/F, when radish has 2–6 leaves.
- Target radish smaller than 250mm in diameter with metribuzin, Group 5/C.
- Use metosulam (e.g. Eclipse®), Group 2/B, for controlling wild radish up to 200mm in diameter or 8-leaf stage.
- Target ryegrass before tillering.

Important points to consider when using post-emergent herbicides

- High uptake of pre-emergent triazines (e.g. simazine, atrazine or terbuthylazine, Group 5/C) following good soil moisture or high usage rates may predispose the lupin crop to damage by typically ‘safe rates’ of post-emergent broadleaf herbicides. Symptoms may include leaf whitening or root rot.

- Diflufenican (e.g. Brodal® Options) and picolinafen (e.g. Glocker®), Group 12/F, alone, or in combination with other herbicides, can cause bleaching or leaf spotting on most lupin varieties. Typically, symptoms diminish over time and the crop outgrows the effects.
- The use of metribuzin (Group 5/C) alone, or in combination with other herbicides, can cause leaf burn and slight crop suppression in most varieties. Newer lupin varieties such as PBA Gunyidi, PBA Barlock, PBA Leeman and Coyote have better metribuzin tolerance than older varieties such as Tanjil.
- It is not advisable to apply metribuzin, Group 5/C, in mixture with other herbicides if brown leaf spot or other leaf diseases are present.
- Metosulam (e.g. Eclipse®), Group 2/B, often causes yellowing, height and/or biomass reduction in most lupin varieties. Plants typically recover rapidly in normal growing conditions.
- Broadleaf herbicides should not be mixed with oil or products containing emulsifying agents.
- Application of broadleaf post-emergent herbicides to moisture-stressed lupins, or when moisture stress is likely soon after application, can lead to crop damage from herbicides that are typically safe when used in typical growing conditions.
- All grass-selective herbicides at label rates are typically safe when used on lupins, but it is not advisable to apply such products in a tank mix with broadleaf herbicides because crop damage will result.
- Ensure at least a 10-day break between spraying broadleaf herbicides and a grass-selective herbicide.

Crop-topping

- Paraquat 250g/L, Group 22/L, e.g. Gramoxone® or Shirquat® is registered for crop-topping at 400 or 800mL/ha for ground application only. Using a higher rate is usually more reliable and provides a greater reduction in annual ryegrass seed set. Current use of paraquat for crop-topping may alter access to markets and prices.
- For best results crop-top when 80% of lupin leaves have fallen off and ryegrass is at the flowering to soft dough stage.
- If the target lupin and ryegrass windows are not going to match up but weed control is the highest priority, some lupin yield may need to be sacrificed (which could be more than 25%). Spray before 80% leaf drop. The higher label rate may also exacerbate yield reduction.
- Do not harvest within seven days of application.

Desiccation

- Diquat 200g/L, Group 22/L, e.g. Reglone® at 2–3L/ha as a pre-harvest desiccant at full crop maturity helps overcome slow and uneven crop ripening and weed problems at harvest.
- Glyphosate, Group 9/M, e.g. Crucial® (glyphosate 600g/kg) at 0.6 to 1.6L/ha and Weedmaster® DST® (glyphosate 470g/kg) at 0.77 to 2.0L/ha are registered as harvest-aid and for annual weeds control. Apply at or after crop maturity when seed moisture content is below 30%. Use higher label rates where crops or weeds are dense and where faster desiccation is required. Do not use on crops intended for seed production and sprouting. Do not harvest crop within seven days of application. Not all glyphosate products are registered for this use; refer to the registered product (Crucial® and Weedmaster® DST®) labels.
- Pyraflufen-ethyl 25g/L, Group 14/G, e.g. Sledge® at 200mL/ha alone or in mixture with the label rate of paraquat (e.g. Inferno®) are registered as a harvest-aid and for the reduction of seed-set and viability of weed seeds. The tank mixture of pyraflufen-ethyl and paraquat may improve harvest efficiency and weed control, and reduce seed set and viability of weed seeds. Apply to lupins at or after 80% lupin-leaf drop and to weeds preferably at full flowering stage for maximum weed-seed-set reduction. Application prior to windrowing will result in severe loss in lupin seed yield. Adhere to the crop growth stage for this application to minimise yield losses. Do not use it with glyphosate. Do not apply less than seven days before harvest.
- Saflufenacil 700g/kg, Group 14/G, e.g. Sharpen® WG is registered as a harvest-aid at 34g/ha in a mixture with label rate of paraquat plus 1% Hasten® or high-quality methylated seed oil (MSO). Apply when 80% of lupin leaves have dropped. Earlier applications than the recommended growth stage may result in grain yield penalties. Do not harvest within seven days of application.

Insect control

- **Emergence:** three weeks post-emergence — red legged earth mite, cutworm and lucerne flea.
- **Flowering:** aphids — consider controlling aphids in flowering lupins if more than 30% of the crop is infested.
- **Pod fill:** native budworm — consider controlling budworm in lupins if more than eight budworms over 15mm are found in one square metre of crop (10 sweeps using a sweep net is about one square metre).

Disease management

- Lupins are susceptible to a wide range of diseases. Roots, hypocotyls, stems, pods and seeds are all subject to infection by disease organisms. Several of these diseases have the capacity to cause catastrophic losses, but this is rare if management guidelines are followed.
- Key steps in the integrated management of lupin diseases include crop rotation, stubble management, fungicide or pesticide application, variety selection and seed testing.

Clean seed

- Where possible, choose seed with low risk of anthracnose or CMV infection. Tolerance of seed infection is lower in more susceptible varieties.

Phomopsis and lupinosis

- A potential issue with grazing lupin stubble or lupin seed is the risk of lupinosis. Lupinosis is a disease that is caused by toxins produced by the Phomopsis fungus (*Diaporthe toxica*) as it grows in the stem after maturity. All varieties carry some lupinosis risk, but it is most pronounced in susceptible varieties. Grazing infected stubbles or desiccated fodder crops, following late season or summer/autumn rain poses greatest risk, particularly when black fruiting bodies (leopard spotting) are visible on stems.

Seed dressings fungicides

- **Brown spot:** on paddocks that have previously grown lupins, seed should be treated with either iprodione (e.g. Rovral®) or procymidone (e.g. Sumisclex® broadacre fungicide) to reduce the risk of brown spot and pleiochaeta root rot.
- **Anthracnose:** to reduce the transmission of seed-borne anthracnose, seed should be treated with thiram seed dressing at the rate of 100–120g active ingredient per 100kg of seed. Thiram is not compatible with rhizobium inoculums.

Foliar fungicide options

- Several foliar fungicide products are registered for control of lupin diseases; refer to the 'Fungicide for Pulses' table at the beginning of the Pulse Section (pages 162–163), and product labels for directions for use.
- **Anthracnose:** products containing mancozeb are registered for anthracnose management. AVPMA permits for products containing azoxystrobin (PER82226) or chlorothalonil (PER82209) for control of anthracnose in albus lupin are current.
- **Sclerotinia:** the product Miravis® Star (750–1000mL/ha) is registered for use in lupin.
- **Botrytis:** Miravis® Star, Amistar Xtra®, Veritas® Opti and products containing mancozeb are registered for botrytis control in pulses, including lupins.

Harvesting

- Harvest lupin crops as soon as they are ripe. Delays can result in significant yield loss due to lodging, pod shattering and pod drop. Start harvesting as soon as the moisture content reaches 14%. In some seasons this will occur when the stems are still pale green.
- Harvest losses can be substantially reduced by harvesting when humidity is high. Lupin plants strip well during the night and early morning. If possible, do not harvest in the middle of the day when it is very hot. In cooler southern environments, daytime temperatures often do not become warm enough to cause major problems for harvest. In these areas it may be better to harvest the crop as quickly as possible rather than swapping between lupins and cereals.
- Harvest seed for next year's crop as soon as it is mature. Set the harvester drum or rotor speed to a minimum and the concave opened fairly wide. This will reduce damage to the embryo and help to ensure a high germination percentage. The seed embryo is very sensitive to impact if it becomes dry and brittle. Even seed with no visible damage may have low percentage germination if it suffered a high impact when its moisture content was low.

Chickpea

Introduction

Chickpea is a suitable break crop for heavier soils with pH above 5.5.

There was an expanding chickpea industry in WA during the 1990s until the arrival of ascochyta blight. Since then, new varieties with improved tolerance to ascochyta have become available, however the pathogen's ability to overcome this resistance has seen a decline in the tolerance of these varieties in recent years. Robust fungicide packages have been developed to manage ascochyta blight.

New herbicides have also become available for extended control of wild radish.

In recent years prices have been high, enticing some growers to start planting chickpeas again. However, prices remain somewhat volatile.

For trouble-free chickpea growing, it is important to:

- select a variety with tolerance to ascochyta.
- have a disease management plan.
- use an inoculant and a seed dressing at sowing.
- sow into a relatively clean paddock as post-emergent broadleaf herbicides can be ineffective.

Using seed free of ascochyta is critical; growers have been caught out sowing seed infected with ascochyta and not knowing the germination rate, resulting in very poor establishment.

What type and variety should I grow?

Western Australian growers have traditionally chosen to plant desi chickpea types as they have been higher yielding and easier to market than kabuli types. Desi chickpea types have small angular seeds weighing about 120mg, which are wrinkled at the beak and range in colour from brown to light brown and fawn. They are normally dehulled and split to obtain dhal. Kabuli types have larger, rounder seeds that are white cream in colour and almost exclusively used whole – so seed size and appearance are critically important. Yields of kabulis are generally lower and more variable than desi varieties, although premiums for larger chickpeas can offset the yield disadvantage.

Regardless of the chickpea type grown, it is a good idea to talk to potential buyers before sowing.

Desi varieties

CBA Captain is a taller variety that performs well in WA and is now available for sale to growers. Older varieties PBA Striker and Neelam are also consistent performers across WA.

Kabuli varieties

Kabulis are often more difficult to sell than desi chickpea – so seek advice from potential buyers before growing kabulis in WA.

Genesis 090 is the most readily available kabuli variety in WA. It can command a premium price above varieties such as Genesis 079, but there is no guarantee that WA growers will be able to produce the required seed size in all years.

Chickpea seed size guide

Table 1. Chickpea seed size guide

	Grade	Seed diameter (mm)	Seed weight (gms per 100)	Varieties
Desi type	Medium		18–27	PBA Striker, Gen836, Neelam, CBA Captain
Kabuli type	Small	6–8	20–35	Gen090, Gen079
	Medium	7–9	35–45	Almaz, PBA Monarch
	Large	8–10	40–50	Kalkee
	Very large	9–11	50–65	Kimberley Large

Source: Australian Pulse Variety Guide 2020 (Pulse Australia)

Recent release

In October 2020, NSW DPI released CBA Captain. CBA Captain is an erect desi chickpea with medium seed size and angular shape. In all agzones where NVT evaluation has been done CBA Captain out-yielded Genesis 836, a current variety with a similar erect plant type. CBA Captain has achieved similar yields to PBA Striker but offers excellent harvestability compared to PBA Striker because its lowest pod is higher in the canopy at maturity.

CBA Captain has a moderately susceptible ascochyta blight rating, which is greater than PBA Striker (rated as susceptible).

CBA Captain has superior grain quality (coat colour, texture and shape) to all current WA chickpea varieties and is considered a 'Jimbour type'. This variety will also be produced in eastern Australia and will provide WA growers with an opportunity to access established markets.

Grain yield

See Tables 2 to 6.

Table 2. Grain yield of chickpea varieties in AGZONE 1 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	1.30	0.90	1.52	1.73	1.52
No. of trials	(2)	(1)	(1)	(1)	(1)
Desi type					
Ambar	104	-	-	-	-
CBA Captain	106	111	116	108	112
Genesis 079	101	-	-	-	-
Genesis 836	97	95	97	97	92
Neelam	101	102	106	105	106
PBA Maiden	104	106	102	103	103
PBA Slasher	102	103	103	102	108
PBA Striker	104	106	108	106	112
Kabuli type					
Genesis 090	82	71	79	93	76

Source: NVT Online, nvtonline.com.au

Table 3. Grain yield of chickpea varieties in AGZONE 2 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	0.58	0.45	0.79	1.55	1.13
No. of trials	(1)	(1)	(2)	(2)	(2)
Desi type					
Ambar	95	-	-	-	-
CBA Captain	109	85	106	102	95
Genesis 079	104	-	-	-	-
Genesis 836	101	92	94	96	93
Neelam	103	91	102	101	99
PBA Maiden	106	88	99	98	101
PBA Slasher	97	112	106	105	108
PBA Striker	101	101	107	105	106
Kabuli type					
Genesis 090	91	87	82	91	93

Source: NVT Online, nvtonline.com.au

Table 4. Grain yield of chickpea varieties in AGZONE 3 expressed as percentage of site mean yield for 2017

Year	2017
Site mean yield (t/ha)	1.89
No. of trials	(1)
Desi type	
Ambar	96
CBA Captain	104
Genesis 836	97
Neelam	97
PBA Striker	105
Kabuli type	
Genesis 090	94

Source: NVT Online, nvtonline.com.au
There has not been a chickpea NVT in Agzone 3 since 2017.

Table 5. Grain yield of chickpea varieties in AGZONE 4 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	1.42	0.86	1.24	1.21	0.65
No. of trials	(2)	(2)	(2)	(2)	(1)
Desi type					
Ambar	97	-	-	-	-
CBA Captain	103	105	117	105	110
Genesis 079	102	-	-	-	-
Genesis 836	99	93	99	98	102
Neelam	102	98	104	103	106
PBA Maiden	104	107	94	95	95
PBA Slasher	100	105	102	104	100
PBA Striker	103	105	104	104	103
Kabuli type					
Genesis 090	97	65	74	97	103

Source: NVT Online, nvtonline.com.au

Table 6. Grain yield of chickpea varieties in AGZONE 5 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2020	2021	2022
Site mean yield (t/ha)	1.16	0.80	1.20
No. of trials	(1)	(1)	(1)
Desi type			
CBA Captain	105	103	-
Genesis 836	95	83	-
Neelam	99	107	-
PBA Striker	104	123	-
Kabuli type			
Genesis 090	82	85	-

Source: NVT Online, nvtonline.com.au
There was high variability in the chickpea NVT in Agzone 5 in 2022, so results have been withheld.

Disease ratings for selected chickpea varieties

Highly aggressive strains of *Ascochyta rabiei* are now present in WA. Growers need to be vigilant and apply fungicides if disease levels are higher than expected for the resistance rating of the variety. Ascochyta resistance ratings listed in Table 7 have been established with ascochyta isolates collected in other states, and should be used as a guide only.

Ascochyta resistance of chickpea varieties using multiple isolates collected from Western Australia was conducted across several years (2019–2022) by both the Centre for Crop and Disease Management (CCDM) and DPIRD. These trials showed that CBA Captain appears to have no significant differences in ascochyta resistance to Genesis 090, and performs either equivalent to, or better than, PBA Striker, PBA Slasher and Neelam when exposed to WA strains of the disease.

Table 7. Disease ratings for selected chickpea varieties

Variety	Ascochyta blight (pathogen group 2-north) resistance#	Botrytis grey mould resistance	*Pratylenchus neglectus* resistance#
Desi type			
Ambar	-	S	MRMS
CBA Captain	MS	S	MR
Genesis 836	MS	S	MR
Neelam	S	S	MRMS
PBA Striker	S	S	MRMS
Kabuli type			
Genesis 090	MS	S	MRMS

Source: NVT Online, nvtonline.com.au
S = Susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant.
# resistance ratings have not been tested in Western Australia and should be used as a guide only.

Variety traits

Table 8. Desi chickpea variety traits

Variety	Plant height (cm)[1]			Maturity[2]	Lodging resistance[2]
	Dalwallinu NVT 2021	Mingenew NVT 2021	Merredin NVT 2020		
Desi type					
Ambar	-	-	-	Early	Very good
CBA Captain	69	67	60	Early-Mid	Moderate
Genesis 836	69	66	59	-	-
Neelam	64	62	55	Mid	Very good
PBA Striker	67	61	57	Early	Moderate
Kabuli type					
Genesis 090	66	58	56	Mid-Late	Good

Source: [1] DPIRD, [2] NSW DPI Winter crop variety sowing guide (2020)

Chickpea agronomy guide

Paddock selection

- Well-drained loamy sands to clay loams with a pH above 5.5 ($CaCl_2$).
- No sulfonylurea or Lontrel® herbicide residues.
- A low broadleaf weed burden.
- Minimal rocks and roots so paddock can be left relatively flat and even after sowing.

Rotation

- One in four years.
- At least 500 metres away from previous year's chickpea, faba, vetch, lentil or narbon bean stubble.

Sowing depth

- Aim for 5cm.
- Can be sown deeper to chase moisture and reduce transmission of seed borne ascochyta blight.

Seed dressing and rhizobia

- Thiram and thiabendazole seed dressing, e.g. Evershield® Seed Treatment, let dry then apply Group N inoculum or use granular products such as ALOSCA at 10kg/ha. If chickpeas have not been grown in the paddock for several years, growers should aim to maximise rhizobia inoculation. For example, mixing ALOSCA with seed is likely to provide more effective nodulation than mixing ALOSCA with fertiliser.

Sowing window

Agzone	Rainfall	Suggested sowing date	
		Desi	Kabuli
Agzone 1	Medium	25 April to 31 May	20 April to 20 May
	High	1 May to 31 May	25 April to 31 May
Agzone 2	Medium	25 April to 31 May	20 April to 20 May
	High	1 May to 31 May	25 April to 31 May
Agzone 3	High	25 April to 31 May	25 April to 31 May
Agzone 4	Low	25 April to 25 May	Not recommended*
Agzone 5	Low	25 April to 25 May	Not recommended*
	Medium	1 May to 31 May	20 April to 20 May
Agzone 6	High	25 April to 31 May Consider spring sowing to reduce disease risk	25 April to 31 May Consider spring sowing to reduce disease risk

*Not generally recommended because failure to meet seed size requirement (>8mm) results in loss of kabuli premium price. A market for small seed kabuli (>7mm) does, however, command a premium above desi types.

Fertiliser

- It takes about eight units of P to grow a one-tonne chickpea crop.
- If soil P levels are between 10mg/kg and 20mg/kg add at least 8kgP/ha. Phosphorus can be applied with compounds containing N (MAP, DAP, Agras etc) or as single superphosphate.

Target density

- Desi: 40–45 plants/m²
- Kabuli: 30–35 plants/m²

Recommended plant density provides better competition with weeds than lower densities and aids efficient harvest.

Seeding rate

- Desi between 90–110kg/ha.
- Kabuli between 130–150kg/ha. Reduce seeding rate in early-sown high rainfall crops to reduce disease.

Calculate seeding rate as seed size and germination vary considerably. Stored chickpea seed can lose viability, so it is important to determine the germination rate of the chickpea seed to be sown.

Row spacing

- Up to 50cm appears to have little effect on yield.
- Wider than 50cm will require specialist equipment for inter-row spraying.

Herbicide options

The following herbicides are registered on chickpea in WA. It is advisable to check labels of specific herbicide products for rates, crop and weed growth-stages for application, recommended surfactants and oils, withholding and plant-back periods, etc.

Pre-seeding and incorporated by sowing (IBS) herbicides

- Carbetamide 900g/kg, Group 23/E, e.g. Ultro® 900 WG at 1.1kg/ha. Do not apply carbetamide pre-sowing if planting with disc seeder as increased contact between the germinating seed and herbicide may reduce crop safety. For broadening the spectrum of weeds controlled, it can be applied mixed with label rate of simazine. Heavy, intense rainfall following application may cause crop damage.
- Cyanazine 900g/kg, Group 5/C, e.g. Bladex® at 1.1kg/ha. Do not use on sand or sandy loam soils as crop damage may result. Where annual ryegrass and wireweed are a major problem, add pendimethalin or trifluralin at the recommended rates. Do not add anti-evaporant spraying oils.
- Dimethenamid-P 720g/L, Group 15/K, e.g. Outlook® at 1L/ha. Annual ryegrass suppression only in higher weed density situations.
- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG (not all brands) at 0.83–1.1kg/ha. Use the lower rate on light sandy soils.
- Flumioxazin 500g/kg, Group 14/G, e.g. Terrain® at 180g/ha. Do not use on lighter soil types (sand) as shorter periods of residual control and unacceptable crop safety can occur.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.5L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.

- Pendimethalin 440g/L, Group 3/D, e.g. Stomp® at 1.5–2.25L/ha. Use the lower rates on light textured soils and the higher rates on medium to heavy textured soils.
- Propyzamide 900g/kg, Group 3/D, e.g. Edge® 900 WG at 0.56–1.11kg/ha. Use rates towards the higher end of the range on heavy soils, if conditions are not optimal or where a heavy grass population is expected.
- Prosulfocarb 800g/L (Group 15/J) + s-metolachlor 120g/L (Group 15/K), e.g. Boxer Gold® at 2.5L/ha.
- Pyroxasulfone 850g/kg, Group 15/K, e.g. Sakura® at 118g/ha.
- Simazine 900g/kg, Group 5/C, e.g. Simagranz® at 0.55–1.1kg/ha. Use 0.55–0.775kg/ha on lighter soils and in the Northern Agricultural areas, and up to 1.1kg on heavier soil types. Do not use on whitish or grey sands.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.86–1.2kg/ha. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40-60%). Sow at least 3cm and preferably 5cm deep. The rates higher than 0.86kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage. Heavy, intense rainfall following application may cause crop damage.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.86–1.2kg/ha + Imazethapyr 700g/kg, Group 2/B, e.g. Skipper® 700 WG at 20g/ha.
- Terbuthylazine 750g/kg (Group 5/C) + Isoxaflutole 75g/kg (Group 27/H), e.g. Palmero® TX at 1kg/ha. Seed crop at 5cm depth. Heavy rains after application may cause crop damage, particularly in sandy or gravelly soils.
- Terbuthylazine 600g/kg (Group 5/C) + Propyzamide 300g/kg (Group 3/D), e.g. Effigy® 900 WG at 1.25–1.75kg/ha. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40-60%). Sow at least 5cm deep. The rates higher than 1.25kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage.
- Tri-allate 500g/L, Group 15/J, e.g. Avadex® Xtra at 1.6L/ha.
- Trifluralin 480g/L, Group 3/D, e.g. TriflurX® at 1.25–1.7L/ha + 1.1kg/ha Simazine 900, Group 5/C. Use with knife-point and press-wheel seeding system only.
- Trifluralin 350g/L (Group 3/D) + Tri-allate 550g/L (Group 15/J), e.g. Jetti Duo® at 1.45–1.8L/ha. For best results apply within 12 hours of crop sowing. Use with knife/blade point sowing system.

Post-sowing pre-emergent (PSPE) herbicides

- Carbetamide 900g/kg, Group 23/E, e.g. Ultro® 900 WG at 1.1kg/ha. Apply within two days of sowing to soil that is relatively flat after sowing operation. Do not apply post-sowing pre-emergent if using knife point and press- wheel seeding system. For broadening the spectrum of weeds controlled, it can be applied mixed with label rate of simazine. Heavy, intense rainfall following application may cause crop damage.
- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG (not all brands) at 550–830g/ha. Use the lower rate on light sandy soils.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.25L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.
- Isoxaflutole 750g/kg, Group 27/H, e.g. Balance® or Palmero® at 100g/ha. Application or heavy rains after its application on sandy or gravely soils, or soils low in clay or organic matter may result in crop damage.
- Metribuzin 750g/kg, Group 5/C, e.g. Mentor® WG or Stacato® at 180–380g/ha. The rate is influenced by soil type, refer to label. Crop should be sown at least 5cm deep. Weeds should be from pre-emergence to 3-leaf stage except wireweed (Hogweed) which should not be beyond the cotyledon stage. Do not apply to chickpeas grown on sandy soils (silt plus clay less than 40%).
- Simazine 900g/kg, Group 5/C, e.g. Simagranz® at 0.55–1.1kg/ha. Use 0.55–0.775kg/ha on lighter soils and in the Northern Agricultural areas, and up to 1.1kg on heavier soil types. Do not use on whitish or grey sands.

- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.6–0.86kg/ha. Apply within two days of sowing. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40-60%). Sow at least 3cm and preferably 5cm deep. Heavy, intense rainfall following application may cause crop damage.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.6–0.86kg/ha + Imazethapyr 700g/kg, Group 2/B, e.g. Skipper® 700 WG at 20g/ha.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.86kg/ha + Isoxaflutole 750g/kg, Group 27/H, e.g. Boundary® 750 WG at 80g/ha.
- Terbuthylazine 750g/kg (Group 5/C) + Isoxaflutole 75g/kg (Group 27/H), e.g. Palmero® TX at 0.7–1kg/ha. Sow crop at 5cm depth. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40–60%).

Post-emergent herbicides for broadleaf weed control

- Flumetsulam 800g/kg, Group 2/B, e.g. Broadstrike® at 25g/ha. Apply at 4–6 branch stage and no later than six weeks after crop emergence. Do not use any spray additives or tank mix with other chemicals.

Post-emergent herbicides for grass weed control

- Butroxydim 250g/kg, Group 1/A, e.g. Factor® WG at 80–180g/ha + Supercharge® Elite® at 1% (v/v) to control 2-leaf to early tillering weeds. The lower rates are for younger weeds growing actively under ideal conditions. The higher rates for the weeds that are at early tillering stage, or in dense populations, or growing in poor growing conditions. For improved control of ryegrass and other grass weeds, it must be combined with clethodim or fop herbicide containing fluazifop-p, haloxyfop-R, propaquizafop or quizalofop. Do not apply at flowering stage of crop.
- Clethodim 240g/L, Group 1/A, e.g. Select® or Status® at 150–500mL/ha + D-C-Trate® at 2% or Hasten® at 1% or Kwickin® at 1% or Uptake® oil at 0.5% (v/v) to control 2-leaf to fully tillered grass weeds. The lower rates will provide effective control if applied under ideal conditions to weeds that are smaller, actively growing, and free from temperature or water stress.. Do not apply beyond full flowering.
- Fluazifop-p 128g/L, Group 1/A, e.g. Fusilade® Forte at 500mL/ha to control actively growing 2–5 leaf brome grass before it commences tillering. Apply up until seven weeks before crop harvest.
- Haloxyfop-R 520g/L, Group 1/A, e.g. Verdict® at 50–100mL/ha + Uptake® oil at 0.5% or non-ionic wetting agent (e.g. BS1000®) at 0.2% (v/v). Application rate depends on weed size, adjuvant type and mix partner, refer to label. Apply from 2nd leaf to pre-flowering crop growth stages. Do not apply it in mixture with broadleaf weed herbicides and apply these at least a week apart. Withholding periods are not required when used as directed.
- Propaquizafop 100g/L, Group 1/A, e.g. Shogun® at 200–450mL/ha + Hasten® or Kwickin® at 0.5% or non-ionic wetting surfactant (e.g. BS1000®) at 0.2% (v/v) to control 3-leaf to mid tillering weeds. Use 300mL/ha where ryegrass is not the dominant weed. Use higher rate for ryegrass control and for best results wait until 75% of ryegrass have begun tillering. Apply up until 12 weeks before crop harvest.
- Quizalofop-p-ethyl 200g/L, Group 1/A, e.g. Elantra® Xtreme® or Leopard® 200 at 65–190mL/ha + Hasten®/Plantocrop™ at 1% or non-ionic surfactant (e.g. BS1000®, Wetspray®) at 0.2% or non-ionic surfactant (1000g a.i./L) at 0.1% plus a mineral spray oil at 1% (v/v) to control 3-leaf to early tillering weeds. The selection of rates depends upon the weed species and their size, refer to label. Use higher rate under heavy weed pressure, and/or when weeds have commenced tillering. Apply up until 12 weeks before crop harvest.

v/v = volume by volume of final spray solution.

Desiccation

Dessiccation can be used as a harvest-aid.

- Diquat 200g/L, Group 22/L, e.g. Reglone® at 2–3L/ha. Spray as soon as the crop has reached full maturity as this helps overcome slow and uneven ripening and weed problems at harvest. Do not harvest for two days after application.
- Glyphosate, Group 9/M, e.g. Crucial® (glyphosate 600g/kg) at 0.6–1.6L/ha, Weedmaster® DST® (glyphosate 470g/kg) at 0.77–2.0L/ha, Roundup Ready® herbicide with PLANTSHIELD® (glyphosate 690g/kg) at 0.53–1.4kg/ha and Raze® (glyphosate 510g/L) at 0.72–1.2L/ha are registered as harvest-aid and for annual weeds control. Both Crucial®

at 0.45–0.95/ha and Weedmaster® DST® at 0.6–1.2L/ha can be applied mixed with 5 g/ha metsulfuron-methyl 600 (e.g. Associate®). Apply when crop is physiologically mature and has less than 15% green pods. Do not harvest crop within seven days of application. Use higher label rates where crops or weeds are dense and where faster desiccation is required. Not all glyphosate products are registered for this use; refer to the registered product labels.

- Pyraflufen-ethyl 25g/L, Group 14/G, e.g. Sledge® at 200mL/ha alone or in mixture with the label rate of paraquat (e.g. Inferno®) or glyphosate (e.g. Raze®) are registered as a harvest-aid and for reduction in seed-set and viability of weed seeds. The tank mixture of pyraflufen-ethyl and paraquat or glyphosate may improve harvest efficiency and weed control, and reduce seed-set and viability of weed seeds. Apply to chickpea at or after 90–95% of the chickpea seeds have reached physiological maturity, typically when 80–85% of pods within crop have turned yellow-brown. For maximum weed-seed-set reduction, weeds should preferably be sprayed at full flowering stage, but adhere to crop growth stage to minimise yield losses. Do not apply less than seven days before harvest.
- Saflufenacil 700g/kg, Group 14/G, e.g. Sharpen® WG at 34g/ha in mixture with recommended label rate of glyphosate or paraquat plus 1% Hasten® or high-quality methylated seed oil (MSO). Apply when 80–85% of chickpea pods within crop have turned yellow brown. Applications earlier than the recommended growth stage can result in grain yield losses. Do not harvest within seven days of application.

Budworm threshold – very low

- **Desi:** one caterpillar per 10 sweeps.
- **Kabuli:** one caterpillar per 20 sweeps.

Disease management

Ascochyta blight is the most significant disease affecting chickpea crops in WA. It is both seed and stubble borne. Management methods including paddock rotation and seed dressing are recommended. Botrytis grey mould (BGM) can be a problem on kabuli grown in higher rainfall regions in the Geraldton Port Zone, with all varieties of chickpea rated susceptible to BGM.

Pre-seeding

- Apply a seed dressing that contains both thiram and thiabendazole, e.g. Evershield® Seed Treatment. This gives about four weeks of protection after which the requirement for foliar fungicide application should be assessed.

Post-emergent fungicide options

- Numerous foliar fungicide products are registered for control of diseases in chickpea; refer to the 'Fungicide for Pulses' table at the beginning of the Pulse Section (pages 162–163).
- The management of ascochyta blight has been traditionally done using preventative fungicides. For example, apply chlorothalonil 720g/L product (1.0–2.0L/ha) or mancozeb 750g/kg product (1.0–2.0kg/ha) fungicides at four to six weeks after emergence, then monitor regularly for disease. If disease is detected, apply fungicide at three-week intervals before rain fronts. Any crop to be retained for seed that has disease present should have a podding spray applied.
- A range of newer chemistry is now available for management of ascochyta blight and/or BGM in chickpeas. This includes Veritas® Opti fungicide (tebuconazole 370g/L, azoxystrobin 222g/L); Miravis® Star (pydiflumetofen 100g/L + fludioxonil 150g/L); Aviator® Xpro® foliar fungicide (bixafen 75g/L, prothioconazole 150g/L) and Amistar Xtra® (azoxystrobin 200g/L + cyproconazole 80g/L).
- Visit Pulse Australia website to find latest fungicide product information – www.pulseaus.com.au/growing-pulses/crop-protection-products

Harvesting

- Reel speed 1.0 x ground speed.
- Table auger 10–20mm.
- Drum or rotor speed 300–600rpm.
- Concave clearance 10–25mm (start at clearance 10mm).
- Fan speed 75–100% (start at 100%).
- Top sieve 16–25mm (start at 25mm). Bottom sieve 8–16mm (start at 16mm).

Faba bean

Introduction

Faba bean is best grown in medium and high-rainfall areas on medium-heavy textured soils where it has the highest yield potential of all pulse crops. It is best suited to early sowing in April. Unlike most pulses, faba beans can tolerate transient waterlogging and mild frosts, but are particularly sensitive to dry conditions.

New bean cultivars have superior disease resistance to those widely grown in the 1990s. Combined with advances in fungicide and spray technology, the risk of epidemics like those seen in the late 1990s are now much lower.

Recent releases

Released in 2019, PBA Amberley is a mid-season flowering faba bean with high yield potential in higher rainfall and long growing-season districts. It has a higher level of resistance to chocolate spot than all current varieties and is also resistant to ascochyta blight. The improved disease resistance of PBA Amberley offers the potential to reduce the risk and cost of faba bean production in high rainfall areas where foliar fungal diseases are a major constraint. In limited trials in WA, PBA Amberley yields have been comparable to PBA Samira. An end point royalty (EPR) of $3.50/t (GST exclusive), which includes breeder royalty, applies upon delivery of this variety. Seed is available from Seednet.

PBA Bendoc was released in 2018 as the first faba bean line with improved tolerance to imidazolinone (IMI) herbicides, and the residues of some Group 2 (formerly Group B) herbicides, including some sulfonylureas. The herbicide Intercept® (containing imazamox and imazapyr) is registered for use on imidazolinone-tolerant faba bean varieties such as PBA Bendoc.

PBA Bendoc has a small-medium sized seed (640mg) suited to Middle East markets. It has lower disease resistance ratings for ascochyta and chocolate spot than the most widely grown bean variety PBA Samira. Seed is available from Seednet with an EPR of $3.90/t (GST exclusive).

PBA Marne was released in 2018. It is an early flowering line with potential for lower rainfall regions. Seed is available from Seednet with an EPR of $3.50/t (GST exclusive).

What variety should I grow?

PBA Samira is considered the benchmark variety for WA and is the most widely grown variety. Growers who can benefit from using an IMI-tolerant variety should try PBA Bendoc, but they must also be prepared to have a robust fungicide program as PBA Bendoc has lower disease ratings than PBA Samira. PBA Amberley is a suggested variety for high rainfall zones with high disease pressure.

PBA Marne performs well in variety trials throughout WA but should only be grown in lower rainfall areas where disease risk is low.

Grain yield of faba bean varieties

Table 1. Grain yield of faba bean varieties in AGZONE 3 and AGZONE 5 expressed as percentage of site mean yield for each trial year (2020–2022)

	Agzone 3			Agzone 5		
Year	2020	2021	2022	2020	2021	2022
Site mean yield (t/ha)	1.63	2.65	2.73	1.92	2.50	2.23
No. of trials	(1)	(2)	(2)	(1)	(2)	(1)
Farah	102	101	98	96	97	97
Fiesta VF	106	106	99	94	96	96
Nura	99	94	96	98	97	98
PBA Amberley	107	102	98	94	97	96
PBA Bendoc	80	85	96	105	101	99
PBA Marne	85	124	110	110	101	104
PBA Rana	-	96	87	-	88	84
PBA Samira	103	97	97	94	98	95
PBA Zahra	78	92	96	99	100	93

Source: NVT Online, nvtonline.com.au

Faba bean variety characteristics

Table 2. Faba bean agronomy characteristics

Variety	Seed grade	Seed size (mg, mean and range)	Seed colour	Plant height	Flowering time	Maturity	Lodging	Necking*
Farah	Medium	690 (590–760)	Light brown–brown	Medium	Early-mid	Early-mid	MS	MS
Nura	Small-med	680 (550–790)	Light brown	Short	Mid	Early-mid	MR	MS
PBA Amberley	Medium	720 (600–840)	Light brown	Medium	Mid	Mid	MR	R
PBA Bendoc	Medium	640 (500–720)	Light brown	Medium	Mid	Early-mid	MS	MS
PBA Marne	Medium	740 (610–870)	Light brown	Medium	Early-mid	Early-mid	MR	MR
PBA Rana	Med-large	750 (650–900)	Light brown	Med/tall	Mid	Mid	MR	MR
PBA Samira	Medium	740 (580–870)	Light brown	Medium	Mid	Mid	MR	MS
PBA Zahra	Med-large	740 (620–860)	Light brown	Med/tall	Mid	Mid-late	MR	S

* Necking occurs under strong winds or moisture stress and results in the stem bending over sharply at about pod height, so that the upper part of the plant is less able to assist in grain-fill. Sometimes plants recover partially from necking and the growing points turn and grow upright again.
S = Susceptible, MS = Moderately susceptible, MR = Moderately resistant, R = Resistant.

Table 3. Faba bean variety disease ratings

Variety	Ascochyta Blight	Cercospora Leaf Spot	Chocolate Spot	*Pratylenchus thornei* #	Rust
Farah	S	S	S	MS	VS
PBA Amberley	MR	S	MRMS	MS	VS
PBA Bendoc	MR	S	S	MRMS	VS
PBA Marne	MS*p*	S	MS*p*	MS	MRMS
PBA Rana	MRMS	S	MS	MS	VS
PBA Samira	MR*p*	S	MS	MRMS	S
PBA Zahra	MRMS	S	MS	MRMS	S

Source: NVT Online, nvtonline.com.au
VS = Very susceptible, S = Susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant.
#Nematode resistance ratings have not been tested in Western Australia and should be used as a guide only.
p = provisional rating.

Faba bean agronomy guide

Rotation

- Faba bean fixes large amounts of N, providing large rotation benefits for following crops.
- To reduce disease risk, grow no more often than one year in four in the same paddock.
- Avoid close rotations with vetch, narbon bean and lentil because some foliar diseases are common between these species.
- Retained cereal stubble can minimise the impact of a dry/hot spring, reduce aphids and lower disease spore splash.

Characteristics

- Vigorous early growth.
- Tolerates transient waterlogging and frosts better than most grain legumes.
- Early flowering enables spring drought to be avoided, but dry and hot weather at flowering can reduce yields.

Paddock selection

- Most suited to fine-textured or duplex soils, neutral to alkaline with a surface pH of 5–8 (in $CaCl_2$). Soils with a surface pH of 5–6 need to be more alkaline (pH >6) at depth (>20cm). In high-rainfall southern areas (e.g. Esperance sandplain) beans can be grown on lower pH sandy duplex paddocks but will benefit from double the normal rate of rhizobia inoculation.
- Soils must be free of sulfonylurea herbicide residues (e.g. Glean®, Logran®), clopyralid residues (Lontrel®) and high exchangeable sodium.
- Paddocks need to have a low broadleaf weed and herbicide resistant ryegrass burden.
- Sow different faba bean varieties at least 500m away from each other to prevent cross-pollination.

Sowing time

High rainfall areas (>450 mm)

- 15 May to 7 June.
- In higher rainfall areas, early sowing can predispose the crop to disease.

Medium rainfall areas (350–450 mm)

- 15 April to 30 May.

Low rainfall areas (<350 mm)

- 15 April to 15 May.
- Faba bean is not well suited to lower rainfall areas in most years, especially on lighter soils. If sowing in these areas, early sowing is important.

Dry seeding is possible but not preferred due to poor rhizobia survival.

Sowing rate

- Aim to establish 25–30 plants/m^2. Sow at 150–200kg/ha depending on seed size and germination percentage.
- Reduced sowing rates may be beneficial in high yielding situations. Seed size can vary markedly between varieties and larger seed may require different seeding set up to prevent blockages. Minor modifications may include modifying the metering mechanism, seed tubes or dividing heads on air seeders.
- Seed should be tested for germination and vigour, with a minimum germination requirement of 70%.

Sowing depth

- 5–8cm (2–3 inches).
- Can be sown at 8–10cm.

Inoculation

- Seed should be inoculated with Group F rhizobia using a peat or liquid slurry, or with liquid or granules in furrow.
- If using a slurry, inoculate at least 24 hours after applying fungicidal seed treatment and seed within 12 hours.
- Double the recommended inoculum rates if soils are not optimal for faba bean (i.e. pH less than 6.0, sandy).
- Avoid putting rhizobia down the same tube as acidic fertiliser, as it will kill the rhizobia.

Fertiliser

- 100–200kg/ha superphosphate, depending on soil test.
- Trace elements as for cereals.

Weed control

The following herbicides are registered on faba bean in WA. It is advised to check labels of specific herbicide products for rates, crop and weed growth stages for application recommended surfactants and oils, withholding and plant back periods.

Pre-seeding and incorporated by sowing (IBS) herbicides

- Bixlozone 400g/L, Group 13/Q, e.g. Overwatch® at 1.25L/ha. Seed faba bean at least 3cm deep using a seeding system that can ensure adequate spatial separation of seed and herbicide, e.g. knife point tynes and press wheels.
- Carbetamide 900g/kg, Group 23/E, e.g. Ultro® 900 WG at 1.1–1.7kg/ha. Apply the lower rate on sandy soils and where lower weed densities are expected. However, use the higher rate on heavier soils and where the weed densities are expected to be moderate to high. Do not apply apply carbetamide pre-sowing if planting with disc seeder as greater contact between the germinating seed and herbicide may reduce crop safety.
- Cyanazine 900g/kg, Group 5/C, e.g. Bladex® at 1.1kg/ha. Do not use on sand or sandy loam soils as crop damage may result. Where annual ryegrass and wireweed are a major problem, add pendimethalin or trifluralin at the recommended rates. Do not add anti-evaporant spraying oils.
- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 0.83–1.1kg/ha. Use the lower rate on light sandy soils.
- Flumioxazin 500g/kg, Group 14/G, e.g. Terrain® at 180g/ha. Do not use on lighter soil types (sand) as shorter periods of residual control and unacceptable crop safety may occur.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.5L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.
- Pendimethalin 440g/L, Group 3/D, e.g. Stomp® at 1.5–2.25L/ha. Use the lower rates on light textured soils and the higher rates on medium to heavy textured soils.
- Propyzamide 900g/kg, Group 3/D, e.g. Edge® 900 WG at 0.56–1.11kg/ha. Use higher rates on heavy soils under sub-optimal conditions or where a heavy grass population is expected.
- Prosulfocarb 800g/L (Group 15/J) + s-metolachlor 120g/L (Group 15/K), e.g. Boxer Gold® at 2.5L/ha.
- Simazine 900g/kg, Group 5/C, e.g. Simagranz® at 1.1–1.4kg/ha. Use the lower rate on light soils.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.86–1.2kg/ha. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40-60%). Sow at least 3cm and preferably 5cm deep. The rates higher than 0.86kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage. Heavy, intense rainfall following application may cause crop damage.
- Terbuthylazine 600g/kg (Group 5/C) + Propyzamide 300g/kg (Group 3/D), e.g. Effigy® 900 WG at 1.25–1.75kg/ha. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40-60%). Sow at least 5cm deep. The rates higher than 1.25kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage.
- Tri-allate 500g/L, Group 15/J, e.g. Avadex® Xtra at 1.6L/ha.
- Trifluralin 480g/L, Group 3/D, e.g. TriflurX® at 800mL/ha + 1.1kg/ha Simazine 900 DF, Group 5/C.Use with knifepoint and press-wheel seeding system only.

Post-sowing pre-emergent (PSPE) herbicides

- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 550–830g/ha. Use the lower rate on light, sandy soils.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.25L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation

(e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.

- Imazethapyr 700g/kg, Group 2/B, e.g. Spinnaker® WDG at 70g/ha. Do not use on light sandy soils. The risk of crop damage on alkaline soils may increase under adverse growth conditions.
- Metribuzin 750g/kg, Group 5/C, e.g. Stacato® or Mentor® WG at 180–380g/ha. Use the lower rate on light sandy soils and higher label rate on heavy clay-loam soils. Crop should be sown at least 5cm deep. Weeds should be from pre-emergence to 3-leaf stage except wireweed (Hogweed) which should not be beyond the cotyledon stage.
- Simazine 900g/kg, Group 5/C, e.g. Simagranz® at 1.1–1.4kg/ha. Use the lower rate on light soils. Sow crop at least 5cm deep. Do not use rates higher than 1.1kg/ha on soils with pH 8.0 and above as unacceptable crop damage may occur. At 0.55–0.8kg/ha, it can be applied mixed with trifluralin 480 at 0.83L/ha, refer to label.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 600–860g/ha. Apply within two days of sowing. Use the lower rate on sandy loams to loamy sand soils and the higher rate on heavier soils (loams, silt plus clay 40–60%). Sow at least 3cm and preferably 5cm deep. Heavy, intense rainfall following application may cause crop damage.

Post-emergent herbicides for broadleaf weed control

- Pyraflufen-ethyl 20g/L, Group 14/G, e.g. Ecopar® at 800mL/ha + BS1000® 0.2% (v/v). Apply when crop is at 3–5 leaf stage to control 2–4 leaf stage weeds that are not more than 6cm in diameter.
- Imazamox 700g/kg, Group 2/B, e.g. Crop Care Claw® or Raptor® WG at 45g/ha + BS1000® 0.2% (v/v). A permit (PER14726) with a validity up to 30 September 2024 is in place for this use pattern. Apply the herbicide when crop is at 3–6 node growth stage about 30–40 days after sowing. Use herbicide rates according to the product labels. Do not use oil or mix with other products containing emulsifying agents. Follow permit restraints carefully.
- PBA Bendoc was released in 2018 as the first faba bean line with improved tolerance to imidazolinone (IMI) herbicides and the residues of some Group 2/B herbicides including some sulfonylureas. Imazamox 33g/L + imazapyr 15g/L, Group 2/B, e.g. Nufarm Intercept® at 350–750mL/ha + Supercharge® Elite or Banjo® at 0.5% (v/v) is registered on IMI-tolerant faba bean varieties such as PBA Bendoc. Intercept® has efficiency on both Group 2/B herbicide susceptible grass and broadleaf weeds. Apply the herbicide when crop is at 3–8 leaf stage and majority of the grass weeds are at 2–4 leaf stage.

v/v = volume by volume of final spray solution.

Post-emergent herbicides for grass weed control

- Butroxydim 250g/kg, Group 1/A, e.g. Factor® WG at 80–180g/ha + Supercharge® Elite® at 1% (v/v) to control 2-leaf to early tillering weeds. The lower rates are for younger weeds growing actively under ideal conditions. The higher rates are for the weeds at early tillering stage, or in dense populations, or growing in poor growing conditions. For improved control of ryegrass and other grass weeds, it must be combined with clethodim or fop herbicide containing fluazifop-p, haloxyfop-R, propaquizafop or quizalofop. Do not apply at flowering stage of crop.
- Clethodim 240g/L, Group 1/A, e.g. Select® or Status® at 150–500mL/ha + D-C-Trate® at 2% or Hasten® at 1% or Kwickin® at 1% or Uptake® oil at 0.5% (v/v) to control 2-leaf to fully tillered grass weeds, refer to label. The lower rates will provide effective control if applied under ideal conditions to weeds that are smaller, actively growing, and free from temperature or water stress. Do not apply beyond full flowering.
- Fluazifop-p 128g/L, Group 1/A, e.g. Fusilade® Forte at 410mL/ha to control actively growing 2-5 leaf weeds before commencement of tillering. Apply up until five weeks before crop harvest.
- Haloxyfop-R 520g/L, Group 1/A, e.g. Verdict® at 50–100mL/ha + Uptake® oil at 0.5% or non-ionic wetting agent (e.g. BS1000®) at 0.2% (v/v). Application rate depends on weed size, adjuvant type and mix partner, refer to label. Apply from 2-leaf to pre- flowering crop growth stages. Do not apply it in mixture with broadleaf weed herbicides and apply these at least a week apart. Withholding periods are not required when used as directed.

- Propaquizafop 100g/L, Group 1/A, e.g. Shogun® at 200–450mL/ha + Hasten® or Kwickin® at 0.5% or non-ionic wetting surfactant (e.g. BS1000®) at 0.2% (v/v) to control 3-leaf to mid tillering weeds. Use 300mL/ha where ryegrass is not the dominant weed. Use higher rate for ryegrass control and for best results wait until 75% of ryegrass have begun tillering. Apply up until seven weeks before crop harvest.
- Quizalofop-p-ethyl 200g/L, Group 1/A, e.g. Elantra® Xtreme® or Leopard® 200 at 65–190mL/ha + Hasten®/ Plantocrop™ at 1% or non-ionic surfactant (e.g. BS1000®, Wetspray®) at 0.2% or non-ionic surfactant (1000g a.i./L strength) at 0.1% plus a mineral spray oil at 1% (v/v) to control 3-leaf to early tillering weeds. The selection of rates depends upon the weed species and their size, refer to label. Use higher rate under heavy weed pressure, and/or when weeds have commenced tillering. Apply up until 12 weeks before crop harvest.

v/v = volume by volume of final spray solution.

Insects

- The main insect pest is native budworm (Helicoverpa) and crops need to be monitored regularly late in the season for grubs.
- Budworm control is vital if producing quality beans for human consumption. Spray if one or more grubs per 10 sweeps.
- Crops also need to be monitored for redlegged earth mite, lucerne flea, cutworm and cowpea aphid.

Diseases

- Avoid previous year's bean stubble and only grow beans once every four years in the same paddock.
- New bean cultivars have superior disease resistance to those widely grown in the 1990s. Combined with advances in fungicide and spray technology, the risk of epidemics like those of the late 1990s are much lower.
- Ascochyta blight mostly occurs in the southern agricultural region and becomes evident in the first month after sowing. In the north, do not buy seed from the south. Many newer varieties have excellent ascochyta resistance and it is less common to see symptoms, but monitoring is still recommended.
- Chocolate spot (*Botrytis fabae*) is the main disease that will require control in WA. Growers should plan to apply most fungicide sprays around flowering to maximise pod set. Monitor crops in late vegetative stage for symptoms with an aim to spray at canopy closure/start of flowering.
- Rust usually occurs from September in WA. Early detection and control are necessary.

Suggested fungicides and timing

It is common to have more than one disease in the crop and fungicide mixes may be required.

Numerous foliar fungicide products are registered for control of diseases in faba bean; refer to the 'Fungicide for Pulses' table at the beginning of the Pulse Section (pages 162–163).

Ascochyta

- Early vegetative stages – monitor to ensure disease is apparent.
- Suggested fungicides are mancozeb, Veritas® Opti (tebuconazole + azoxystrobin), Miravis® Star (pydiflumetofen + fludioxonil), Aviator® Xpro® (prothioconazole + bixafen) or Amistar Xtra® (azoxystrobin + cyproconazole).

Chocolate spot

- At canopy closure/flowering.
- Suggested fungicides are carbendazim, procymidone, Veritas® Opti (tebuconazole + azoxystrobin), Miravis® Star (pydiflumetofen + fludioxonil), Aviator® Xpro® (prothioconazole + bixafen) or Amistar Xtra® (azoxystrobin + cyproconazole).

Cercospora

- Often seen 6–8 weeks after sowing.
- Suggested fungicides are Veritas® Opti (tebuconazole + azoxystrobin), Miravis® Star (pydiflumetofen + fludioxonil), Aviator® Xpro® (prothioconazole + bixafen), or Amistar Xtra® (azoxystrobin + cyproconazole) or tebuconazole (refer PER13752).

Rust

- Suggested fungicides are mancozeb, chlorothalonil, Veritas® Opti (tebuconazole+ azoxystrobin), Aviator® Xpro® (prothioconazole + bixafen), or Amistar Xtra® (azoxystrobin + cyproconazole). or tebuconazole (refer PER13752).

Crop-topping

- Paraquat 250g/L, Group 22/L, e.g. Gramoxone® at 400 or 800mL/ha. Spray the crop when annual ryegrass is at the optimum stage, that is when the last annual ryegrass seed heads at the bottom of the plant have emerged, and most are at or just past flowering (with anthers present or glumes open) but before haying off is evident – usually October to November.
- Reduction in crop yield can occur (more than 25%) especially if the crop is less advanced relative to the ryegrass, i.e. if crops have mostly green immature pods. The higher label rate may also exacerbate any yield reduction. Do not harvest within seven days of application.

Desiccation

- Diquat 200g/L, Group 22/L, e.g. Reglone® at 2 to 3L/ha. Spray as soon as the crop has reached full maturity as this helps overcome slow and uneven crop ripening and weed problems at harvest. Do not harvest for seven days after application.
- Glyphosate 690g/kg, Group 9/M, e.g. Roundup Ready® herbicide with PLANTSHIELD® at 250–1400g/ha. Apply when faba bean pods turn black and average seed moisture content is below 30%. Application before this time could significantly reduce yields (in practice losses more than 25% can occur). Use lower rate if ryegrass is flowering and higher label rate if ryegrass is at milky dough stage. Use higher label rates where crops or weeds are dense and faster desiccation is required. Do not use on crops intended for seed or sprouting. Do not harvest within seven days of application. Not all glyphosate products are registered for this use; refer to the registered product labels.
- Pyraflufen-ethyl 25g/L, Group 14/G, e.g. Sledge® at 200mL/ha alone or in mixture the label rate of paraquat (e.g. Inferno®) or glyphosate (e.g. Raze®) are registered as a harvest-aid and for reduction in seed-set and viability of weed seeds. The tank-mixture of pyraflufen-ethyl and paraquat or glyphosate may improve harvest efficiency and weed control, and reduce of seed-set and viability of weed seeds. Apply to faba bean at or after hilum turns black in the pods at the top of the crop canopy, typically when 30–80% of pods are ripe and dark. The faba bean plants may still be green at this stage, particularly if it is a late maturing variety. For maximum weed-seed-set reduction, weeds should preferably be sprayed at full flowering stage, but adhere to crop growth stage to minimise yield losses. Do not apply less than seven days before harvest.
- Saflufenacil 700g/kg, Group 14/G, for example, Sharpen® WG at 34g/ha in mixture with label rate of glyphosate or paraquat + 1% Hasten® or high-quality methylated seed oil (MSO). Apply when 30–80% of pods are ripe and dark (hilum black in the pods at the top of the canopy). Earlier applications made before the recommended growth stage could result in grain yield losses. Do not harvest within seven days of application.

Harvesting

- Faba beans turn black at maturity and are ready to harvest when the pods are black and stems are still slightly green.
- Delayed harvest will increase the risk of staining, lodging, shattering and pod loss. Handle seed minimally to reduce physical damage.
- Use a conventional open front header. Alternate wires and blanking off plates may need removing. Use barley sieves.

Reel speed	1.0 x ground speed
Spiral clearance	High
Drum speed	300–600rpm
Top sieve	32–38mm
Fan speed	High
Concave clearance	15–35mm
Bottom sieve	8–16mm

Stubble grazing

- Faba bean stubble can be a useful sheep feed over summer but avoid over-grazing stubbles on fragile soils.
- Most of the feed value is in the spilt grain. To minimise risk of wind erosion, leave sheep in the paddock no longer than is necessary to recover the spilt grain.
- Graze either soon after harvest, relying on summer rain to stabilise the soil, or late in autumn after most of the erosion risk has passed.

Field pea

Field pea

Introduction

Field pea is the most widely adapted pulse species to WA conditions and is grown in most regions. It is adapted to a wide range of soil types and there is widespread experience with this pulse among growers and agronomists. Excellent weed control options are available for field pea, which combined with delayed sowing and crop-topping, enable very clean paddocks for following crops.

Most field peas grown in WA are of the dun grade – either Kaspa types or Australian dun (e.g. Parafield). Kaspa types are favoured in the Indian subcontinent, while some sprouting markets still favour trailing varieties such as PBA Percy and Parafield. White varieties are rarely grown in WA, so the marketing of white peas can be problematic. Mixing white and dun types together will result in a downgrade to feed.

Recent releases

GIA Kastar and GIA Ourstar were released in 2020 by Grains Innovation Australia (GIA).

GIA Kastar and GIA Ourstar have improved tolerance to IMI herbicides and GIA Ourstar also has improved tolerance to SU residues and improved tolerance to Broadstrike®. GIA Ourstar is a dun type and GIA Ourstar is a Kaspa type. In limited testing in WA, GIA Kastar and GIA Ourstar have produced low yields. Seed is available from AG Schilling & Co and both varieties have an EPR of $3.30/t (GST inclusive).

PBA Taylor (tested as OZP1408) was released in 2021. Compared to our benchmark variety PBA Butler, PBA Taylor has improved resistance to viruses, less resistance to bacterial blight and similar susceptibility to fungal diseases. PBA Taylor is available from Seednet, with an EPR of $2.97/t (GST inclusive).

What variety should I grow?

PBA Butler and PBA Gunyah are the top-yielding Kaspa-type field pea varieties in WA. PBA Wharton also produces high yields in trials, but most farmers have found that PBA Gunyah and, more recently, PBA Butler produce superior results on-farm. PBA Taylor shows promise in central and northern wheatbelt areas.

For farmers wishing to grow trailing field pea types, PBA Percy reliably out-yields Parafield.

Grain yield of field pea varieties

Refer to Tables 1 to 5.

Table 1. Grain yield of field pea varieties in AGZONE 1 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	1.46	1.21	3.09	2.14	2.88
No. of trials	(2)	(1)	(1)	(1)	(1)
GIA Kastar	-	-	81	86	81
GIA Ourstar	-	-	84	91	89
Kaspa	100	101	107	99	103
Parafield	78	-	-	-	-
PBA Butler	108	99	110	106	108
PBA Gunyah	96	95	106	97	102
PBA Oura	98	99	97	99	99
PBA Pearl	108	92	111	-	-
PBA Percy	101	106	91	-	-
PBA Taylor	106	99	106	103	102
PBA Twilight	94	98	103	95	98
PBA Wharton	98	99	98	97	96

Source: NVT Online, **nvtonline.com.au**

Table 2. Grain yield of field pea varieties in AGZONE 2 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	1.36	0.86	1.94	2.31	2.34
No. of trials	(2)	(1)	(1)	(1)	(1)
GIA Kastar	-	-	87	70	89
GIA Ourstar	-	-	85	78	85
Kaspa	108	102	94	104	98
Parafield	84	-	-	-	-
PBA Butler	113	108	103	113	104
PBA Gunyah	98	99	100	106	101
PBA Oura	96	95	98	97	97
PBA Pearl	107	100	105	-	-
PBA Percy	105	90	87	-	-
PBA Taylor	103	113	113	109	112
PBA Twilight	96	98	97	100	99
PBA Wharton	92	103	108	99	107

Source: NVT Online, **nvtonline.com.au**

Table 3. Grain yield of field pea varieties in AGZONE 3 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2022
Site mean yield (t/ha)	1.14	2.19	2.05	1.48
No. of trials	(1)	(1)	(1)	(1)
GIA Kastar	-	-	84	66
GIA Ourstar	-	-	77	82
Kaspa	85	96	105	100
Parafield	69	81	-	-
PBA Butler	95	103	110	108
PBA Gunyah	84	95	104	115
PBA Oura	106	100	94	99
PBA Pearl	106	104	104	-
PBA Percy	123	102	84	-
PBA Taylor	94	104	114	111
PBA Twilight	84	94	101	107
PBA Wharton	96	100	104	106

Source: NVT Online, **nvtonline.com.au**
Results for field pea NVT in Agzone 3 were not released in 2021 due to trial quality being compromised.

Table 4. Grain yield of field pea varieties in AGZONE 4 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	1.90	0.60	1.54	1.00	2.37
No. of trials	(1)	(1)	(1)	(1)	(1)
GIA Kastar	-	-	92	69	81
GIA Ourstar	-	-	81	90	94
Kaspa	100	112	96	92	103
Parafield	75	-	-	-	-
PBA Butler	105	120	104	105	106
PBA Gunyah	96	106	101	105	105
PBA Oura	95	83	96	103	100
PBA Pearl	93	89	98	-	-
PBA Percy	91	56	80	-	-
PBA Taylor	113	139	118	104	99
PBA Twilight	97	104	99	97	101
PBA Wharton	106	116	111	101	96

Source: NVT Online, nvtonline.com.au

Table 5. Grain yield of field pea varieties in AGZONE 5 expressed as percentage of site mean yield for each trial year (2018–2022)

Year	2018	2019	2020	2021	2022
Site mean yield (t/ha)	0.96	0.82	1.20	1.56	1.51
No. of trials	(4)	(3)	(4)	(4)	(4)
GIA Kastar	-	-	83	77	69
GIA Ourstar	-	-	89	84	83
Kaspa	88	97	97	97	101
Parafield	72	89	-	-	-
PBA Butler	91	101	105	110	113
PBA Gunyah	86	98	101	94	99
PBA Oura	102	100	99	99	99
PBA Pearl	85	102	112	-	-
PBA Percy	111	98	94	-	-
PBA Taylor	101	104	106	105	103
PBA Twilight	90	97	98	90	93
PBA Wharton	105	102	101	95	93

Source: NVT Online, nvtonline.com.au

Field pea variety characteristics

Table 6. Agronomic characteristics of field pea varieties suited to WA

Variety	Seed type	Plant habit	Plant vigour, early season	Flowering time	Maturity time	Lodging	Pod shattering	Boron tolerance	Salinity tolerance
GIA Kastar	Kaspa dun	SL	-	Mid	Early-mid	Fair-good	R	-	-
GIA Ourstar	Aus dun	SL	-	Early-mid	Early-mid	Fair	MR	-	-
Kaspa	Kaspa dun	SD–SL	Moderate	Late	Mid	Fair-good	R: SP	I	I
PBA Butler	Kaspa dun	SD–SL	High	Mid-late	Mid	Good	R: SP	I	I
PBA Gunyah	Kaspa dun	SD–SL	High	Early-mid	Early	Fair-good	R: SP	I	IMI
PBA Oura	Aus dun	SD–SL	Moderate	Early-mid	Early	Fair-good	MR: NSP	MI	I
PBA Pearl	White	SD–SL	Moderate	Early-mid	Early-mid	Good	MR: NSP	MI	MI
PBA Percy	Aus dun	C	High	Early	Early	Poor	MR: NSP	I	MT
PBA Taylor	Kaspa dun	SD–SL	High	Mid	Early-mid	Fair-good	R: SP	I	I
PBA Twilight	Kaspa dun	SD–SL	High	Early	Early	Fair-good	R: SP	I	I
PBA Wharton	Kaspa dun	SD–SL	Moderate	Early-mid	Early	Fair-good	R: SP	MT	MT

Source: PBA and GIA variety release documents.
SD = semi-dwarf, C = conventional, SL = semi-leafless, R = resistant, MR = moderately resistant, SP = sugar pod type pod, NSP = non sugar pod type, MT = moderately tolerant, MI = moderately intolerant, IMI = intolerant to moderately intolerant, I = intolerant.

Table 7. Resistance of field pea varieties to diseases commonly found in WA crops

Variety	Blackspot[a]	Downy mildew	PSbMV[b]
GIA Kastar	MS*p*	S	-
GIA Ourstar	MS*p*	S	-
Kaspa	MS	S	S
PBA Butler	MS	S	S
PBA Gunyah	MS	S	S
PBA Oura	MS	S	S
PBA Pearl	MS	S	S
PBA Percy	MS	S	S
PBA Taylor	MS	S	R
PBA Twilight	MS	S	S
PBA Wharton	MS	S	R

Source: NVT Online, nvtonline.com.au
[a]also known as ascochyta blight, [b]pea seedborne mosaic virus
S = Susceptible, MS = Moderately susceptible, R = Resistant.
p = provisional rating.

Table 8. Resistance of field pea varieties to diseases rarely found in WA crops

Variety	Powdery mildew	Bacterial blight	Bean leafroll virus
GIA Kastar	RMR	S	-
GIA Ourstar	S	S*p*	-
Kaspa	S	S	S
PBA Butler	S	MS	S
PBA Gunyah	S	S	S
PBA Oura	S	MS	MR
PBA Pearl	S	MS	R
PBA Percy	S	MRMS	S
PBA Taylor	S	S	R
PBA Twilight	S	S	S
PBA Wharton	RMR	S	R

Source: NVT Online, nvtonline.com.au
S = Susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, RMR = Resistant to moderately resistant, R = Resistant. *p* = provisional rating.

Table 9. Nematode resistance of field pea varieties (Victorian ratings)

Variety	*Pratylenchus neglectus* resistance	*Pratylenchus thornei* resistance
GIA Kastar	MR	MS
GIA Ourstar	MRMS	MSS
Kaspa	RMR	MRMS
PBA Butler	RMR	MRMS
PBA Gunyah	RMR	MRMS
PBA Oura	MR	MRMS
PBA Pearl	MR	MRMS
PBA Percy	RMR	RMR
PBA Taylor	RMR	MRMS
PBA Twilight	MR	MRMS
PBA Wharton	MR	MRMS

Source: NVT Online, nvtonline.com.au Nematode resistance relates to the effect of the variety on the nematode density present within the paddock.
MSS = Moderately susceptible to susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, RMR = Resistant to moderately resistant.

Field pea agronomy guide

Paddock selection

- Well-drained loamy sands to clay loams with a pH 4.5–9.0 ($CaCl_2$).
- A soil structure or slope that allows good drainage.
- Ensure rocks and roots are removed to enable a flat and even sowing surface.
- No sulfonylurea herbicide residues such as chlorsulfuron (e.g. Nufarm Lusta®) and triasulfuron (e.g. Logran®).
- Avoid Lontrel® residues.
- A low frost risk.
- A low broad-leaved weed burden.
- To minimise the risk of diseases, do not grow field peas more often than one year in three in the same paddock, or adjacent to last year's field pea stubble.
- Because field pea stubble does not provide good protection against wind erosion after harvest, field peas should not be grown on soils with a sandy surface prone to wind erosion.

Varieties

- It is advisable to only grow the same type of varieties on your farm to avoid an admixture of white peas within dun peas, or vice versa, as contamination can result in downgrading.

High quality seed

- When sourcing new seed, where possible, use certified seed where details of germination percentage, seed size and presence of seed-borne diseases are provided.
- Avoid seed with high levels of fungal infection – use seed with less than 15% blackspot infection.
- If using uncertified seed, seed from low-rainfall areas is likely to carry less blackspot infection than seed from high-rainfall areas.

A good start

- Plant at the correct time. Planting immediately after the break increases the severity of blackspot by exposing field pea seedlings to spore release in autumn.
- During the growing season, DPIRD produces a field pea sowing time guide, which is available on the web (https://www.agric.wa.gov.au/field-peas/blackspot-field-peas-disease-forecast) and also by SMS.
- The ideal sowing window for field pea occurs seven to 28 days after the break of the season irrespective of the rainfall zone. Varieties grown in WA are best suited to sowing in the following window with adjustments each year being based on the blackspot forecast.

Low rainfall

- Early May – mid June

Medium rainfall

- Mid May – late June

High rainfall

- Late May – late June

Seeding rate

- On average, the optimum plant density is 50 plants/m².
- Actual sowing rates will depend on seed size, germination percentage and field pea type.
- In most situations, a seeding rate of 120kg/ha is adequate.

Seeding depth

- Recommended planting depth is 5–8cm.

Inoculum

Seed should be inoculated with Group E inoculum every year, particularly on marginal (acid) soil types. With a good history of field pea production and alkaline soils, inoculating in WA mallee areas might not be necessary. With pickled seed, sow seed within 6–10 hours of inoculation.

Fertiliser

- A maintenance application of 50–100kg/ha superphosphate is recommended.
- Fertiliser treated with fungicides such as flutriafol may reduce early blackspot infection in high-risk areas.

Rolling

- Field pea paddocks should be rolled with rubber tyre or steel rollers to level the paddock surface and partially bury any cereal stubble, rocks and/or sticks present after sowing.
- Roll either before the crop emerges or after the three-node growth stage.
- Rolling should not be done two weeks before or after the application of post-emergent herbicides.
- Rolling should be done before the plants are 20–25cm tall.

Weed control

- The delayed sowing of field pea, which is necessary to avoid blackspot, provides a good opportunity to control weeds using knockdown herbicides or cultivation.
- Field pea should be planted in paddocks with as few broadleaf weeds as possible, i.e. doublegee, wild mustard and wild radish. For this reason, field pea should be sown into paddocks with cereal stubbles and where weeds are primarily controlled pre-sowing.

Numerous herbicides are registered on field pea in WA. Check labels of specific herbicide products for rates, crop and weed growth stages for application, recommended surfactants and oils, withholding and plant-back periods, etc.

Pre-seeding and incorporated by sowing (IBS) herbicides

- Bixlozone 400g/L, Group 13/Q, e.g. Overwatch® at 1.25L/ha. Seed field pea at least 3cm deep using a seeding system that can ensure adequate spatial separation of seed and herbicide, e.g. knife point tynes and press wheels.
- Carbetamide 900g/kg (e.g. Ultro® 900 WG), Group 23/E, at 1.1–1.7kg/ha. Do not apply carbetamide pre-sowing if planting with disc seeder as increased contact between the germinating seed and herbicide may reduce crop safety. Apply the lower rate on sandy soils and where lower weed densities are expected. Apply the higher rate on heavier soils and where the weed densities are expected to be moderate to high.
- Cyanazine 900g/kg, Group 5/C, e.g. Bladex® at 1.1kg/ha. Do not use on sand or sandy loam soils as crop damage may result. Where annual ryegrass and wireweed are a major problem, add pendimethalin or trifluralin at the recommended rates. Do not add anti-evaporant spraying oils.
- Dimethenamid-P 720g/L, Group 15/K, e.g. Outlook® at 1L/ha. Annual ryegrass suppression only if weeds are at high density.
- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 0.83–1.1kg/ha. Use the lower rate on light sandy soils.
- Flumioxazin 500g/kg, Group 14/G, e.g. Terrain® at 180g/ha. Do not use on lighter soil types (sand) as shorter periods of residual control and unacceptable crop safety can occur.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.5L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.
- Metribuzin 750g/kg, Group 5/C, e.g. Stacato® at 180–380g/ha. Use an IBS application when furrow seeding using knife points and press wheels. Use lower rate on light sandy soils and higher label rates on heavy clay loam soils. Sow field pea 5cm deep.
- Pendimethalin 440g/L, Group 3/D, e.g. Stomp® at 1.5–2.25L/ha. Use the lower rates on light textured soils and the higher rates on medium to heavy textured soils.
- Propyzamide 900g/kg, Group 3/D, e.g. Edge® 900 WG at 0.56–1.11kg/ha. Use higher rates on heavy soils under sub-optimal conditions or where a heavy grass population is expected.
- Prosulfocarb 800g/L (Group 15/J) + s-metolachlor 120g/L (Group 15/K), e.g. Boxer Gold® at 2.5L/ha.
- Pyroxasulfone 850g/kg, Group 15/K e.g. Sakura® at 118g/ha.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.86–1.2kg/ha. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40–60%). Sow at least 3cm and preferably 5cm deep. The rates

higher than 0.86kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage. Heavy, intense rainfall following application may cause crop damage.

- Terbuthylazine 600g/kg (Group 5/C) + Propyzamide 300g/kg (Group 3/D), e.g. Effigy® 900 WG at 1.25–1.75kg/ha. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40-60%). Sow at least 5 cm deep. The rates higher than 1.25kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage.
- Tri-allate 500g/L, Group 15/J, e.g. Avadex® Xtra at 1.6L/ha.
- Trifluralin 480g/L, Group 3/D, e.g. TriflurX® at 1.2–1.7L/ha. The rates depend upon the soil type, refer to label.
- Trifluralin 350g/L (Group 3/D) + Tri-allate 550g/L (Group 15/J), e.g. Jetti Duo® at 1.45–1.8L/ha. For best results apply within 12 hours of crop sowing. Use with knife/blade point seeding system.

Post-sowing pre-emergent (PSPE) herbicides

- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 550–830g/ha. Use the lower rate on light sandy soils.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.25L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.
- Imazethapyr 700g/kg, Group 2/B, e.g. Spinnaker® WDG at 70g/ha. Some of the weeds will not be completely controlled but will be retarded enough not to compete with crop.
- Metribuzin 750g/kg, Group 5/C, e.g. Stacato® at 180–380g/ha. PSPE application is recommended for flat surface created with use of harrows and/or rolling of paddock after crop sowing. Use lower rate on light sandy soils and higher label rates on heavy clay loam soils. Sow field pea 5cm deep.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 600–860g/ha. Apply within two days of crop sowing. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40–60%). Sow at least 3cm and preferably 5cm deep. The rates higher than 0.86kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage. Heavy, intense rainfall following application may cause crop damage.

Post-emergent herbicides for broadleaf weed control

- Cyanazine 900g/kg, Group 5/C, e.g. Bladex® at 0.55–1.1kg/ha. Apply at 3–5 crop nodes. Use the higher rate on heavier soil types and under high weed pressure.
- Diflufenican 500g/L, Group 12/F, e.g. Brodal® Options or Bonanza® Elite at 100–200mL/ha. Apply from third node to pre-flowering of crop growth stages. Apply diflufenican 500 at 100mL,150mL and 200mL/ha for control of up to 2, 4 and 6-leaf stage weeds (wild radish, hedge mustard, Indian hedge mustard and wild turnip), respectively. Suppression of capeweed up to 4 leaf stage at 200mL/ha rate.
- Flumetsulam 800g/kg, Group 2/B, e.g. Broadstrike® at 25g/ha. Apply at 2–6 crop nodes and no later than six weeks after crop emergence. Do not tank-mix any spraying additives or other chemicals.
- Imazamox 700g/kg, Group 2/B, e.g. Raptor® at 45g/ha + BS1000® at 0.2% (v/v). If planning to use imazamox, maximum recommended rate of pre-emergent diuron is 250g/ha and do not roll field peas after germination. Do not apply it after four-node stage of crop and if frost is in the forecast.
- Metribuzin 750g/kg, Group 5/C, e.g. Stacato® at 180–380g/ha. Use lower rate on light sandy soils and higher label rates on heavy clay-loam soils up to three-node stage of the crop. Apply as an early post-em application up to three-node stage of the crop to control weeds up to 4-true-leaf stage that are not more than 120mm in diameter. Consider alternatives to avoid damage on lighter soil types.
- MCPA 250g/L K and Na salts, Group 4/I, e.g. Nufarm MCPA 250 at 1L/ha. Apply when crop is 10–15cm high. Do not apply if flowering has begun. It could delay maturity by up to two weeks when applied at the recommended growth stage.
- Picolinafen 750g/kg, Group 12/F, e.g. Glocker® 750 WG at 33–50g/ha. Apply from third node to pre-flowering crop growth stages. Use the lower rate on 2–4 leaf and higher rate on 6–8 leaf wild radish and good spray coverage of weeds is essential. Suppression of capeweed only at the higher rate.

- Pyraflufen-ethyl 20g/L, Group 14/G, e.g. Ecopar® at 400mL/ha + 200mL/ha Aspect® Options (diflufenican 500g/L), Group 12/F or Ecopar® at 400mL/ha + 200g/ha Stacato® 750 (metribuzin 750g/kg), Group 5/C, for medium to heavy soils only (see restraints on the Ecopar® label). Apply at 2–5 crop nodes to control 2–4 leaf stage weeds that are not more than 6cm in diameter.

Post-emergent herbicides for grass weed control

- Butroxydim 250g/kg, Group 1/A, e.g. Factor® WG at 80–180g/ha + Supercharge® Elite® at 1% (v/v) to control 2-leaf to early tillering weeds. The lower rates are for younger weeds growing actively under ideal conditions. The higher rates for the weeds that are at early tillering stage, or in dense populations, or growing in poor growing conditions. For improved control of ryegrass and other grass weeds, it must be combined with clethodim or fop herbicide containing fluazifop-p, haloxyfop-R, propaquizafop or quizalofop. Do not apply at flowering stage of crop.
- Clethodim 240g/L, Group 1/A, e.g. Select® or Status® at 150–500mL/ha + D-C-Trate® at 2% or Hasten® at 1% or Kwickin® at 1% or Uptake® oil at 0.5% (v/v) to control 2-leaf to fully tillered grass weeds, refer to label. The lower rates will provide effective control if applied under ideal conditions to weeds that are smaller, actively growing, and free from temperature or water stress. Do not apply beyond full flowering of field peas.
- Diclofop-methyl 375g/L, Group 1/A, e.g. Di-Grass or Sirofop® at 1–2L/ha + wetting surfactant (e.g. Wetspray® 1000) at 0.25% (v/v) to control 2–4 leaf weeds. The rate selection depends upon the weed species and their size, refer to label. Do not spray when temperatures are higher than 25°C.
- Fluazifop-p 128g/L, Group 1/A, e.g. Fusilade® Forte at 500mL/ha to control actively growing 2–5 leaf brome grass before it commences tillering. Apply up until seven weeks before crop harvest.
- Haloxyfop-R 520g/L, Group 1/A, e.g. Verdict® at 50–100mL/ha + Uptake® oil at 0.5% or non-ionic wetting surfactant (e.g. BS1000®) at 0.2% (v/v). Application rate depends on weed size, adjuvant type and mix partner, refer to label. Apply from 2nd-node stage to before crop flowering. Do not apply it in mixture with diflufenican (e.g. Brodal® Options) as crop yellowing can occur and separate applications are recommended. Withholding periods are not required when used as directed.
- Propaquizafop 100g/L, Group 1/A, e.g. Shogun® at 200–450mL/ha + Hasten® or Kwickin® at 0.5% or non-ionic wetting surfactant (e.g. BS1000®) at 0.2% (v/v) to control 3-leaf to mid tillering weeds. Use 300mL/ha where ryegrass is not the dominant weed. Use higher rate for ryegrass control and for best results wait until 75% of ryegrass have begun tillering. Apply up until 12 weeks before crop harvest.
- Quizalofop-p-ethyl 200g/L, Group 1/A, e.g. Elantra® Xtreme® or Leopard® 200 at 65–190mL/ha + Hasten®/ Plantocrop™ at 1% or non-ionic surfactant (e.g. BS1000®, Wetspray®) at 0.2% or non-ionic wetting surfactant (1000g a.i./L strength) at 0.1% plus a mineral spray oil at 1% (v/v) to control 3-leaf to early tillering weeds. The selection of rate depends upon the weed species and their size, refer to label. Use higher rate under heavy weed pressure, and/or when weeds have commenced tillering. Apply up until nine weeks before crop harvest.

v/v = volume by volume of final spray solution.

Insect control

- During emergence, monitor crop for red-legged earth mite and lucerne flea.
- Following emergence, monitor crop for pasture looper cutworm.
- During and after flowering, monitor for pea weevil and budworm.
- Budworm can reduce grain quality considerably. The plant is very susceptible to budworm from flowering through to pod fill. Spray if there are one or more grubs per 10 sweeps of a sweep net. Spray before the grubs grow to 1cm. Controlling large grubs (20–25mm) is costly as most of the damage to the crop has already occurred for the grubs to grow to this size.
- At early flowering, spray for pea weevil as the first pods are appearing (10–14 days after flowering commences). Border spraying is an effective strategy in most areas. Control of pea weevil is needed when there is more than one weevil per 100 sweeps of a sweep net (human consumption) or one weevil per 10 sweeps (stock feed).

- Some growers try to control budworm and pea weevil with one spray – very careful monitoring is required for this to be successful.

Diseases

Blackspot is the most serious disease of field pea and can be minimised by:

- sowing field pea at least 500m from previous season's pea stubble.
- not sowing in paddocks where peas have been grown in the past three years.
- sowing crops after 60% or more spores have been released from previous seasons' stubble. The DPIRD Blackspot Manager website provides this information. Refer to https://www.agric.wa.gov.au/field-peas/field-pea-blackspot-management-guide-western-australia-16-may-2023

Marketing

- Field peas find a ready market as a component in animal feed rations due to their high lysine content.
- Given WA's time of harvest and geographic location, varieties that can be split can be sold as whole seed to south-east Asia and the Indian subcontinent for human consumption.
- Field pea can be delivered to CBH in some locations.
- Buyers of field pea are readily available in Perth and Esperance.

Crop-topping

- Paraquat 250g/L, Group 22/L, for example, Gramoxone® or Shirquat® at 400 or 800mL/ha. Use of higher rate is usually more reliable and provides a greater reduction in annual ryegrass seed set.
- Spray the crop when the annual ryegrass is at the optimum stage; that is, when the last annual ryegrass seed heads at the bottom of the plant have emerged, and most plants are at or just past flowering (with anthers present or glumes open) but before haying off is evident – usually October to November.
- Reduction in crop yield can occur (more than 25%) especially if the crop is less advanced relative to the ryegrass; i.e, if crops have mostly green immature pods. The higher-label rate can exacerbate any yield reduction. Do not harvest within seven days of application.

Desiccation

- Diquat 200g/L, Group 22/L, e.g. Reglone® at 2–3L/ha. Spray as soon as the crop has reached full maturity.
- Glyphosate, Group 9/M, e.g. Crucial® (glyphosate 600g/kg) at 0.6–1.6L/ha, Weedmaster® DST® (glyphosate 470g/kg) at 0.77–2.0L/ha, Roundup Ready® herbicide with PLANTSHIELD® (glyphosate 690g/kg) at 0.25–1.4kg/ha and Raze® (glyphosate 510g/L) at 0.335–1.2L/ha are registered as harvest-aid and for annual weeds control. Apply when field pea seeds turn yellow and average seed moisture content is below 30%. Application before this time could significantly reduce yields (in practice losses higher than 25% can occur). Use lower rate if ryegrass is flowering and higher label rate if ryegrass is at milky dough stage. Use higher label rates where crops or weeds are dense and faster desiccation is required. Do not use on crops intended for seed or sprouting. Do not harvest within seven days of application. Not all glyphosate products are registered for this use; refer to the registered product labels.
- Pyraflufen-ethyl 25g/L, Group 14/G, e.g. Sledge® at 200mL/ha alone or in mixture with the label rate of paraquat (e.g. Inferno®) or glyphosate (e.g. Raze®) are registered as a harvest-aid and for reduction in seed-set and viability of weed seeds. The tank mixture of pyraflufen-ethyl and paraquat or glyphosate may improve harvest efficiency and weed control and reduce seed-set and viability of weed seeds. Apply to field pea at or after seed moisture is less than 30%, typically when the pods are leathery and the lower 75% of pods are brown with firm seeds. For maximum weed-seed-set reduction, weeds should preferably be sprayed at full flowering stage, but adhere to crop growth stage to minimise yield losses. Do not apply less than seven days before harvest.
- Saflufenacil 700g/kg, Group 14/G, e.g. Sharpen® WG at 34g/ha in mixture with recommended label rate of glyphosate or paraquat plus 1% Hasten® or high-quality methylated seed oil (MSO). Apply when lower 75% of pods are brown with firm seeds and leathery pods or at 30% seed moisture. Earlier applications made before the recommended growth stage could result in grain yield losses. Do not harvest within seven days of application.

Harvesting

- As field pea lodges at maturity, crop lifters or pea pluckers are often required. In recent years, growers with harvesters with good height control have successfully harvested semi-leafless field pea using only the reel to bring the crop in – significantly reducing the amount of soil brought into the harvester.
- Field pea is easily threshed, so concave clearances should be opened, and the drum speed reduced.
- Alternate wires and blanking plates on the concave may need to be removed.

Further reading

GRDC GrowNotes

https://grdc.com.au/resources-and-publications/grownotes

Table 10. Suggested harvest settings or modifications for trailing and semi-leafless field pea

Variety	Trailing e.g. Parafield	Semi-leafless sugar pod varieties e.g. Kaspa
Harvest timing	Cool conditions At beginning of program	Warm conditions – sugar pod plant trait makes the vines ropey and hard to thresh and chop in cool damp conditions Harvest may be delayed provided pea weevil management and marketing is not compromised
Crop lifters	Essential	May be possible to remove lifters if crop is upright, resulting in less dirt in sample
Finger tyne adjustment	Tilted back slightly to assist lifting of material	Set in vertical position to force material down and onto draper fronts
Reel speed	1.1 times ground speed	1.0–1.3 times ground speed
Raised cross auger	Not required in most crops	Essential for draper fronts Improves speed of harvest of pluckers
Raised cross auger with paddles on middle section	Not required in most crops	
Lupin breakers	Not required in most crops	Useful addition to raised cross auger for draper fronts and table auger for conventional fronts Essential addition for table auger of plucker fronts if no raised cross auger fitted
Position of broad elevator feeder house auger	Set back	Moving the feeder house auger forward may reduce blockages
Stripper plate		Thought to be a useful addition to stop material building up behind raised cross augers and going over the rear of the table
Flexible fingers above plucker	Useful addition	Useful addition
Wire fence across back of fronts	Useful addition	May assist in light crops but not a reliable method compared to raised cross auger fitted with paddles
Crop dividing coulters	Useful addition	Most setups will benefit
Drum or rotor speed	Low 300–600rpm	Low 300–600rpm
Engine capacity		More power required
Concave	Easy to thresh 10–25mm	Ensure concave wire gaps are at least 7mm and not blocked. The extra time taken for the increased dry matter to be threshed when sieves are blocked may lead to seed damage.
Fan speed	60–75%	60–75%
Screens	Crop is likely to pick up dirt, fit screens to remove dirt wherever possible	Correct screen size is required, or damage will occur due to increased threshing time
Top sieve	20–25mm	20–25mm
Bottom sieve	10–15mm	10–15mm
Straw chopper	Useful addition	Essential due to the ropey nature of the vine

Lentil

Introduction

There is a small but rapidly expanding lentil industry developing in the Esperance Port Zone. Growers have had success sowing lentils in mid-late April, which has resulted in rapid growth and good yields of 1.4–2.5t/ha in recent years. Lentil can also produce good yields when sown in May – albeit with much slower growth.

Lentil grows best on soils with pH above 5.2.

The crop is particularly susceptible to transient waterlogging. Growers should expect to see more crop variability across paddocks than in most other crops.

There have been issues with herbicide damage on WA soils. Growers are encouraged to seek advice before growing lentil and to choose paddocks with a low burden of broadleaf weeds.

Modern harvester fronts have made harvesting easier, but it is still important to have clean paddocks and to roll the lentils to ensure a flat surface and minimise header damage.

As WA has only recently recommenced growing lentils, disease pressure is low. However, most growers budget one or two fungicide sprays from canopy closure onwards.

Recent releases

GIA Metro, GIA Sire and GIA Thunder were released in 2022, with seed available to growers in 2023. GIA Metro has tolerance to metribuzin + IMI herbicides – and is particularly useful on light-textured soils prone to damage from the applications of Group 5 (formerly Group C) herbicides.

GIA Sire is a small-seeded red lentil with tolerance to both clopyralid residues (Lontrel®) and IMI herbicides.

GIA Thunder is a small-seeded IMI tolerant red lentil, which has performed well in WA NVT trials.

GIA Lightning was also released in 2022 and is a small seeded red lentil with IMI tolerance and improved adaptation to lighter textured soils.

GIA Leader was released in 2021 and is a medium seed-size red lentil with IMI tolerance. It is a longer season variety best suited to areas with a favourable finish.

All of the varieties listed above are available for sale through PB Seeds. GIA Metro has an EPR of $7.50/t (GST excl.). GIA Thunder, GIA Lightning and GIA Leader have an EPR of $5.94/t (GST incl.).

PBA Kelpie XT was released in 2020. It is a large red lentil, with grain size slightly smaller than PBA Jumbo2 and similar disease resistance to other XT IMI-tolerant varieties. PBA Kelpie XT has an EPR of $5.94/t (GST incl.) and is licensed to Seednet.

PBA Highland XT was released in 2019. It is slightly earlier flowering than the other XT lines and has performed well in WA trials. PBA Highland XT has an EPR of $5.94/t (GST incl.) and is licensed to PB Seeds.

GIA and XT lentil lines have tolerance to IMI herbicides and reduced sensitivity to some sulfonylurea residues.

What variety should I grow?

PBA Bolt is the most widely grown variety in WA, particularly in the Esperance mallee. Growers have commented favourably on its harvestability and capacity to perform on soils with a sodic subsoil with elevated levels of boron. In recent years, WA-grown PBA Bolt has been readily accepted by overseas markets.

In other parts of WA, varieties with IMI tolerance, such as the PBA XT and GIA varieties outperform PBA Bolt

In recent years it has been an advantage to wait for market acceptance of new varieties in the eastern states before adopting new lines in WA.

Growers should note that due to variations in seed size and colour, not all lentil varieties can be co-mingled. Similarly, not all varieties are sought after by WA marketers – therefore it is vital that growers talk to potential buyers before committing to a variety.

Grain yield of lentil varieties

Refer to Tables 1 and 2.

Table 1. Grain yield of lentil varieties in AGZONE 1, AGZONE 2 and AGZONE 3 expressed as percentage of site mean yield for each trial year (2020–2022)

Agzone	Agzone 1		Agzone 2			Agzone 3
Year	2020	2021	2020	2021	2022	2021
Site mean yield (t/ha)	1.68	1.58	1.42	1.70	1.87	2.05
No. of trials	(1)	(1)	(1)	(1)	(1)	(1)
GIA Leader	89	97	107	98	98	104
GIA Lightning	122	105	128	105	105	114
GIA Metro	-	72	-	71	74	70
GIA Sire	-	80	-	82	87	96
GIA Thunder	123	112	132	115	115	116
Nipper	51	-	63	-	85	-
PBA Ace	95	-	83	-	93	-
PBA Blitz	92	94	73	93	94	84
PBA Bolt	105	98	90	94	93	97
PBA Hallmark XT	92	95	113	97	98	105
PBA Highland XT	116	103	114	103	103	106
PBA Hurricane XT	98	98	112	99	100	105
PBA Jumbo2	107	113	79	109	105	97
PBA Kelpie XT	117	102	110	105	107	100

Source: NVT Online, nvtonline.com.au

Table 2. Grain yield of lentil varieties in AGZONE 5 expressed as percentage of site mean yield for each trial year (2020–2022)

Agzone	Agzone 5		
Year	2020	2021	2022
Site mean yield (t/ha)	0.49	1.72	1.08
No. of trials	(1)	(1)	(1)
GIA Leader	103	105	98
GIA Lightning	125	113	115
GIA Metro	-	73	88
GIA Sire	-	93	119
GIA Thunder	113	112	100
Nipper	76	-	82
PBA Ace	88	-	102
PBA Blitz	87	82	97
PBA Bolt	103	100	112
PBA Hallmark XT	111	104	101
PBA Highland XT	115	104	111
PBA Hurricane XT	110	104	102
PBA Jumbo2	72	101	90
PBA Kelpie XT	110	94	104

Source: NVT Online, nvtonline.com.au

Lentil variety characteristics

Table 3. Agronomic characteristics of lentil varieties suited to WA

Variety	Market category	Seed shape	Flowering time	Maturity	Lodging
GIA Leader	Medium red	Lens	Mid-Late	Mid-Late	MR
GIA Lightning	Small red	Round	Mid-Late	Mid	MR
GIA Thunder	Small red	Round	Mid	Mid	MRMS
PBA Bolt	Medium red	Lens	Early-Mid	Early-Mid	R
PBA Hallmark XT	Medium red	Round	Mid	Mid	MR
PBA Highland XT	Small red	Lens	Early	Early-Mid	MR
PBA Hurricane XT	Medium red	Round	Mid	Mid	MR
PBA Jumbo2	Large red	Lens	Mid	Mid	MRMS
PBA Kelpie XT	Large red	Lens	Mid	Mid	MR

MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, R = Resistant.

No variety is immune to disease, and fungicide application could be required under severe disease pressure.

Table 4. Lentil variety disease resistance ratings

Variety	Botrytis grey mould	Ascochyta blight (Hurricane Virulent)	Ascochyta blight (Nipper Virulent)	Nematode resistance # (*Pratylenchus neglectus*)
GIA Leader	MRMS*p*	MR	MR	R
GIA Lightning	MS	MRMS	R	R
GIA Metro	MRMS	RMR	MR	MR
GIA Sire	MS	MRMS*p*	R	MR
GIA Thunder	MRMS	MRMS	R	MR
Nipper	MRMS*p*	MR	MRMS	RMR
PBA Ace	MS	MR	R	MR
PBA Blitz	MS*p*	MR	MRMS	MR
PBA Bolt	S	MRMS	MR	MR
PBA Hallmark XT	MRMS*p*	MRMS	RMR	MR
PBA Highland XT	MS	MR	MR	MR
PBA Hurricane XT	MS	MRMS	RMR	MRMS
PBA Jumbo2	MR*p*	RMR*p*	R	MR
PBA Kelpie XT	MS*p*	MRMS	MRMS	MRMS

Source: NVT Online, **nvtonline.com.au**
S = Susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, RMR = Resistant to moderately resistant, R = Resistant. *p* = provisional assessment where ratings may change.
# Nematode resistance ratings have not been tested in Western Australia and should be used as a guide only.

Table 5. Lentil tolerance to soil conditions

Variety	Boron	Salinity
GIA Leader	I*p*	I*p*
PBA Bolt	MI	MI
PBA Hallmark XT	I	MI
PBA Highland XT	I	MI
PBA Hurricane XT	I	I
PBA Jumbo2	MI	I
PBA Kelpie XT	I	MI

I = intolerant, MI = moderately intolerant *p* = provisional rating

Lentil agronomy guide

Paddock selection

- Relatively flat without rocks or large stones.
- Well drained loamy sands to clay loams with a pH above 5.2 ($CaCl_2$).
- Avoid sulfonylurea or Lontrel® (clopyralid) herbicide residues, except for varieties with specific tolerance, e.g. GIA Sire.
- A low broadleaf weed burden – avoid paddocks with a history of vetch.
- Avoid paddocks prone to waterlogging.
- XT varieties have improved tolerance to SU residues.

Rotation

- One in three years.
- Avoid lentil, chickpea, vetch, or faba bean stubble – at least 500m away from previous year's stubble.

Sowing window

Low and medium rainfall

- April 15 to end of May.
- Best results sown early but this increases frost risk in some areas.

High rainfall

- Lentils might not be the best crop choice as they are very susceptible to waterlogging.
- Delay seeding (late May to 20 June) to reduce disease risk.

Seeding depth

- 4–6cm.

Seed dressing

- Thiram and thiabendazole seed dressing, e.g. Evershield® Seed Treatment, let dry then apply Group E inoculum.

Fertiliser

- Maintenance of 5–10kg/ha of phosphorus, which can be applied with compounds containing nitrogen (MAP, DAP, Agras, etc) or as single superphosphate.

Target density

- 100–110 plants/m². Recommended plant density provides better competition with weeds than lower densities and aids efficient harvest.

Seeding rate

- Small-seeded varieties (PBA Hurricane XT) 35–40kg/ha.
- Medium-sized varieties (PBA Bolt, PBA Hallmark XT) 40–50kg/ha.
- Large-seeded varieties (PBA Jumbo2) 50+ kg/ha.

Always check seed size and germination percentage as both vary widely from year to year.

Row spacing

- Similar yield response on wide range of row spacings. Inter-row sowing between previous year's cereal rows can assist harvest and has been shown to increase yields by 10%.

Rolling

- Rolling the paddock after sowing improves harvest efficiency and reduces the risk of harvester damage.
- Lentils can be rolled after sowing but before crop emergence or post-emergent at the 3–5 leaf stage.
- Depth of sowing, seeding systems (furrow sowing, harrows etc.) and time of rolling can alter the safety of herbicides.
- Rolling post-emergent is preferred on lighter soil types to reduce wind erosion risk and improve crop safety from herbicides applied immediately before sowing.

Herbicide options

A range of following herbicides are registered on lentil in WA. It is advisable to check labels of specific herbicide products for rates, crop and weed growth-stages for application, recommended surfactants and oils, withholding and plant-back periods, etc.

Pre-seeding and incorporated by sowing (IBS) herbicides

- Carbetamide 900g/kg, Group 23/E, e.g. Ultro® 900 WG at 1.1–1.7kg/ha. Apply the lower rate on sandy soils and where lower weed densities are expected. Apply the higher rate on heavier soils and where the weed density is expected to be moderate to high. Do not apply carbetamide pre-sowing if planting with disc seeder as greater contact between the germinating seed and herbicide may reduce crop safety.
- Cyanazine 900g/kg, Group 5/C, e.g. Bladex® at 1.1kg/ha. Do not use on sand or sandy loam soils as crop damage may result. Where annual ryegrass and wireweed are a major problem, add pendimethalin at the recommended rates. Do not add anti-evaporant spraying oils.
- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 0.83–1.1kg/ha. Use lowest rate or consider alternatives to avoid damage on lighter soil types.
- Flumioxazin 500g/kg, Group 14/G, e.g. Terrain® at 120g/ha. Do not use on lighter soil types (sand) as shorter periods of residual control and unacceptable crop damage may occur. Avoid rolling the paddock before lentil emergence as it can reduce crop establishment.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.0L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.
- Pendimethalin 440g/L, Group 3/D, e.g. Stomp® at 1.5–2.25L/ha. Use the lower rates on light textured soils and the higher rates on medium to heavy textured soils.
- Prosulfocarb 800g/L (Group 15/J) + s-metolachlor 120g/L (Group 15/K), e.g. Boxer Gold® at 2.5L/ha.
- Propyzamide 900g/kg, Group 3/D, e.g. Edge® 900 WG at 0.56–1.1kg/ha. Use higher rates on heavy soils under sub-optimal conditions or where a heavy grass population is expected.
- Pyroxasulfone 850g/kg, Group 15/K, e.g. Sakura® at 118g/ha.
- Terbuthylazine 875g/kg, Group 5/C, e.g. Terbyne® Xtreme® at 0.86–1.2kg/ha. Use the lower rate on light soils (sandy loams to loamy sands) and the higher rate on heavier soils (loams, silt plus clay 40-60%). Sow at least 3cm and preferably 5cm deep. The rates higher than 0.86kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage. Heavy, intense rainfall following application may cause crop damage.
- Terbuthylazine 600g/kg (Group 5/C) + Propyzamide 300g/kg (Group 3/D), e.g. Effigy® 900 WG at 1.25–1.75kg/ha. Do not use on sandy loam to loamy sand soils with less than 40% clay. Use higher rates on heavier soils like loams (silt plus clay 40–60%). Sow at least 5cm deep. The rates higher than 1.25kg/ha on soils with a pH of 8 or above could cause unacceptable crop damage.

Post-sowing pre-emergent (PSPE) herbicides

- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 0.55–0.83kg/ha. Rolling before spraying can improve crop safety. Use lowest rate or consider alternatives to avoid damage on lighter soil types.
- Imazethapyr 700g/kg, Group2/B, e.g. Genfarm Imazethapyr at 70g/ha on XT (IMI tolerant) varieties only – refer to label. Some of the weeds will not be completely controlled, but will be suppressed enough to be uncompetitive with the crop.
- Metribuzin 750g/kg, Group 5/C, e.g. Stacato® at 180–380g/ha. Rolling before spraying can improve crop safety. Consider alternatives to avoid damage on lighter soil types or use lower rate on light sandy soils and higher label rates on heavy clay-loam soils. Crop should be sown at least 5cm deep. The crop vigour may be reduced, especially if heavy rain falls after spraying. Weeds should be from pre-emergence to 3-leaf stage except wireweed (Hogweed) which should not be beyond the cotyledon stage.

Post-emergent herbicides for broadleaf weed control

- Diflufenican 500g/L, Group 12/F, e.g. Brodal® Options at 100–200mL/ha. Application window is between third leaf and start of crop flowering. Apply diflufenican 500g/L at 100mL,150mL and 200mL/ha for control of up to 2, 4 and 6-leaf stage weeds (wild radish, hedge mustard, Indian hedge mustard and wild turnip), respectively. Suppression of capeweed up to 4-leaf stage at 200mL/ha rate.
- Flumetsulam 800g/kg, Group 2/B, e.g. Broadstrike® at 25g/ha + Uptake® oil at 0.5% or BS1000® at 0.2% (v/v). Do not apply later than six-weeks after crop emergence i.e. 4–8 fully expanded leaves of crop. It may cause transient height reduction, crop discolouration and delayed flowering without yield reduction in most situations.
- Imazamox 33g/L + imazapyr 15g/L, Group 2/B, e.g. Intercept® at 375–750mL/ha + Supercharge® Elite® or Banjo® at 0.5% (v/v) – XT (IMI tolerant) varieties only. Apply at 3–6 leaf/node stage of crop to target 2–4 leaf stage grass weeds.

Post-emergent herbicides for grass weed control

Lentil markets have low tolerance for cereals so include products in grass selective mixes that control volunteer cereals.

- Butroxydim 250g/kg, Group 1/A, e.g. Factor® WG at 80–180g/ha + Supercharge® Elite® at 1% (v/v) to control 2-leaf to early tillering weeds. The lower rates are for younger weeds growing actively under ideal conditions. The higher rates for the weeds that are at early tillering stage, or in dense populations, or growing in poor growing conditions. For improved control of ryegrass and other grass weeds, it must be combined with clethodim or fop herbicide containing fluazifop-p, haloxyfop-R, propaquizafop or quizalofop. Do not apply at flowering stage of crop.
- Clethodim 240g/L, Group 1/A, e.g. Select® or Status® at 150–500mL/ha + D-C-Trate® at 2% or Hasten® at 1% or Kwickin® at 1% or Uptake® oil at 0.5% (v/v) to control 2-leaf to fully tillered grass weeds, refer to label. The lower rates will provide effective control if applied under ideal conditions to weeds that are smaller, actively growing, and free from temperature or water stress. Apply up to the seven-node/early branching of lentils.
- Haloxyfop-R 520g/L, Group 1/A, e.g. Verdict® at 50–100mL/ha + Uptake® oil at 0.5% or non- ionic wetting surfactant (e.g. BS1000®) at 0.2% (v/v). Application rate depends on weed size, adjuvant type and mix partner, refer to label. Apply from second-node to pre-flowering crop growth stages. Do not apply it in mixture with broadleaf weed herbicides and apply these at least a week apart. Withholding periods are not required when used as directed.
- Propaquizafob 100g/L, Group 1/A, e.g. Shogun® at 200–450mL/ha + Hasten® or Kwickin® at 0.5% or non-ionic wetting surfactant (e.g. BS1000®) at 0.2% (v/v) to control 3-leaf to mid tillering weeds. Use 300mL/ha where ryegrass is not the dominant weed. Use higher rate for ryegrass control and for best results wait until 75% of ryegrass have begun tillering. Apply up until 12 weeks before crop harvest.
- Quizalofop-p-ethyl 200g/L, Group 1/A, e.g. Elantra® Xtreme® or Leopard® 200 at 65–190mL/ha + Hasten®/ Plantocrop™ at 1% or non-ionic surfactant (e.g. BS1000®, Wetspray®) at 0.2% or non-ionic surfactant (1000g a.i./L strength) at 0.1% plus a mineral spray oil at 1% (v/v) to control 3-leaf to early tillering weeds. The selection of rates depends upon the weed species and their size, refer to label. Use higher rate under heavy weed pressure, and/or when weeds have commenced tillering. Apply up until 12 weeks before crop harvest.

v/v = volume by volume of final spray solution.

Aphid threshold

- More than 30% of plants colonised.

Budworm threshold

- One caterpillar per 30 sweeps – very low threshold compared to other pulse crops.

Disease management

Numerous foliar fungicide products are registered for control of diseases in lentil; refer to the 'Fungicide for Pulses' table at the beginning of the Pulse Section (pages 162–163).

Botrytis grey mould (BGM)

- BGM is the most likely disease in WA lentil crops. Regular crop monitoring and protection will be required in high-risk situations – e.g. immediately adjacent to last year's crop; in bulky, dense canopies sown with narrow row spacing; non-optimal paddock selection (e.g. waterlogging); high disease pressure the previous year; a susceptible variety is planted; or lentil has been grown on the paddock in the past two years.
- Varieties vary in their susceptibility to BGM.
- Best time to apply the first fungicide for BGM is just before canopy closure, which occurs about 12 weeks after sowing. Follow-up applications can be required during early to mid-flowering to maintain protection, depending on the varietal susceptibility (R and MR varieties might not require follow up sprays in low-risk situations), growth and seasonal conditions. Depending on seasonal conditions, further sprays can become necessary through pod fill.

Suggested fungicides for BGM*

- 500mL/ha carbendazim (500g a.i/L) e.g. SpinFlo®
- 500mL/ha procymidone (500g a.i./L) e.g. Sumisclex®, Fortress®
- 400–540mL/ha of Veritas® Opti (tebuconazole 370g/L + azoxystrobin 222g/L)
- 0.75–1.0L/ha of Miravis® Star (pydiflumetofen 100g/L + fludioxonil 150g/L)
- 400–600mL/ha of Amistar Xtra® (azoxystrobin 200g/L + cyproconazole 80g/L)
- 400–600mL/ha of Aviator® Xpro® (150g/L prothioconazole + 75g/L bixafen

* Visit Pulse Australia web site to find latest fungicide product information – www.pulseaus.com.au/growing-pulses/crop-protection-products

Ascochyta blight

Most varieties grown in WA are rated MRMS or higher for resistance to ascochyta, therefore early sprays might not be required. Monitor crops. Spraying can be required during podding to produce clean seed.

Suggested fungicides for ascochyta*

- 1–2L/ha of chlorothalonil (720g a.i./L) e.g. Barrack®
- 400–540mL/ha of Veritas® Opti (tebuconazole 370g/L + azoxystrobin 222g/L)
- 250–500mL/ha of Miravis® Star (pydiflumetofen 100g/L + fludioxonil 150g/L)
- 400–600mL/ha of Aviator® Xpro® (150g/L prothioconazole + 75g/L bixafen)
- 400–600mL/ha of Amistar Xtra® (azoxystrobin 200g/L + cyproconazole 80g/L)
- 1–2.2kg/ha of mancozeb (750g a.i./kg) e.g. Dithane®

* Visit Pulse Australia web site to find latest fungicide product information – www.pulseaus.com.au/growing-pulses/crop-protection-products

Crop-topping

- Paraquat 250g/L, Group 22/L, e.g. Gramoxone® or Shirquat® at 400–800mL/ha. Use of higher rate is usually more reliable and provides a greater reduction in annual ryegrass seed set.
- Spray the crop when the annual ryegrass is at the optimum stage, i.e. when the last annual ryegrass seed heads at the bottom of the plant have emerged, and most are at or just past flowering (with anthers present or glumes open) but before haying off is evident – usually October to November.
- Reduction in crop yield can occur (more than 25%) especially if the crop is less advanced relative to the ryegrass, i.e. if crops have mostly green immature pods. The higher label rate might also exacerbate any yield reduction. Do not harvest within seven days of application.

Desiccation

- Diquat 200g/L, Group 22/L, e.g. Reglone® at 2–3L/ha. Spray as soon as the crop has reached full maturity – more than 50% of seeds have changed colour to yellow-buff.
- Glyphosate, Group 9/M, e.g. Crucial® (glyphosate 600g/kg) at 0.6–1.6L/ha, Weedmaster® DST® (glyphosate 470g/kg) at 0.77–2.0L/ha, Roundup Ready® herbicide with PLANTSHIELD® (glyphosate 690g/kg) at 0.53–1.4kg/ha and Raze® (glyphosate 510g/L) at 0.72–1.2L/ha are registered as harvest-aid and for annual weeds control. Apply when crop is physiologically mature and has less than 15% green pods. Use higher label rates

where crops or weeds are dense and faster desiccation is required. Do not harvest within seven days of application. Application to crops intended for seed production might reduce germination percentage to commercially unacceptable levels. Not all glyphosate products are registered for this use; refer to the registered product labels.

- Pyraflufen-ethyl 25g/L, Group 14/G, e.g. Sledge® at 200mL/ha alone or in mixture with the rate of paraquat (e.g. Inferno®) or glyphosate (e.g. Raze®) are registered as a harvest-aid and for reduction in seed-set and viability of weed seeds. The tank mixture of pyraflufen-ethyl and paraquat or glyphosate may improve harvest efficiency and weed control, and reduce seed-set and viability of weed seeds. Apply to lentils at or after the crop starts to turn yellow (senesce), typically when less than 15% of the pods are still green. For maximum weed-seed-set reduction, weeds should preferably be sprayed at full flowering stage, but adhering to crop growth stage is important to minimise yield losses. Do not apply less than seven days before harvest.
- Saflufenacil 700g/kg, Group 14/G, e.g. Sharpen® WG at 34g/ha in mixture with recommended label rate of glyphosate or paraquat plus 1% Hasten® or high-quality methylated seed oil (MSO). Apply just after crop starts to yellow (or senesce). Sharpen® WG can have a negative effect on lentil germination. Do not use Sharpen® WG on lentil crops for seed production.

Harvesting

- Harvesting reel speed slightly faster than ground speed.
- Table auger 7–10mm.
- Drum or rotor speed 300–600rpm.
- Concave clearance 10–12mm (start at clearance 10mm).

Vetch

By Mark Seymour and Harmohinder Dhammu (DPIRD), Stuart Nagel (SARDI) and Gregg Kirby (SARDI)

Introduction

Vetch is a multi-purpose crop grown mostly for a disease break in rotation with cereals on a wide range of soil types from light sands to heavier clay soils. The versatility of common vetch varieties (Morava, Rasina, Volga, Timok and Studenica) allows cropping for grain or hay production, early grazing as green pasture or for dry grazing, hay production or green manure. Grain vetches have been grown in low-medium rainfall cereal areas where they have achieved similar grain yields to peas.

Vetch grain is not used for human consumption due to the presence of neurotoxins. Common vetch grain can be used without limit to feed all ruminants and used in pig rations up to a maximum inclusion rate of 20%. Modern varieties such as Studenica, Morava, Rasina, Volga and Timok possess less toxin in grain (<0.65%) compared with older varieties such as Blanchefleur (0.95%) and Languedoc (1.65%).

Forage vetches are used for hay, green manure or mid–late winter feed for grazing. They include purple vetch (*V. benghalensis* – e.g. Barloo) and/or woolly pod vetches (*V. villosa* ssp. – e.g. RM4). Grain from woolly pod vetch varieties CANNOT be used to feed any livestock.

Disease management is critical when growing a vetch crop regardless of end use. Where possible, disease-resistant varieties should be planted. The most common disease in WA vetch is botrytis grey mould (BGM), which favours cool/wet growing seasons with high amounts of vegetative growth. Although there is little difference between vetch varieties in their resistance to BGM, varieties such as Morava, which produce more vegetative growth and have denser canopies, will be more prone to this disease in higher-rainfall areas.

Ascochyta blight occurs in earlier stages of the vetch crop and can reduce grain and dry matter production, but it is less common than BGM in WA. Later in the season rust can also infect common vetch varieties that are not resistant, and damage can occur very quickly in spring. Care must be taken when growing rust-susceptible varieties as grazing or feeding hay/silage from rust-infected plants can induce abortions in pregnant livestock. Fortunately, newly released common vetch varieties have good resistance to rust.

LEFT: Mark Walter (Cascade), Mark Roberts (Cascade) and Stuart Nagel (vetch breeder SARDI).

What variety should I grow?

Studenica, Morava, Rasina, Volga and Timok are resistant to rust and are the preferred varieties for grain in areas prone to rust infections. Morava's late flowering/maturity results in more variable yield than other vetch varieties, and it is best suited to long seasons.

Studenica is a new release from the National Vetch Breeding Program and is the earliest common vetch variety (flowering in about 85–90 days). It has improved winter growth and vigour over existing varieties with better frost tolerance. It is targeted at low-rainfall mixed-farming systems looking to fill the late-winter feed gap. Due to limited testing in WA, the information provided below is from South Australia through the National Vetch Breeding Program.

See Tables 4 and 5 for suggested varieties for grain, hay, silage, grazing and green manuring for each rainfall zone in WA.

Table 1. Grain yield of grain vetch varieties in AGZONES 2, 3 and 5 expressed as percentage of site mean yield for each trial year (2015–2018)

Agzone Location		Agzone 2 Cunderdin			Agzone 3 Kojonup		Agzone 5 Grass Patch		Multi-site
Year		2016	2017	2018	2015	2016	2016	2017	2015–2018
Site mean yield (t/ha)		1.7	2.5	1.2	1.4	1.2	1.8	2.3	1.70
	No. of trials	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(7)
Morava	(7)	97	109	59	80	125	101	33	86
Timok	(7)	110	107	118	136	96	93	103	109
Volga	(7)	118	114	123	101	95	96	116	109
Rasina	(7)	95	118	-	-	-	-	109	-

Source: PBA and DPIRD

Table 2. Grain and dry matter yield of grain vetch varieties in the West Midlands in 2021 and 2022

Genotype	2021		2022
	Grain yield (t/ha)	Dry matter in early September (t/ha)	Dry matter (t/ha)
Morava	2.6	3.3	9.3
Studenica	2.4	4.4	7.8
Timok	2.5	3.9	9.5
Volga	2.7	3.6	9.5

Table 3. Grain and dry matter yields (t/ha) of current vetch varieties for 5 sites x 5 years in South Australia (2016–2020)

Variety	Grain yield	% of Volga	Dry matter	% of Morava
Studenica	1.7	86	4.7	92
Rasina	1.8	92	-	-
Morava	1.6	82	5.1	100
Timok	1.9	100	4.8	94
Volga	1.9	100	4.9	96
Mean	**1.8**	**-**	**4.9**	**-**

Source: Data courtesy of Stuart Nagel, SARDI

Table 4. Suggested grain vetch varieties for WA rainfall zones

Low	Medium	High	Very high
Studenica	Studenica	Timok	Morava
Volga	Rasina	Rasina	Timok
Timok	Timok	Morava	-
Rasina	Volga	-	-

Table 5. Suggested vetch varieties for WA by rainfall zone for use as dry matter (hay/silage/grazing) or green manure crop

Use	Low	Medium	High	Very high
Late summer/early autumn sown – grazing	RM4	RM4	RM4	RM4
April sown – green manure	RM4	RM4	RM4	RM4
	Morava	Morava	Morava	Morava
April sown graze and grain	Studenica	Studenica	Morava	Morava
	Volga	Timok	Timok	Timok
	Timok	Volga	Volga	-
	Rasina	Rasina	-	-
		Morava	-	-

Table 6. Dry matter yields (t/ha) in 2018 at low-rainfall Mallee sites in SA and Vic and cut in August to show early growth

Variety	Waikerie (SA) 15 August	Walpeup (Vic) 25 August
Studenica	4.8	3.2
Morava	3.7	1.7
Rasina	4.0	-
Timok	3.8	2.1
Volga	4.2	2.2

Source: Data courtesy of Stuart Nagel, SARDI

Table 7. Average hay yields (t/ha, cut mid-September) of current vetch varieties at low-rainfall sites in South Australia

Variety	2014	2015	2016	Multi-site 2014–2016
Studenica	2.2	3.1	2.2	2.5
Rasina	-	2.9	2.2	2.5
Timok	2.1	3.2	2.1	2.4
Volga	2.3	3.1	2.4	2.6

Source: Data courtesy of Stuart Nagel, SARDI

Table 8. Woolly pod vetch dry matter (3 sites x 5 years in 450+mm rainfall zones in South Australia)

Variety	Dry matter (t/ha)	% of Capello
Cappello	5.7	100
RM 4	5.9	104

Source: Data courtesy of Stuart Nagel, SARDI

Table 9. Characteristics of selected vetch varieties

Variety	Maturity	Grain yield	Dry matter yield	Flower colour	Pod shatter (%)	Hard seed (%)	Rust	Ascochyta	Botrytis	BCN (%)
Common vetch (*Vicia sativa*)										
Morava	Late	High	High	Purple	0	0	R	MS	VS	0.65
Rasina	Early-mid	High	Mod	Purple	0–2	0	R	S*p*	S	0.60
Studenica	Very early	High	High	White	0–2	0	R	MR*p*	S	0.65
Timok	Mid	High	Very high	Purple	0–2	0–2	R	S*p*	S	0.57
Volga	Early	Very high	High	Purple	0–2	2–5	R	MRMS*p*	S	0.54
Purple vetch (*Vicia villosa subsp. benghalensis*)										
Barloo*	Mid	Low	High	Purple	20–30	5–10	R	S	VS	NS
Benatas	Very late	Low	High	Purple	-	-	-	S*p*	MRMS*p*	NS
Popany	Very late	Low	High	Purple	20–30	5–10	R	MR*p*	S*p*	NS
Presto	Early	Low	-	Purple	0–2	-	-	-	-	NS
Woolly pod vetch (*Vicia villosa subsp. dasycarpa*)										
Capello	Late	Low	Very high	Purple	5–10	15–20	R	S	VS	NS
Haymaker	Late	Low	Very high	Purple	5–10	20–30	R	MR*p*	S*p*	NS
RM4	Mid	Moderate	Very high	Purple	2–5	2-5	R	MR*p*	S*p*	NS

Source: Data curtesy of Joshua Fanning, Agriculture Victoria.
* Also known as Early Purple or Early Popany.
VS = Very susceptible, S = Susceptible, MS = Moderately susceptible, MRMS = Moderately resistant to moderately susceptible, MR = Moderately resistant, R = Resistant.
p = provisional rating.
BCN = cyanoalanines – which limit their safe use for human consumption and some feed markets.
NS = grain is not suitable for consumption.

Vetch agronomy guide

Weed control

The following herbicides are registered on different vetch species:

Pre-seeding and incorporated by sowing (IBS) herbicides

- Carbetamide 900g/kg, Group 23/E, e.g. Ultro® 900 WG at 1.1–1.7kg/ha. Do not apply carbetamide pre-seeding if planting with disc seeder as increased contact between the germinating seed and herbicide may reduce crop safety. Apply the lower rate on sandy soils and where lower weed densities are expected. Apply the higher rate on heavier soils and where the weed density is expected to be moderate to high.
- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 0.83–1.1kg/ha (Common vetch only). Use the lower rate on light sandy soils.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 0.5–1.5L/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.
- Trifluralin 480g/L, Group 3/D, e.g. TriflurX® at 1.7L/ha.

Post-sowing pre-emergent (PSPE) herbicides

- Diuron 900g/kg, Group 5/C, e.g. Diurex® WG at 550–830g/ha (Common vetch only). Use the lower rate on light sandy soils.
- Fomesafen 240g/L, Group 14/G, e.g. Reflex® at 500–900mL/ha. Use higher rates where higher weed densities are expected, or longer residual control is required. To reduce the risk of injury to the following crops in rotation (e.g. cereals) on lighter texture and/or non-wetting soils with low organic carbon (0.5% to 1.5%), use a maximum rate of 750mL/ha. Do not use Reflex® on soils that have less than 0.5% organic carbon.
- Metribuzin 750, Group 5/C, at 180–380g/ha. The rate is influenced by soil type, refer label. At the time of application, weeds should be from pre-emergence to 3-leaf stage except wireweed (Hogweed) which should not be beyond the cotyledon stage.

Post-emergent herbicides for broadleaf weed control

- Flumetsulam 800g/kg, Group 2/B, e.g. Broadstrike® at 25g/ha at three fully expanded leaves onwards (Purple or Popany vetch only). Do not apply tank-mixed with other herbicides.
- Pyraflufen-ethyl 20g/L, Group 14/G, e.g. Ecopar® at 800mL/ha + BS1000® 0.2% (v/v) at 3–5 crop leaves to control 2–4 leaf stage weeds that are not more than 6cm in diameter. It is registered only on certain vetch varieties, refer label.

Post-emergent herbicides for grass weed control

- Butroxydim 250g/kg, Group 1/A, e.g. Factor® WG at 80–180g/ha + Supercharge® Elite® at 1% (v/v) to control 2-leaf to early tillering weeds. The lower rates are for younger weeds growing actively under ideal conditions. The higher rates for the weeds that are at early tillering stage, or in dense populations, or growing in poor growing conditions. For improved control of ryegrass and other grass weeds, it must be combined with fop herbicide containing fluazifop-p, haloxyfop-R, propaquizafop or quizalofop. Do not apply at flowering stage of crop.
- Fluazifop-p 128g/L, Group 1/A, e.g. Fusilade® Forte at 820mL/ha for control of actively growing 5-leaf to early tillering weeds.
- Haloxyfop-R 520g/L, Group 1/A, e.g. Verdict® at 50–100mL/ha + Uptake® oil at 0.5% or non-ionic wetting agent (e.g. BS1000®) at 0.2% (v/v). Application rate depends on weed size, adjuvant type and mix partner, refer label. Apply from second crop leaf to pre-flowering growth stages. Do not apply it in mixture with broadleaf weed herbicides and apply these at least a week apart. Withholding periods are not required for seed harvest when used as directed.

- Propaquizafob 100g/L, Group 1/A, e.g. Shogun® at 200–450mL/ha + Hasten® or Kwickin® at 0.5% or non-ionic wetting surfactant (e.g. BS1000®) at 0.2% (v/v) to control 3-leaf to mid tillering weeds. Use 300mL/ha where ryegrass is not the dominant weed. Use higher rate for ryegrass control and for best results wait until 75% of ryegrass have begun tillering. Do not graze or cut for stock food for three days after application.
- Quizalofop-p-ethyl 200g/L, Group 1/A, e.g. Elantra® Xtreme® or Leopard® 200 at 65–190mL/ha + Hasten®/ Plantocrop™ at 1% or non-ionic surfactant (e.g. BS1000®, Wetspray®) at 0.2% or non-ionic surfactant (1000g a.i./L) at 0.1% plus a mineral spray oil at 1% (v/v) to control 3-leaf to early tillering weeds. The selection of rates depends upon the weed species and their size, refer label. Use higher rate under heavy weed pressure, and/or when weeds have commenced tillering. Apply up until 12-weeks before crop harvest.

v/v = volume by volume of final spray solution.

Crop-topping

- Paraquat 250g/L, Group 22/L, e.g. Gramoxone® or Shirquat® at 400–800mL/ha. Use of higher rate is usually more reliable and provides a greater reduction in annual ryegrass seed set.
- Spray the crop when the annual ryegrass is at the optimum stage, i.e. when the last annual ryegrass seed heads at the bottom of the plant have emerged, and most are at or just past flowering (with anthers present or glumes open) but before haying off is evident – usually October to November.
- Reduction in crop yield can occur (more than 25%) especially if the crop is less advanced relative to the ryegrass, i.e. if crops have mostly green immature pods. The higher label rate might also exacerbate any yield reduction. Do not harvest within seven days of application.

Desiccation

- Glyphosate, Group 9/M, e.g. Crucial® (glyphosate 600g/kg) at 0.6–1.6L/ha and Weedmaster® DST® (glyphosate 470g/kg) at 0.77–2.0L/ha are registered as harvest-aid and for annual weeds control. Apply at or after crop maturity when seed moisture content is below 30%. Use higher label rates where crops or weeds are dense and where faster desiccation is required. Do not use on crops intended for seed production and sprouting. Do not harvest crop within seven days of application. Not all glyphosate products are registered for this use; refer to the registered product labels.

Oats and Vetches for Hay and Silage

By F. E. RYAN
Agrostologist

OATEN hay, or oats conserved in the form of silage, is always a valuable insurance against lean periods on the dairy farm—but if that hay or silage is made from a mixture of oats and vetches, it will be infinitely more valuable. The vetches give a much greater bulk of feed and, being legumes, they boost the protein content of the fodder, so that it cuts down the need for costly supplementary feeding.

The Dairying Division of the Department of Agriculture has carried out a lot of experimental work in recent years to determine the best types of vetches and oats to use, and the best methods of producing the crops.

The most satisfactory mixture used in the experiments so far has been 15 lb. of Commercial Purple vetch seed sown with 60 lb. of Algerian oats per acre, using 2 cwt. of superphosphate or a similar quantity of super-copper-zinc if the land is copper or zinc deficient.

A bulky crop of oats and vetches grown at Armadale

On potash deficient areas, good crops cannot be expected unless the deficiency is rectified by the application of 1 cwt. of muriate of potash to the acre.

TYPE OF VETCHES TO SOW

Common vetches (Golden Tares), Commercial Purple, several introduced strains of purple vetch and common vetch and one flowered vetch (*Vicia articulata*) were among the varieties tested.

Commercial Purple was outstanding in the dairying districts although *Vicia articulata* gave good results in the drier districts such as Boyup Brook and Darkan.

Vetches are weak-stemmed plants which lodge quickly if grown alone. A cereal crop provides support for the vetches, and oats are the most satisfactory crop for this purpose.

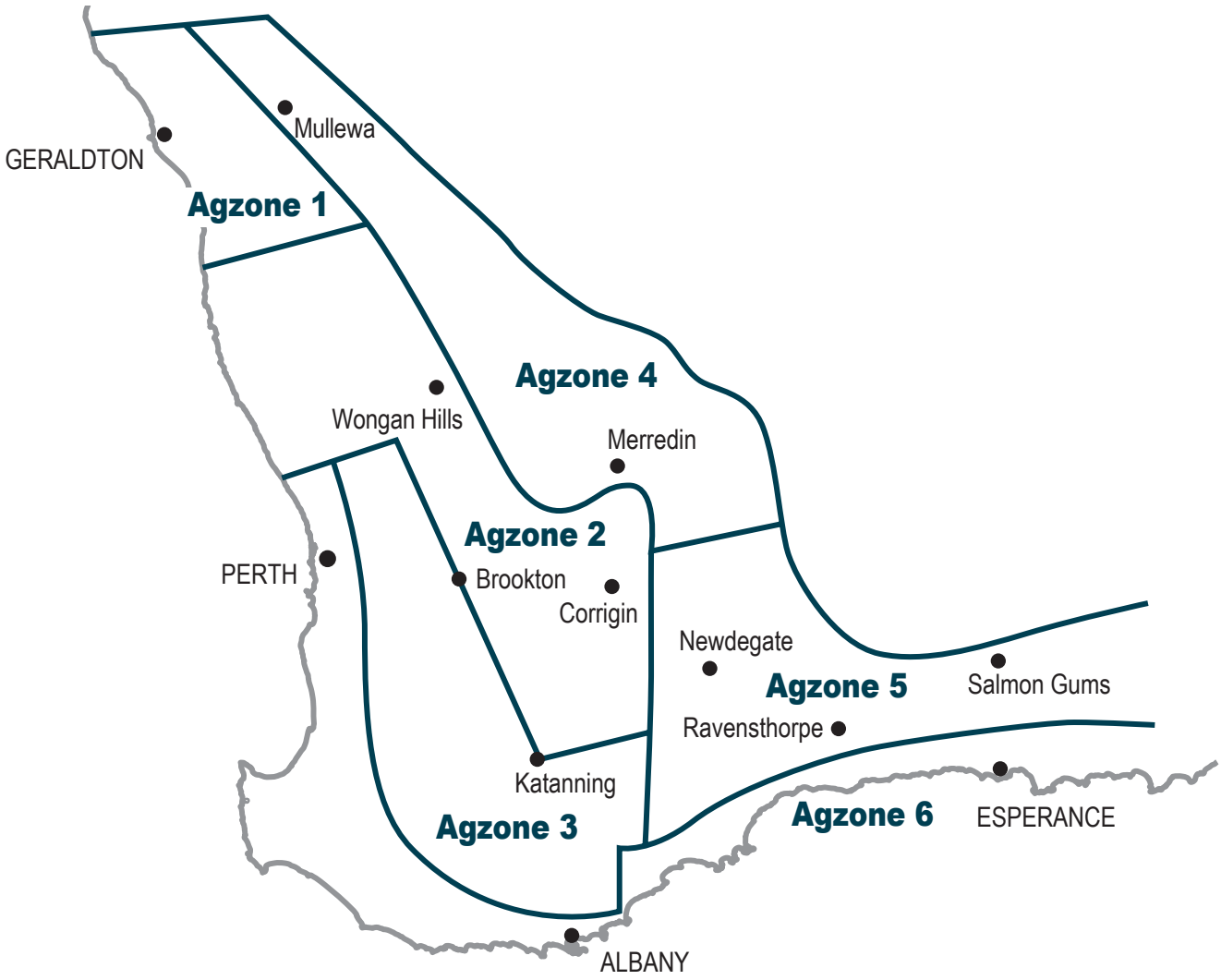
TYPE OF OATS TO SOW

In selecting an oat variety to combine with the vetches, it was necessary to take into consideration the differences in growth habits of the two plants. In our trials, the vetches grew slowly during autumn and winter and made rapid progress in spring. Oats which made vigorous autumn and early winter growth were apt to "smother" the vetches.

Algerian oats are the recommended variety, as their growth habits most closely approximate those of the vetches.

Extract from Journal of the Department of Agriculture of Western Australia, Vol. 5, No. 6, November – December, 1956. An Agrostologist is a person who specialises in the scientific study of the grasses.

Notes



Western Australian Agzones used for wheat, barley, oat and pulse NVTs

Refer to page 100 for the distribution of Low-Med Rainfall and Med-High Rainfall Canola NVTs, previously known as 'Early' and 'Mid' trial series respectively.