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2023 Western Australian Crop Sowing Guide

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GRDC NATIONAL VARIETY TRIALS™

Department of
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2023 Western Australian Crop Sowing Guide

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This guide can be downloaded to your computer or tablet at: www.agric.wa.gov.au

Remember to update it each October.

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Plant Breeder's Rights

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 (ɒ), however this symbol has been omitted in this bulletin.

Plant Breeder's Rights are exclusive commercial rights for a registered variety. In most instances the breeder will license these rights to a selected seed company (the licensee). Any unauthorised commercial propagation or any sale, conditioning, import, export or stocking of propagation material of these varieties is an infringement under the *Plant Breeder's Rights Act 1994*.

Exceptions to Plant Breeder's Rights under Section 17 of the Act, are the rights of farmers to save seed for sowing future commercial crops. However, harvested material derived from farm saved seed remains subject to the End Point Royalty (EPR) applicable to that variety. Where EPRs apply, growers will be required to enter into arrangements with the breeder or licensee whereby royalties are paid on delivery of the grain. Some varieties may have a Seed Royalty (SR) paid on purchase of seed rather than an EPR. Further details can be found at **www.varietycentral.com.au**. Royalties collected are used to support ongoing research and the breeding of new and improved varieties.

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* 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 will decrease slightly when moderately resistant varieties are grown.

MS **Moderately susceptible:** nematode numbers will increase slightly 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 2023 edition of the Crop Sowing Guide for WA, which introduces 31 new variety releases: two wheat, seven barley (one as feed only and six currently under malt evaluation), 15 canola, three hay-only oat and four lentil varieties.

The Crop Sowing Guide for WA 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.

In this edition, 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 all varieties for each of the major crops grown in WA are evaluated using the same environmental regions. Refer to back cover page details or page 98 for canola.

Herbicide mode-of-action classifications have been updated internationally to capture new active constituents and to ensure the system is globally relevant. The science has not changed – the classification codes on product labels and literature currently used in Australia will change 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.

International trade flows for barley continue to be significantly affected by China's ban on imports of Australian barley grain and geopolitical tensions between Ukraine and Russia. A tight global supply of quality malt barley has allowed Australian barley and malt exports to diversify. High-quality malt barley is in strong demand from export customers of our malt barley grain and from domestic processors for export as malt. This demand has influenced the premium for malt over feed with premiums offered over the last twelve months. There is also a growing awareness of the value proposition afforded by including barley in animal feed rations. To help with barley decisions, market feedback from GIWA can be found on page 55 of this guide. Before making a barley choice, it will be important to consider market demand, pricing signals, location of segregation sites and the risks 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 varieties are provided in the wheat section of this guide to help match sowing opportunities with the best variety. **Flower power** is also a useful tool to match the flowering times of wheat, barley and oats in your area (https://fp.dpird.app). No wheat and barley varieties are tolerant to frost, and other crops also 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 2023 to confirm variety resistance ratings for new varieties and any changes to existing varieties. The latest NVT data will be available early in 2023 via the NVT website and the Long Term MET Yield Reporter tool.

Image: Gerard McSweeny, Mt Walker
Photo: Ben Crosthwaite Photography

WHEAT

Introduction

Brenda Shackley, Dion Nicol and Jeremy Curry, (DPIRD)

In 2021, Western Australian growers produced the state's largest ever wheat crop of 12.9M tonnes. Growers responded to the favourable season by sowing early, increasing sowing area and using best practice to manage for nitrogen and disease. 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). Variety snapshots for 20 of the most common and recently released wheat varieties can be found at the back of the guide.

Scepter accounted for more than 50% of the area sown to wheat in 2022, 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).

As environmental conditions are a major driver of crop performance, it is important to review variety performance over multiple years to better understand how a variety in a specific environment might perform across variable seasons. It is also important to consider how varietal differences can 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.

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 2023

Brumby is an APW wheat 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. InterGrain suggest that Brumby has a maturity between Scepter and RockStar, however DPIRD 2021 data indicates the variety to be of similar maturity to RockStar. A key attribute of Brumby is its powdery mildew resistance of R*, with provisional ratings of RMR*p* for stripe rust, MR*p* for stem rust and a SVS*p* rating for leaf rust. InterGrain suggests that Brumby is likely to possess a pre-harvest sprouting tolerance similar to Mace.

* a pathotype in eastern Australia can attack this variety.

LRPB Anvil CL Plus was released by LongReach in 2022 and is a quick maturing AH wheat with tolerance to imidazolinone herbicide. It was included in the 2020 WA NVT in Agzones 2,4 and 5 and all agzones in 2021. It achieved the highest yields of the current IMI tolerant varieties but was marginally lower yielding than Scepter. LongReach suggests that LRPB Anvil is well suited to the harsh finishing conditions of the low to medium rainfall areas of WA. LRPB Anvil has a similar disease profile to Hammer CL Plus, although weaker for leaf rust and yellow spot.

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

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 10 years old and which have accounted for less than 0.1% of deliveries over the previous four seasons. In attempts to improve wheat quality exports of udon noodle to Japan, Calingiri will be removed from the master list and, **from the 2022 harvest onwards, will only be received as a feed grade wheat in WA**. In 2023, the soft-wheat varieties Wedin and Kunjin and the APWN wheat LRPB Envoy will also be removed from the list due to inadequate plantings.

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 Envoy, LRPB Havoc, LRPB Trojan, LRPB Scout, Mace, RockStar, Sheriff CL Plus, Vixen, Westonia and Wyalkatchem.

New classification pending: 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 such general-purpose wheat with less complex qualities than existing classes. AWW is designed to also allow breeders to focus more on yield traits and less on quality testing, which in turn enables faster breeding cycles within breeding programs. AWW was included in the 2021 classification guidelines and Longsword (a fast winter) is the first variety to be classified for this class in 2022. However, it is uncertain when segregations/delivery locations will be offered.

In the next few years AWW will feature in the Wheat Quality Australia Master List and the Wheat Standards, however, this wheat class **will not be available in commercial volumes for several seasons**. No protein minimum specification has been set for AWW and its value will potentially sit below ASW.

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). Vixen and Rockstar increased in planted area in 2022, and while the area sown to Chief CL Plus declined slightly, the total area sown to IMI tolerant wheat remained static as the area sown to Hammer CL Plus increased. 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, Magenta, Calingiri and 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 (Figure 1).

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 the respective years. 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

With the release of LRPB Anvil CL Plus in 2022 and Calibre and LRPB Avenger in 2021, growers now have a wider range of wheat varieties to choose from for May and June sowing times. Growers are encouraged to take advantage of varietal herbicide and disease tolerances and also 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 that achieves consistently high yields and has relatively good disease and pre-harvest sprouting resistance (see Tables 2 and 20). Within the main season NVT, Vixen achieved the highest yield overall, with the yield advantage more evident in Agzones 2, 4 and 5. LRPB Avenger and Sting achieved higher yields than Scepter in lower-yielding environments (<2.5t/ha). Calibre was included in the NVT for 2020 and 2021, where it yielded similar to Scepter.

Calibre and LRPB Avenger have a slightly longer coleoptile length than Scepter, similar to Magenta but inferior to very long coleoptile wheats like Halberd (see Variety Traits for more detail).

Calibre offers an improved stem and stripe rust rating in the quick–mid season maturity group. Apart from LRPB Anvil CL Plus and LRPB Avenger, which are provisionally rated MSS and MS for yellow spot, all other 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. Following a rating increase to MS in 2021, LRPB Havoc now has the highest powdery mildew rating in the group (Table 2), however Brumby has the highest rating at R* for all main season varieties (Table 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 to mid maturity varieties like Scepter yield similarly in seasons with later emergence and the quick maturity wheats do not perform well in seasons with late end-of-season rainfall or early germination.

TABLE 2. Relative performance of top-yielding Quick and Quick–mid maturity wheat varieties compared to Scepter

	Scepter	Vixen	Calibre	Devil	Sting	LRPB Avenger	LRPB Havoc	LRPB Anvil CL Plus
Statewide MET yield (% site mean)[1]	110%	112%	111%	110%	109%	109%	107%	106%
Maturity	Quick–mid	Quick	Quick–mid	Quick–mid	Quick	Quick	Quick–mid	Quick
Classification	AH	AH (N)	AH	AH (N)	AH	APW (N)	AH (N)	AH
Falling no. index	5	3	-	3	-	-	3	-
Stem rust	MRMS	MRMS	MR	MS	MRMS	MS	S	MR
Stripe rust	MR*	MRMS	RMR	MR	MR	MRMS	MR	RMR
Leaf rust	MSS	SVS	S	SVS	SVS	S	S	SVS
Powdery mildew	S	SVS	MSS*p*	SVS	S	S*p*	MS	S*p*
Yellow spot	MRMS	MRMS	MRMS	MRMS	MRMS	MS	MRMS	MSS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2017–2021). Readers are directed to Tables 6 to 11 for a more precise estimate of variety performance in their region. (N) = Denotes supplementary classification of APWN. * = Some races in eastern Australia can attack these varieties. *p* =provisional rating. Falling no. index please refer to page 32.

Vixen has a quick maturity and offers an alternative variety in this group. In 2021, Vixen sown in mid to late May flowered, on average, seven days before Scepter (see Maturity section). Vixen is more yield competitive over several seasons than predecessors in the quick maturity group and is likely to be the preferred option when choosing a quick season wheat. Vixen 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®.

LRPB Anvil CL Plus is an AH quick IMI tolerant variety released by LongReach in 2022. It was included in the WA NVT in 2020 in Agzones 2, 4 and 5 and all agzones in 2021. While LRPB Anvil CL Plus is the overall highest yielding IMI wheat, it has a clear advantage in the quicker season environments of Agzones 2, 4 and 5 (Tables 6–11).

In 2021 InterGrain released the long maturity Valiant CL Plus, which provides growers with a more appropriate variety for use with the Clearfield system in earlier sowing opportunities. Only tested in the main season NVT in 2020 and 2021, Valiant CL Plus has yielded similarly to Cutlass (Table 4), but lower than LRPB Anvil CL Plus, Razor CL Plus, Hammer CL Plus, Chief CL Plus and Sheriff CL Plus (Table 3). Valiant CL Plus has a similar maturity to Cutlass and InterGrain report it has a longer coleoptile than Scepter.

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 and far out-yielded previous CL Plus varieties. However, their yields are inferior to other non-imidazolinone resistant varieties. Hammer CL Plus is AH and APWN, while Chief CL Plus and Sheriff CL Plus are both classified as APW and APWN. Razor CL Plus is classified as ASW. In the lower yielding NVTs, the yield of Chief CL Plus was lower than LRPB Anvil CL Plus, Razor CL Plus and Hammer CL Plus. Disease packages vary significantly within Clearfield varieties, and this might drive adoption of certain varieties.

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

Mid–slow maturity varieties

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 enable flowering to be maintained at an optimum date. When sown on mainstream sowing dates mid–slow maturity wheats exhibit delayed development, which can help to avoid frost.

Brumby is a new entry into this maturity group with limited data from 2021 suggesting its maturity is similar to RockStar. When sown in mid-May, Brumby flowers about five days after Scepter and six days before Cutlass, Denison and Valiant CL Plus (Table 13).

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

	Scepter	LRPB Anvil CL Plus	Razor CL Plus	Hammer CL Plus	Chief CL Plus	Valiant CL Plus
Statewide MET yield (% site mean)[1]	110%	106%	104%	103%	102%	99%
Maturity	Quick–mid	Quick	Quick–mid	Quick–mid	Mid	Mid–slow
Classification	AH	AH	ASW	AH(N)	APW(N)	AH
Falling no. index	5	-	4*p*	-	4	-
Stem rust	MRMS	MR	MR	MR	MR	MR
Stripe rust	MR*	RMR	RMR	RMR	S	RMR
Leaf rust	MSS	SVS	S	S	MR*	S
Powdery mildew	S	S*p*	MS	S	S	S*p*
Yellow spot	MRMS	MSS	MSS	MRMS	MRMS	MRMS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2017–2021). Readers are directed to Tables 6 to 11 for a more precise estimate of variety performance in their region. (N) = Denotes supplementary classification of APWN. * = Some races in eastern Australia can attack these varieties. *p* =provisional rating. Falling no. index please refer to page 32.

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

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 and Early season NVT). 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 and Kinsei have inferior ratings for yellow spot compared to other mid–slow varieties, which are all MRMS/MRMS*p*. Brumby has the highest powdery mildew rating (R) of all main season varieties.

Falling number index ratings suggest RockStar is at higher risk of low falling number than Catapult. The difference in ratings is very evident when RockStar is sown in April or early May. InterGrain suggest that Brumby is similar to Mace for tolerance of pre-harvest sprouting.

TABLE 4. Relative performance of Mid–slow maturity wheat varieties compared to Scepter

	Scepter	RockStar	Brumby	Catapult	Kinsei	Denison	Valiant CL Plus	Cutlass
Statewide MET yield (% site mean)[1]	110%	109%	107%^	104%	103%	101%	99%	97%
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	APW (N)
Falling no. index	5	2	-	6	4	-	-	4
Stem rust	MRMS	MR	MRp	MR	MSS	MS	MR	R
Stripe rust	MR*	RMR	RMR*p*	RMR	MRMS	MR	RMR	RMR*
Leaf rust	MSS	S	SVS*p*	S	MSS	S	S	RMR*
Powdery mildew	S	MSS	R*	S	SVS	SVS	S*p*	S
Yellow spot	MRMS	MRMS	MRMS*p*	MRMS	MS	MRMS	MRMS	MSS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2017–2021). Readers are directed to Tables 6 to 11 for a more precise estimate of variety performance in their region. ^= single year of NVT data in 2021. (N) = Denotes supplementary classification of APWN. * = Some races in eastern Australia can attack these varieties. *p* =provisional rating. Falling no. index please refer to page 32.

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

	Scepter	Ninja	Kinsei	Zen	Calingiri
Statewide MET yield (% site mean)[1]	110%	105%	103%	102%	93%
Maturity	Quick–mid	Mid	Mid–slow	Mid–slow	Mid–slow
Classification	AH	ANW	ANW	ANW	Feed (2022)
Falling no. index	5	4	4	3	4
Stem rust	MRMS	S	MSS	SVS	SVS
Stripe rust	MR*	MS	MRMS	MRMS	SVS
Leaf rust	MSS	S	MSS	S	S
Powdery mildew	S	S	SVS	SVS	SVS
Yellow spot	MRMS	MRMS	MS	MRMS	MS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2017–2021). Readers are directed to Tables 6 to 11 for a more precise estimate of variety performance in their region. * = Some races in eastern Australia can attack these varieties. Falling no. index please refer to page 32.

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 from the relatively stable and long-term 60:40 ratio of ANW to APW, to a ratio of 80:20 or 90:10 over the last two years. Increasing the volume/proportion of ANW to the premium Japanese market. The APW component has also become the APWN classification varieties only.

Calingiri is now classified as FEED for the 2022 harvest with its yield and quality superseded by Kinsei, Ninja and Zen.

Ninja remains the highest yielding ANW in the main season NVT but yielding below Scepter over the past five years (Table 5). The slower maturing Kinsei has also performed well, and Ninja and Kinsei have achieved higher yields than all other ANW varieties. Ninja is marginally quicker in maturity than Zen and Calingiri, while Kinsei is slightly slower in maturity. As Ninja is 'S' to powdery mildew, leaf rust and stem rust, disease should be actively monitored and managed. Disease ratings for Kinsei are marginally better than Zen and Ninja, particularly for stem and stripe rust.

When sown in late April in the Early NVT, yields of Kinsei were slightly below RockStar and similar to Denison and Catapult (Table 14). However, with a rating of S for blackpoint, there is a higher risk of Kinsei's grain being downgraded when sown early.

YIELD IMPROVEMENT

Wheat yield increases through breeding and management have been impressive since breeding commenced in Australia. While the gains in yield directly related to genetics can often be obscured by advances in crop management, mechanisation and crop sequences, they become clear when yields of varieties are shown in comparison to their year of release (Figure 1). Top performing varieties in WA NVT (May to early June sowing) are commonly quick to mid maturing with yield improvements over the last twenty years equating to about 0.7% per year. However, there have been notable improvements in the performance of mid–slow maturing varieties released in the past five years. This should give growers confidence when utilising these longer maturity types to chase earlier germination opportunities, that should germination be later than ideal, the yield trade-off will be lower than with older mid–slow maturity varieties.

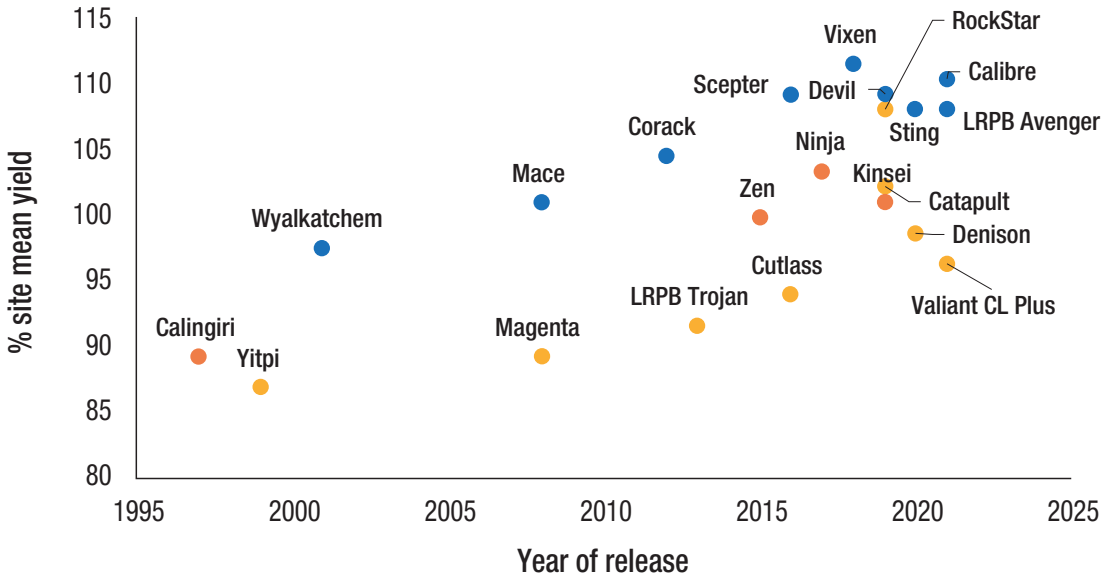

FIGURE 1. Wheat yield improvement in WA (based on NVT MET analysis 2017–2021, all Agzones, 192 NVT sites). Blue dots are top performers, orange dots are ANW varieties and yellow dots are mid–slow maturing varieties. Average yield is 3.12t/ha.

Source: NVT Online, nvtonline.com.au

Manisha Shankar looking at wheat for yellow spot with Donna Foster and Dorthe Jorgenson. Photo: DPIRD

Photo: Ben Crosthwaite Photography

Grain yield

Brenda Shackley, Dion Nicol and Jeremy Curry (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 2017 and 2021. 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 that environment. 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 (2017–2021) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)			2.58	3.56	1.15	3.57	3.94	
Variety	Maturity	(No. trials)	(5)	(6)	(5)	(4)	(5)	(25)
Australian Hard								
Emu Rock	Quick	(25)	88	100	96	96	99	**95**
LRPB Anvil CL Plus	Quick	(5)	-	-	-	-	106	**-**
Sting	Quick	(14)	-	-	114	106	108	**107**
Vixen (N)	Quick	(25)	93	115	117	106	112	**109**
Calibre	Quick–mid	(9)	-	-	-	107	104	**108**
Devil (N)	Quick–mid	(25)	105	109	114	107	108	**109**
Hammer CL Plus (N)	Quick–mid	(9)	-	-	-	101	101	**101**
LRPB Havoc (N)	Quick–mid	(25)	96	111	109	99	112	**106**
Mace (N)	Quick–mid	(25)	98	105	106	99	102	**102**
Scepter	Quick–mid	(25)	103	109	113	107	108	**108**
Catapult	Mid–slow	(20)	-	101	106	104	99	**103**
RockStar (N)	Mid–slow	(20)	-	107	111	109	107	**109**
Yitpi	Mid–slow	(25)	101	90	90	91	87	**92**
Valiant CL Plus	Mid–slow	(5)	-	-	-	-	99	**-**
Australian Premium White								
LRPB Avenger (N)	Quick	(9)	-	-	114	100	-	**106**
Corack	Quick–mid	(20)	98	109	109	97	-	**105**
Chief CL Plus (N)	Mid	(25)	103	103	103	98	105	**103**
Sheriff CL Plus (N)	Mid	(19)	102	-	101	102	103	**102**
Brumby	Mid–slow	(5)	-	-	-	-	109	**-**
Cutlass (N)	Mid–slow	(25)	108	95	97	97	93	**98**
Denison	Mid–slow	(9)	-	-	-	102	102	**103**
LRPB Trojan (N)	Mid–slow	(25)	99	93	92	103	95	**96**
Magenta	Mid–slow	(25)	104	90	91	98	88	**94**
Australian Noodle Wheat								
Ninja	Mid	(25)	104	104	106	108	104	**105**
Kinsei	Mid–slow	(25)	108	102	103	104	104	**104**
Zen	Mid–slow	(25)	103	104	103	99	107	**103**
Australian Standard White								
Razor CL Plus	Quick–mid	(25)	92	106	106	102	106	**103**

(N) = Denotes supplementary classification of APWN

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 (2017–2021) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)			3.46	4.03	2.22	2.72	4.40	
Variety	Maturity	(No. trials)	(16)	(14)	(16)	(14)	(15)	(75)
Australian Hard								
Emu Rock	Quick	(75)	98	94	101	99	96	**98**
LRPB Anvil CL Plus	Quick	(29)	-	-	-	105	105	**107**
Sting	Quick	(45)	-	-	115	112	108	**110**
Vixen (N)	Quick	(75)	111	109	118	114	112	**113**
Calibre	Quick–mid	(29)	-	-	-	112	109	**111**
Devil (N)	Quick–mid	(75)	109	110	111	110	110	**110**
Hammer CL Plus (N)	Quick–mid	(29)	-	-	-	104	101	**103**
LRPB Havoc (N)	Quick–mid	(75)	107	105	110	107	109	**108**
Mace (N)	Quick–mid	(75)	103	102	107	103	103	**104**
Scepter	Quick–mid	(75)	108	109	111	110	110	**110**
Catapult	Mid–slow	(59)	-	105	104	103	103	**103**
RockStar (N)	Mid–slow	(59)	-	110	107	108	110	**108**
Valiant CL Plus	Mid–slow	(29)	-	-	-	95	101	**98**
Yitpi	Mid–slow	(75)	92	92	93	89	90	**91**
Australian Premium White								
LRPB Avenger (N)	Quick	(30)	-	-	116	109	-	**110**
Corack	Quick–mid	(75)	106	104	110	104	-	**106**
Chief CL Plus (N)	Mid	(75)	102	103	102	100	104	**102**
Sheriff CL Plus (N)	Mid	(61)	101	-	99	101	103	**101**
Brumby	Mid–slow	(15)	-	-	-	-	109	**-**
Cutlass (N)	Mid–slow	(75)	97	99	96	94	97	**97**
Denison	Mid–slow	(45)	-	-	96	98	104	**101**
LRPB Trojan (N)	Mid–slow	(75)	95	96	91	97	94	**95**
Magenta	Mid–slow	(75)	93	94	91	92	91	**92**
Australian Noodle Wheat								
Ninja	Mid	(75)	104	106	103	106	105	**105**
Kinsei	Mid–slow	(75)	103	105	99	102	105	**103**
Zen	Mid–slow	(75)	103	103	101	101	105	**103**
Australian Standard White								
Razor CL Plus	Quick–mid	(75)	104	102	108	107	104	**105**

(N) = Denotes supplementary classification of APWN

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 (2017–2021) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)			4.26	2.99	3.32	3.72	5.00	
Variety	Maturity	(No. trials)	(4)	(3)	(4)	(5)	(4)	(20)
Australian Hard								
Emu Rock	Quick	(20)	92	96	97	92	93	**94**
LRPB Anvil CL Plus	Quick	(4)	-	-	-	-	95	**-**
Sting	Quick	(13)	-	-	111	106	105	**107**
Vixen (N)	Quick	(16)	-	111	114	107	106	**109**
Calibre	Quick–mid	(9)	-	-	-	109	108	**109**
Devil (N)	Quick–mid	(20)	110	109	111	110	109	**110**
Hammer CL Plus (N)	Quick–mid	(9)	-	-	-	100	100	**101**
LRPB Havoc (N)	Quick–mid	(20)	101	110	110	103	101	**105**
Mace (N)	Quick–mid	(20)	100	103	106	101	100	**102**
Scepter	Quick–mid	(20)	110	109	110	109	108	**109**
Catapult	Mid–slow	(16)	-	102	104	105	105	**105**
RockStar (N)	Mid–slow	(16)	-	109	108	111	111	**110**
Valiant CL Plus	Mid–slow	(9)	-	-	-	103	101	**102**
Yitpi	Mid–slow	(20)	91	91	93	92	92	**92**
Australian Premium White								
LRPB Avenger (N)	Quick	(9)	-	-	114	104	-	**106**
Corack	Quick–mid	(20)	100	108	110	102	-	**104**
Chief CL Plus (N)	Mid	(20)	101	105	104	101	100	**102**
Sheriff CL Plus (N)	Mid	(17)	103	-	100	102	102	**102**
Brumby	Mid–slow	(4)	-	-	-	-	107	**-**
Cutlass (N)	Mid–slow	(20)	99	97	98	100	99	**99**
Denison	Mid–slow	(13)	-	-	101	106	104	**104**
LRPB Trojan (N)	Mid–slow	(20)	100	93	91	98	100	**97**
Magenta	Mid–slow	(16)	96	91	91	96	-	**94**
Australian Noodle Wheat								
Ninja	Mid	(20)	108	104	103	107	107	**106**
Kinsei	Mid–slow	(20)	107	104	102	106	106	**105**
Zen	Mid–slow	(20)	102	106	104	102	101	**103**
Australian Standard White								
Razor CL Plus	Quick–mid	(20)	100	103	104	101	101	**102**

(N) = Denotes supplementary classification of APWN

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 (2017–2021) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)			2.15	3.27	1.18	2.30	3.97	
Variety	Maturity	(No. trials)	(9)	(9)	(9)	(11)	(6)	(44)
Australian Hard								
Emu Rock	Quick	(44)	94	97	103	104	100	**100**
LRPB Anvil CL Plus	Quick	(17)	-	-	-	112	109	**111**
Vixen (N)	Quick	(44)	109	111	123	119	115	**116**
Sting	Quick	(26)	-	-	120	114	111	**113**
Calibre	Quick–mid	(17)	-	-	-	111	109	**114**
Devil (N)	Quick–mid	(44)	110	109	113	109	110	**110**
Hammer CL Plus (N)	Quick–mid	(17)	-	-	-	106	103	**105**
LRPB Havoc (N)	Quick–mid	(44)	102	107	109	112	112	**108**
Mace (N)	Quick–mid	(44)	104	103	109	105	104	**105**
Scepter	Quick–mid	(44)	109	109	114	110	110	**110**
Catapult	Mid–slow	(35)	-	103	106	99	101	**103**
RockStar (N)	Mid–slow	(35)	-	108	107	105	108	**107**
Valiant CL Plus	Mid–slow	(6)	-	-	-	-	98	**-**
Yitpi	Mid–slow	(44)	97	92	93	87	88	**91**
Australian Premium White								
LRPB Avenger (N)	Quick	(20)	-	-	120	113	-	**112**
Corack	Quick–mid	(44)	103	106	110	109	-	**107**
Chief CL Plus (N)	Mid	(44)	101	102	99	102	104	**101**
Sheriff CL Plus (N)	Mid	(26)	-	-	97	101	102	**100**
Brumby	Mid–slow	(6)	-	-	-	-	109	**-**
Cutlass (N)	Mid–slow	(44)	102	97	95	91	94	**96**
Denison	Mid–slow	(17)	-	-	-	95	100	**98**
LRPB Trojan (N)	Mid–slow	(44)	95	95	91	94	93	**94**
Magenta	Mid–slow	(44)	98	93	91	87	88	**91**
Australian Noodle Wheat								
Ninja	Mid	(44)	104	105	104	104	104	**104**
Kinsei	Mid–slow	(44)	103	103	96	100	103	**101**
Zen	Mid–slow	(44)	100	103	98	103	105	**102**
Australian Standard White								
Razor CL Plus	Quick–mid	(44)	101	104	111	110	107	**107**

(N) = Denotes supplementary classification of APWN

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 (2017–2021) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)			3.23	2.43	2.05	2.08	4.00	
Variety	Maturity	(No. trials)	(5)	(4)	(4)	(6)	(5)	(24)
Australian Hard								
Emu Rock	Quick	(24)	95	96	100	102	94	**98**
LRPB Anvil CL Plus	Quick	(11)	-	-	-	117	101	**110**
Sting	Quick	(15)	-	-	117	118	110	**114**
Vixen (N)	Quick	(24)	111	117	120	123	112	**117**
Calibre	Quick–mid	(11)	-	-	-	118	113	**118**
Devil (N)	Quick–mid	(24)	111	114	113	113	112	**113**
Hammer CL Plus (N)	Quick–mid	(11)	-	-	-	107	102	**106**
LRPB Havoc (N)	Quick–mid	(24)	101	106	109	114	105	**107**
Mace (N)	Quick–mid	(24)	103	107	108	108	102	**106**
Scepter	Quick–mid	(24)	111	114	113	114	112	**113**
Catapult	Mid–slow	(19)	-	109	106	102	105	**106**
RockStar (N)	Mid–slow	(19)	-	111	109	109	112	**110**
Valiant CL Plus	Mid–slow	(11)	-	-	-	93	100	**97**
Yitpi	Mid–slow	(24)	95	95	94	87	89	**92**
Australian Premium White								
LRPB Avenger (N)	Quick	(10)	-	-	117	118	-	**113**
Corack	Quick–mid	(24)	101	107	109	112	-	**107**
Chief CL Plus (N)	Mid	(24)	98	100	100	102	101	**100**
Sheriff CL Plus (N)	Mid	(20)	100	-	98	100	102	**100**
Brumby	Mid–slow	(5)	-	-	-	-	109	**-**
Cutlass (N)	Mid–slow	(24)	100	100	97	92	97	**97**
Denison	Mid–slow	(15)	-	-	96	95	103	**98**
LRPB Trojan (N)	Mid–slow	(24)	98	92	91	91	97	**94**
Magenta	Mid–slow	(19)	97	94	91	86	-	**92**
Australian Noodle Wheat								
Ninja	Mid	(24)	107	105	104	105	108	**106**
Kinsei	Mid–slow	(24)	102	101	99	100	105	**101**
Zen	Mid–slow	(24)	98	99	100	103	102	**101**
Australian Standard White								
Razor CL Plus	Quick–mid	(24)	103	106	108	111	104	**107**

(N) = Denotes supplementary classification of APWN

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 (2017–2021) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)			3.63	3.77	4.30	3.66	4.24	
Variety	Maturity	(No. trials)	(2)	(2)	(1)	(3)	(2)	(10)
Australian Hard								
Emu Rock	Quick	(10)	91	93	89	90	93	**91**
LRPB Anvil CL Plus	Quick	(2)	-	-	-	-	97	**-**
Sting	Quick	(6)	-	-	104	105	106	**104**
Vixen (N)	Quick	(8)	-	105	106	108	109	**106**
Calibre	Quick–mid	(5)	-	-	-	109	106	**108**
Devil (N)	Quick–mid	(10)	107	108	111	112	110	**110**
Hammer CL Plus (N)	Quick–mid	(5)	-	-	-	98	99	**99**
LRPB Havoc (N)	Quick–mid	(10)	95	102	105	105	107	**103**
Mace (N)	Quick–mid	(10)	99	100	100	100	100	**100**
Scepter	Quick–mid	(10)	106	108	110	111	110	**109**
Catapult	Mid–slow	(8)	-	105	105	106	103	**106**
RockStar (N)	Mid–slow	(8)	-	110	114	115	112	**112**
Valiant CL Plus	Mid–slow	(5)	-	-	-	106	103	**105**
Yitpi	Mid–slow	(10)	100	94	90	89	87	**92**
Australian Premium White								
LRPB Avenger (N)	Quick	(4)	-	-	103	104	-	**103**
Corack	Quick–mid	(10)	96	101	103	103	-	**101**
Chief CL Plus (N)	Mid	(10)	99	101	105	104	104	**103**
Sheriff CL Plus (N)	Mid	(8)	100	-	104	104	104	**103**
Brumby	Mid–slow	(2)	-	-	-	-	110	**-**
Cutlass (N)	Mid–slow	(10)	105	100	100	100	96	**100**
Denison	Mid–slow	(6)	-	-	110	109	107	**107**
LRPB Trojan (N)	Mid–slow	(10)	101	98	96	97	97	**98**
Magenta	Mid–slow	(10)	103	97	94	94	-	**96**
Australian Noodle Wheat								
Ninja	Mid	(10)	106	106	108	109	108	**108**
Kinsei	Mid–slow	(10)	105	105	109	109	108	**107**
Zen	Mid–slow	(10)	98	102	106	105	106	**103**
Australian Standard White								
Razor CL Plus	Quick–mid	(10)	97	100	99	100	102	**100**

(N) = Denotes supplementary classification of APWN

Source: 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 agronomy trials (see *Sowing time response of wheat varieties in WA* on page 23). 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 of a variety relative to Scepter are 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. Key management strategies for frost 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 minimal 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 predominant in WA because of its suitability for sowing in mid-May. 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 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 quicker time to flowering. For this reason, winter wheats are seen as having more appropriate development times for an early April sowing in WA, primarily due to their vernalisation requirement.

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
Mid–slow and 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												
Quick: Emu Rock, LRPB Anvil CL Plus, LRPB Avenger, Sting, Vixen												

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

TABLE 13. Duration of days from sowing to flowering (relative to Scepter) at selected NVT and DPIRD trials in 2021

Variety	Maturity	Northern NVTs*	Southern NVTs*	Mullewa	Merredin	Katanning	Grass Patch	Average
Sowing date		**15-May**	**25-May**	**6-May**	**14-May**	**11-May**	**13-May**	
Emu Rock	Quick	-15	-6	-15	-	-9	-8	**-11**
LRPB Anvil CL Plus	Quick	-12	-6	-12	-8	-10	-9	**-10**
Vixen	Quick	-7	-7	-10	-6	-5	-4	**-7**
Sting	Quick	-5	-5	-10	-5	-5	-1	**-5**
Razor CL Plus	Quick–mid	-4	-4	-	-	-	-	**-4**
LRPB Havoc	Quick–mid	-3	-6	-	-	-	-	**-5**
Mace	Quick–mid	-1	-2	-	-	-	-	**-2**
Devil	Quick–mid	-1	0	-1	-1	1	1	**0**
Hammer CL Plus	Quick–mid	0	0	2	0	3	0	**1**
Calibre	Quick–mid	-3	-1	1	3	1	1	**0**
Scepter	Quick–mid	0	0	0	0	0	0	**0**
Chief CL Plus	Mid	1	2	4	2	4	1	**2**
Ninja	Mid	2	1	3	6	4	3	**3**
Sheriff CL Plus	Mid	4	4	-	-	-	-	**4**
Zen	Mid–slow	5	4	-	-	-	-	**5**
Magenta	Mid–slow	5	-	-	-	-	-	**5**
Brumby	Mid–slow	6	4	6	3	9	3	**5**
RockStar	Mid–slow	5	4	8	6	9	4	**6**
Kinsei	Mid–slow	8	6	10	7	11	7	**8**
Catapult	Mid–slow	9	6	10	4	10	3	**7**
Denison	Mid–slow	12	10	15	7	14	10	**11**
Valiant CL Plus	Mid–slow	13	10	-	-	-	-	**12**
Yitpi	Mid–slow	13	10	-	-	-	-	**12**
Cutlass	Mid–slow	13	9	11	8	12	11	**11**
Scepter's flowering date		**Av 26-Aug**	**Av 28 Sept**	**15-Aug**	**23-Aug**	**11-Sep**	**6-Sep**	

*NVT sites include Northern: Eradu, Nabawa, Mullewa, Oglivie and Yuna; Southern: Gnowangerup, Kojonup and Narrogin

Scepter is classified as quick–mid maturity and Table 13 outlines how other varieties compared to Scepter when sown mid to late May at northern and southern NVT sites and in DPIRD trials in 2021. A more detailed flowering comparison between Scepter and other varieties can be found in the variety snapshots (pages 34 to 43).

Flowering dates change with sowing date, location and from season to season due to differences in temperatures. 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 a variety's maturity.

FlowerPower: FlowerPower is an online tool to predict cereal flowering dates (or cutting dates for oats) across the WA wheatbelt. 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**.

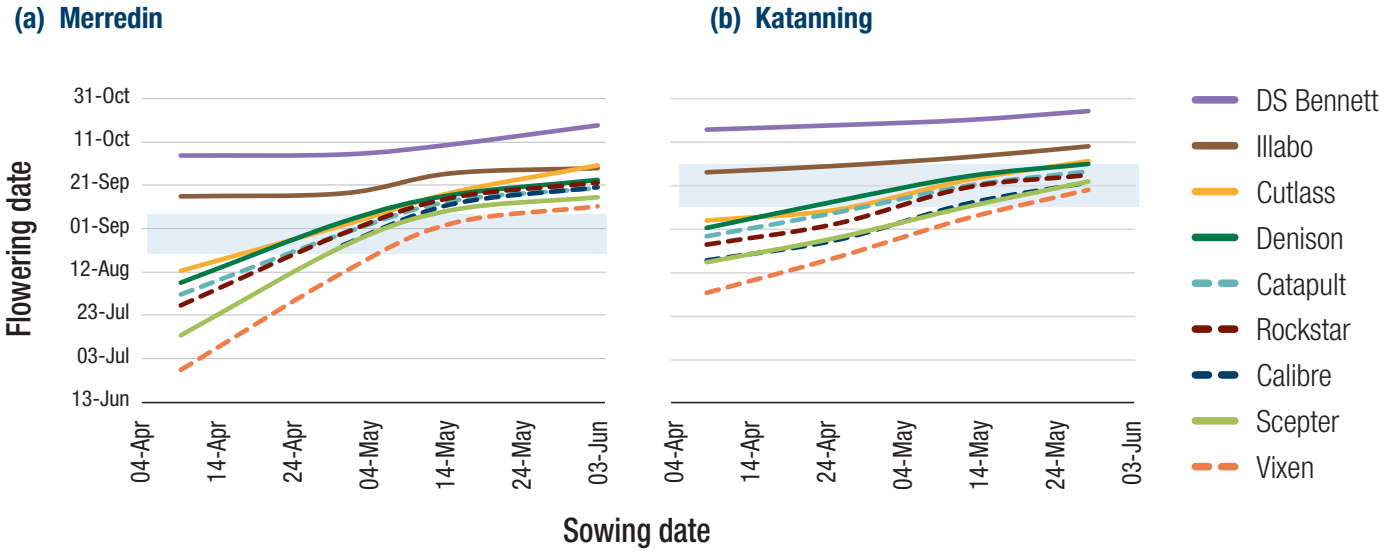

FIGURE 2. Flowering date response of varieties sown on a range of sowing dates (mid-April to early June) at a) Merredin and b) Katanning in 2021.

Shaded area is the estimated optimum flowering window.

SOWING TIME RESPONSE OF WHEAT VARIETIES IN WA

Matching varieties to their appropriate sowing date is the 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 that can guide appropriate variety choice for any sowing opportunity.

Most of the main season wheat NVTs are germinated from mid-May onwards, a time best suited to the quicker maturity varieties that currently dominate WA's wheat area. In 2020 and 2021, DPIRD research assessed the optimal 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.

Frost: In 2021, areas in the central wheatbelt were devastated by frost in early September. None of the current wheat varieties are tolerant to frost, but frost can be avoided or its impact reduced by manipulating sowing times and by using different maturity types. In areas of higher frost risk, it is important to avoid sowing quick or quick–mid maturing varieties in late April (Figure 3d) or even early May in areas further south. However, keep in mind that yield loss from sowing late to avoid frost risk is often outweighed by the yield gained from avoiding spring heat and moisture stress by sowing on time when frost is not an issue (Figure 3c).

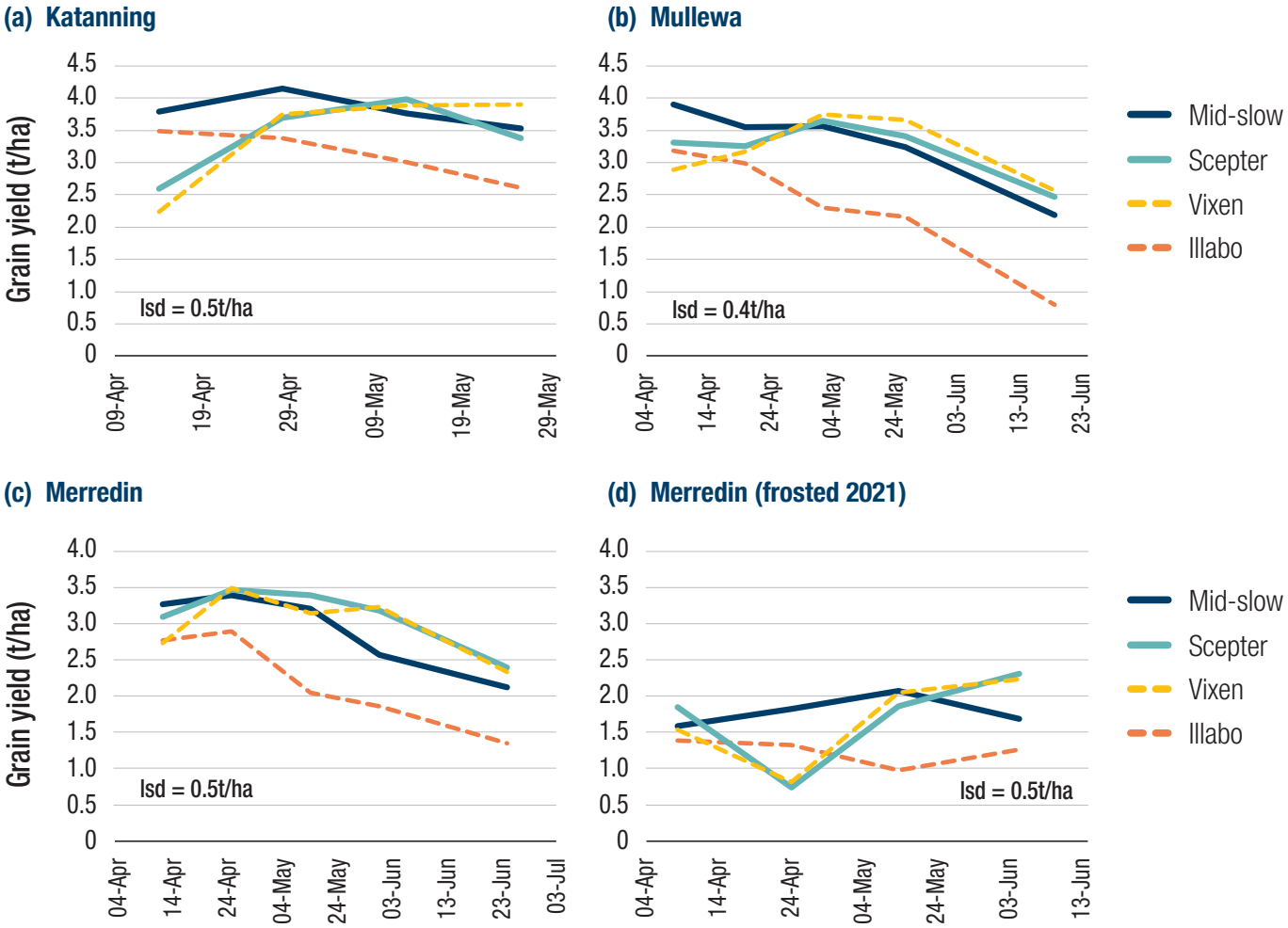

FIGURE 3. Grain yield (t/ha) response of varieties sown on four to five sowing dates (early April to mid-June) at a) Katanning (2020 and 2021), b) Mullewa (2018, 2020 & 2021), c) Merredin (2018 & 2020) and d) Merredin (frosted 2021).

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 2017 and 2021 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 as shown in Figure 4.

RockStar is the highest yielding variety in the early season NVT, followed by Denison, Kinsei, Catapult, Cutlass and Valiant CL Plus (only included in 2021). Catapult tends to yield more than Cutlass 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, so avoid environments conducive to lower falling numbers.

Kinsei is susceptible to blackpoint, which is also expressed more with April sowings.

Scepter was also included in the early-season NVT in 2018 and 2019 and performed similarly to the mid-long maturing varieties at some sites. However, it is important to note, there is more risk involved with earlier sowing of quicker maturing varieties in areas prone to frost, higher disease burden or low biomass.

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).

TABLE 14. Relative performance of slower maturity wheat varieties in Early season NVT

	RockStar	Denison	Kinsei	Catapult	Cutlass	Valiant CL Plus^	Longsword	Illabo
Statewide MET yield (% site mean)[1]	118%	114%	114%	113%	111%	110%	103%	98%
Maturity	Mid–slow	Mid–slow	Mid–slow	Mid–slow	Mid–slow	Mid–slow	Quick winter	Quick winter
Classification	AH(N)	APW	ANW	AH	APW(N)	AH	AWW	AH
Falling no. index	2	-	4	6	4	-	-	5
Stem rust	MR	MS	MSS	MR	R	MR	MR	MRMS
Stripe rust	RMR	MR	MRMS	RMR	RMR*	RMR	RMR	RMR
Leaf rust	S	S	MSS	S	RMR*	S	MS*	S
Powdery mildew	MSS	SVS	SVS	S	S	Sp	MRMS	R
Yellow spot	MRMS	MRMS	MS	MRMS	MSS	MRMS	MRMS	MS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat EARLY SEASON NVT MET data (2017–2021). Readers are directed to Tables 15 and 16 for a more precise estimate of variety performance in their region.

(N) = Denotes supplementary classification of APWN

^ = single year of NVT data in 2021.

* = Some races in eastern Australia can attack these varieties. Falling no. index please refer to page 32.

TABLE 15. Relative performance of varieties in the Early season NVT for AGZONES 1 and 4 combined (2017–2021), 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				2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)				2.24	3.45	2.02	2.37	4.44	
Variety (order of maturity)	Classification	Maturity	(No. trials)	(2)	(2)	(2)	(2)	(2)	(10)
Scepter	AH	Quick–mid	(4)	-	101	100	-	-	-
RockStar	AH (N)	Mid–slow	(6)	-	-	118	116	108	**113**
LRPB Trojan	APW (N)	Mid–slow	(10)	98	104	104	101	100	**101**
Magenta	APW	Mid–slow	(10)	100	102	102	101	100	**101**
Catapult	AH	Mid–slow	(8)	-	108	109	106	104	**106**
Kinsei	ANW	Mid–slow	(10)	111	109	109	110	106	**109**
DS Pascal	APW	Mid–slow	(6)	104	103	104	-	-	**104**
Denison	APW	Mid–slow	(3)	-	-	-	115	112	**112**
Valiant CL Plus	AH	Mid–slow	(2)	-	-	-	-	109	-
Yitpi	AH	Mid–slow	(10)	96	101	99	98	96	**98**
Cutlass	APW (N)	Mid–slow	(10)	110	111	111	114	108	**111**
LRPB Nighthawk	APW	Very slow	(8)	-	98	99	101	102	**100**
Longsword	AWW	Quick winter	(10)	114	91	96	98	106	**101**
Illabo	AH	Quick winter	(10)	93	92	97	91	100	**95**
Forrest	ASW	Very slow	(4)	-	100	101		-	-
EGA Wedgetail	APW	Mid winter	(8)	77	82	85	77	-	**82**
DS Bennett	Feed	Mid–slow winter	(2)	-	-	80		-	-
Sowing dates				20 and 24 April	20 and 30 April	11 and 17 April	21-Apr	21-Apr	

Agzone 1 site is Ogilivie and Agzone 4 sites were Bencubbin, Moorine Rock (2019) and Kalannie (2020 and 2021)

TABLE 16. Relative performance of varieties in the Early season NVT for AGZONES 2, 3, 5 and 6 combined (2017–2021), 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				2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)				2.78	2.06	2.97	3.26	4.73	
Variety (order of maturity)	Classification	Maturity	(No. trials)	(3)	(2)	(4)	(3)	(6)	(18)
Scepter	AH	Quick–mid	(6)	-	108	120	-	-	**115**
RockStar	AH (N)	Mid–slow	(13)	-	-	119	127	119	**121**
LRPB Trojan	APW (N)	Mid–slow	(18)	108	105	109	109	107	**108**
Magenta	APW	Mid–slow	(18)	104	101	104	103	103	**103**
Catapult	AH	Mid–slow	(15)	-	115	117	119	114	**116**
Kinsei	ANW	Mid–slow	(18)	117	114	119	120	115	**117**
DS Pascal	APW	Mid–slow	(16)	99	105	98	103	101	**101**
Denison	APW	Mid–slow	(9)	-	-	-	121	113	**115**
Valiant CL Plus	AH	Mid–slow	(6)	-	-	-	-	110	**-**
Yitpi	AH	Mid–slow	(18)	100	93	100	98	99	**99**
Cutlass	APW (N)	Mid–slow	(18)	110	111	109	115	110	**111**
LRPB Nighthawk	APW	Very slow	(13)	-	-	91	94	95	**94**
Longsword	AWW	Quick winter	(18)	102	113	106	104	101	**104**
Illabo	AH	Quick winter	(18)	96	113	98	99	99	**100**
Forrest	ASW	Very slow	(6)	-	88	88	-	-	**90**
EGA Wedgetail	APW	Mid winter	(12)	80	94	81	77	-	**83**
DS Bennett	Feed	Mid–slow winter	(11)	-	-	79	75	83	**82**
RGT Accroc	Feed	Mid–slow winter	(2)	-	-	-	-	76	**-**
Average sowing date				22-Apr	26-Apr	17-Apr	25-Apr	24-Apr	

Sites are: Agzone 2 is Eneabba or Tincurrin-N (2019), Agzone 3 is York or Narrogin, Agzone 5 is Hyden and Jerramungrup (2021) and Agzone 6 is Gibson or South Stirlings (2021)

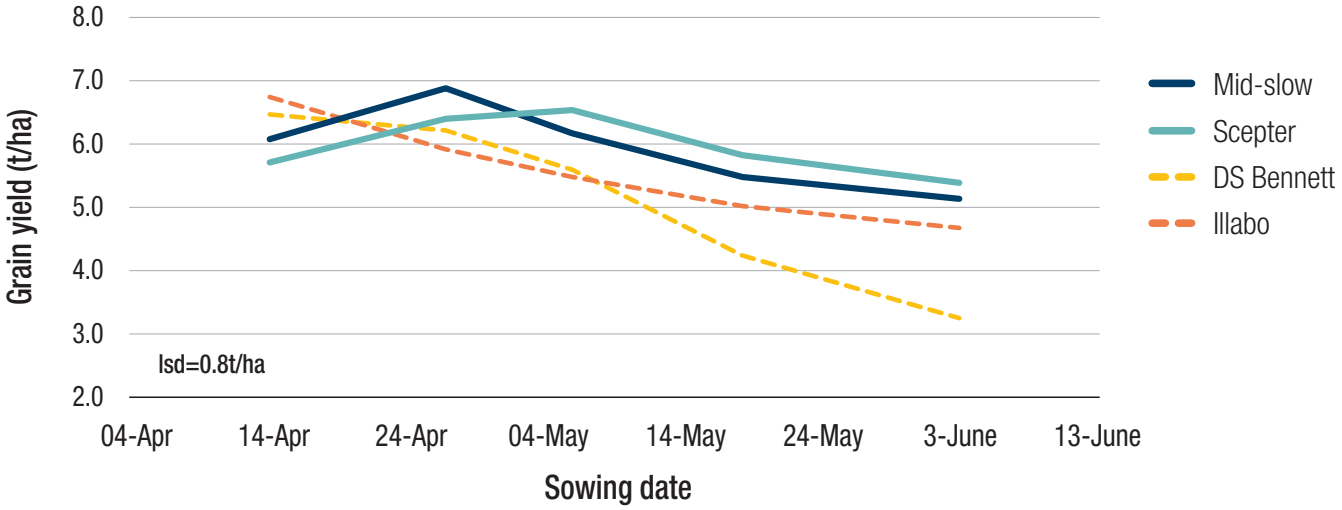

FIGURE 4. Grain yield (t/ha) response of mid–slow spring and winter wheat varieties compared to Scepter when sown on five sowing dates at Dale in 2021.

Source: DPIRD Wheat Agronomy research

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 in-season disease management can be planned
- Do not plant a susceptible variety into a high disease risk paddock
- Use a diversity of wheat varieties and crop types

When selecting a wheat variety, it is important to consider its yield and potential quality grade along with its 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 and crown rot.
Green bridge	Root lesion nematode, 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 amount of pathogen or pest inoculum and the favourability of the environment for the disease. For example, it is not advisable to sow Yitpi, which is rated S to VS for yellow spot, onto wheat stubble.

Understanding the disease strengths and weaknesses of a variety enables more effective disease management during the season. For example, Scepter is susceptible to powdery mildew and in a season or environment conducive to powdery mildew it is prudent to use seed dressing or in-furrow fungicide and proactively monitor for the presence of disease to enable a rapid response if the disease is detected.

Using a diverse range of varieties with different disease resistance traits reduces the risk of the whole farm requiring 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.

Rhizoctonia bare patch is probably the most prevalent and damaging soilborne disease in WA wheat, and there is no varietal resistance.

Root lesion nematodes (RLN) cause damage when they puncture the root surface and enter plant roots to 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*). *Pratylenchus 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 their populations. Wheat, barley and canola are all susceptible crops 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.

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 **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

Application of fungicide can help control disease and limit yield impacts. A rapidly developing issue for the Australian grains industry is development of fungicide resistance in a range of wheat and barley pathogens. 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*p*	–	–	MR*p*	RMR*p*	SVS*p*	R*
Calibre	AH	MRMS	MS*p*	MSS*p*	MR	RMR	S	MSS*p*
Calingiri	ANW	MS	MSS	MSS	SVS	SVS	S	SVS
Catapult	AH	MRMS	MS	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	MRMS	MRMS	MS	MR	SVS	SVS
Denison	APW	MRMS	MRMS	MRMS	MS	MR	S	SVS
DS Bennett	Feed	MRMS	MR	RMR	MRMS	R	SVS	R
DS Pascal	APW	MS	MRMS	MRMS	MSS	RMR	MS	RMR
EGA Bonnie Rock	AH (N)	MRMS	MRMS	MSS	MSS	SVS	SVS	S
EGA Wedgetail	APW	MSS	MRMS	MRMS	MRMS	MS	MSS	MRMS
Hammer CL Plus	AH (N)	MRMS	MS	MRMS	MR	RMR	S	S
Illabo	AH	MS	MRMS	MR	MRMS	RMR	S	R
Kinsei	ANW	MS	MRMS	MR	MSS	MRMS	MSS	SVS
Longsword	AWW	MRMS	MRMS	MR	MR	RMR	MS*	MRMS
LRPB Anvil CL Plus	AH	MSS	MRMS*p*	MS*p*	MR	RMR	SVS	S*p*
LRPB Avenger	APW (N)	MS	MSS*p*	MRMS*p*	MS	MRMS	S	S*p*
LRPB Cobra	AH	MRMS	MRMS	MS	MR	MSS	MR*	MSS
LRPB Havoc	AH (N)	MRMS	MS	MS	S	MR	S	MS
LRPB Nighthawk	APW	MS	MRMS	MRMS	RMR	RMR	MSS	S
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	MR*	MRMS
Ninja	ANW	MRMS	MRMS	MS	S	MS	S	S
Razor CL Plus	ASW	MSS	MS	MS	MR	RMR	S	MS
RockStar	AH (N)	MRMS	MRMS	MR	MR	RMR	S	MSS
Scepter	AH	MRMS	MRMS	MS	MRMS	MR*	MSS	S
Sheriff CL Plus	APW (N)	MRMS	MRMS	MRMS	MS	MS	SVS	SVS
Sting	AH	MRMS	MS	MS	MRMS	MR	SVS	S
Valiant CL Plus	AH	MRMS	MRMS*p*	MRMS*p*	MR	RMR	S	S*p*
Vixen	AH (N)	MRMS	MS	MSS	MRMS	MRMS	SVS	SVS
Westonia	APW (N)	MSS	MSS	MSS	SVS	VS	SVS	SVS
Wyalkatchem	APW (N)	MRMS	MS	MRMS	MSS	S	S	SVS
Yitpi	AH	SVS	MRMS	MRMS	S	MRMS	S	MS
Zen	ANW	MRMS	MS	MRMS	SVS	MRMS	S	SVS

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.

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

* 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.

[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	–	–	–	–	–	–	–
Calibre	AH	SVS*p*	–	–	–	–	–	S
Calingiri	ANW	MSS	RMR	MRMS	SVS	S	–	S
Catapult	AH	MSS	RMR	MRMS	S	MS*p*	R	MSS
Chief CL Plus	APW (N)	S	SVS	MR	MRMS	MS*p*	MS	MSS
Corack	APW	MSS	S	MSS	MSS	MSS	RMR	S
Cutlass	APW (N)	MSS	MSS	S	MSS	MS*p*	MR	S
Devil	AH (N)	SVS	SVS	MR	MSS	MS*p*	MSS	MSS
Denison	APW	MS	R*p*	MR*p*	S	–	MS	S
DS Bennett	Feed	MR	SVS	RMR	S	–	S	VS
DS Pascal	APW	MSS	S	SVS	S	–	S	S
EGA Bonnie Rock	AH (N)	S	S	MS	VS	S	S	–
EGA Wedgetail	APW	MS	–	–	S	–	S	S
Hammer CL Plus	AH (N)	MSS	RMR	RMR	MSS	–	MRMS	MSS
Illabo	AH	MRMS	R	MS	MSS	MR*p*	MRMS	S
Kinsei	ANW	MS	RMR	MR	S	S*p*	MSS	MSS
Longsword	AWW	MRMS	MRMS	RMR	MRMS	–	MRMS	MSS
LRPB Anvil CL Plus	AH	SVS*p*	–	–	MSS	–	MS*p*	MSS
LRPB Avenger	APW (N)	S*p*	S	S	MSS	–	MSS	S*p*
LRPB Cobra	AH	MSS	MS	VS	MSS	MSS	MS	S
LRPB Havoc	AH (N)	MRMS	MS	R	S	MRMS*p*	S	MSS
LRPB Nighthawk	APW	MRMS	MSS	RMR	MSS	MRMS*p*	MS	MSS
LRPB Trojan	APW (N)	MSS	SVS	SVS	MSS	MS*p*	MS	MS
Mace	AH (N)	SVS	S	MRMS	MS	MRMS	MRMS	S
Magenta	APW	MSS	MSS	SVS	MSS	MSS	S	MSS
Ninja	ANW	MSS	MR	RMR	S	S*p*	MS	S
Razor CL Plus	ASW	SVS	RMR	RMR	S	–	MR	S
RockStar	AH (N)	S	VS	MR	MRMS	MRMS*p*	MSS	S
Scepter	AH	S	MSS	MSS	S	MS	MRMS	MSS
Sheriff CL Plus	APW (N)	MSS	S	RMR	MRMS	MRMS*p*	MS	S
Sting	AH	SVS	SVS	S	MRMS	MS*p*	MS	MSS
Valiant CL Plus	AH	MRMS*p*	–	–	–	–	–	S
Vixen	AH (N)	MSS	SVS	RMR	MRMS	MSS*p*	MSS	S
Westonia	APW (N)	S	SVS	S	SVS	S	S	S
Wyalkatchem	APW (N)	S	S	MR	MRMS	MSS	S	S
Yitpi	AH	MRMS	MR	S	MSS	MS	MR	S
Zen	ANW	S	MS	MR	MRMS	MRMS*p*	S	S

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.

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

* 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 increase 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.

Varieties have inherently different coleoptile lengths. Table 20 provides a guide to coleoptile groups and replaces previous reporting of coleoptile index. 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 Cutlass, Magenta and Yitpi. Calibre, LRPB Avenger have with limited testing.
- The impact of deep sowing on grain yield depends on growing season conditions and on 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 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 of a range of varieties germinated on filter paper 'cigars' or sown at 10cm, the resulting plant establishment at 10cm and grain yields when sown at 4 or 10cm (Katanning 2021)

Variety (Coleoptile group)	Coleoptile length (cm)		Establishment (m^2) 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 (m^2)	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/m^2. Variable seed sources and grain weights.

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). There are several causes of low falling number in wheat, 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 the 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 Catapult (rated 6), Illabo (5), RockStar (2) and Sheriff CL Plus (4).

DPIRD research found crops that mature earlier in the harvest period (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 the risk varies across WA's wheat growing regions.

TABLE 20. Black point ratings, falling number index and coleoptile group of wheat varieties in 2021

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

Blackpoint ratings not updated due to unconducive conditions in 2021.

Black point ratings are provided through the NVT project and based on the research of Dr Tara Garrad at the Field Crop Pathology Unit (SARDI).

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 2022.

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 general description of the variety's essential characteristics and highlights key strengths and weaknesses. Grain yields relative to Scepter for each year between 2017 and 2021 for each agzone are presented as extracted from nvtonline.com.au. Disease ratings are as per Table 18.

Flowering information is sourced from DPIRD experiments in 2019, 2020 and 2021 and 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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CALIBRE(Þ)

AH

Comments

Calibre is the first Scepter cross to be released by AGT in 2021. It is a quick-mid maturing AH variety with a longer coleoptile than its parent Scepter (similar to Magenta). Calibre was included in the NVT for the first time in 2020, yielding similar to or slightly higher than Scepter, and was competitive with Vixen, Rockstar and Devil across the various agzones. Preliminary data indicates Calibre is comparable to Scepter for pre-harvest sprouting.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	100	96
Agzone 2	-	-	-	102	99
Agzone 3	-	-	-	100	100
Agzone 4	-	-	-	101	99
Agzone 5	-	-	-	104	101
Agzone 6	-	-	-	98	96
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS*p*				
Nodorum blotch (glume)	MSS*p*				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	MSS*p*				
Septoria tritici blotch	SVS*p*				
Flag smut	–				
Common bunt	–				
RLN (*P. quasitereoides*)	–				
RLN (*P. neglectus*)	–				
CCN	–				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2021 DPIRD trials	**11-Apr**	**25-Apr**	**11-May**	**21-May**	**08-Jun**
Mullewa	-	+3	+1	+0	+0
Merredin	-	+0	+3	-	-
Katanning	1	-1	+1	-1	-
Grass Patch	3	+1	+1	-	+0
Agronomic traits					
Coleoptile group	Long(*p*)				
Black point	–				
Falling number index	–				
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				

p = provisional assessment

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, LRPB Trojan and Magenta, but lower than Scepter in the main season trials. In the early season NVT trials, Catapult has yielded similiar to Kinsei with a more robust performance in agzones 2, 3, 5 and 6 compared to agzones 1 and 4. Catapult is S to leaf rust and powdery mildew. With a provisional falling number rating of 6, Catapult appears to be 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)	2017	2018	2019	2020	2021
Agzone 1	-	93	94	97	92
Agzone 2	-	96	94	94	94
Agzone 3	-	94	95	96	97
Agzone 4	-	94	93	90	92
Agzone 5	-	96	94	89	94
Agzone 6	-	97	95	95	94
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	MSS				
Flag smut	RMR				
Common bunt	MRMS				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	S				
CCN	R				
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	+19	+12	+10	+8	+6
Merredin	+15	+8	+6	+4	-
Katanning	+15	+11	+8	+4	-
South East	+19	+13	+6	-	+5
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	MSS				
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				

p = provisional assessment

DEVIL(b)

AH (N)

Comments

Devil is a quick-mid maturity AH (N) 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 is 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.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	102	100	101	100	100
Agzone 2	101	101	100	100	100
Agzone 3	100	100	101	101	101
Agzone 4	101	100	99	99	100
Agzone 5	100	100	100	99	100
Agzone 6	101	100	101	101	100
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MRMS				
Stem rust	MS				
Stripe rust	MR				
Leaf rust	SVS				
Powdery mildew	SVS				
Septoria tritici blotch	SVS				
Flag smut	SVS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MS*p*				
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(*p*)				
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				

p = provisional assessment
(N) denotes the supplementary classification of APWN

HAMMER CL PLUS(b)

AH (N)

Comments

Hammer CL Plus is an AH (N) imidazolinone tolerant variety recently released in 2020 by AGT. Hammer CL Plus has been included in the WA NVT in 2020 and 2021, 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. Hammer CL Plus is RMR for stripe rust, MR for stem rust, S for leaf rust and S 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)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	94	94
Agzone 2	-	-	-	95	92
Agzone 3	-	-	-	92	93
Agzone 4	-	-	-	96	94
Agzone 5	-	-	-	94	91
Agzone 6	-	-	-	88	90
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	MSS				
Flag smut	RMR				
Common bunt	RMR				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	MSS				
CCN	MRMS				
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	-	-	-	+0	-1
Merredin	-	+0	+0	-1	–
Katanning	-	-1	+1	+0	-
South East	-	+1	+0	-	+0
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	MRMS*p*				
Falling number index	-				
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				

p = provisional assessment
(N) denotes the supplementary classification of APWN

LRPB ANVIL® CL PLUS

AH

Comments

LPRB Anvil was released by Long Reach in 2022, as a quick AH imidazoline tolerant variety. It has been included in the WA NVT in 2020 and 2021 for agzones 2, 4 and 5 and only 2021 for agzones 1, 3 and 6 achieving the highest yields of the current IMI tolerant varieties overall but marginally lower yielding than Scepter. LongReach suggests that LRPB Anvil is well suited to the real-tough finishing in the low to medium rainfall areas of WA. LRPB Anvil has a similar stem and stripe rust profile to Hammer CL Plus, but 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)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	98
Agzone 2	-	-	-	95	95
Agzone 3	-	-	-	-	88
Agzone 4	-	-	-	102	99
Agzone 5	-	-	-	103	90
Agzone 6	-	-	-	-	88
Disease resistance	**Adult rating**				
Yellow spot	MSS				
Nodorum blotch (leaf)	MRMS*p*				
Nodorum blotch (glume)	MS*p*				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	SVS				
Powdery mildew	S*p*				
Septoria tritici blotch	SVS*p*				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	MSS				
CCN	MS*p*				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2021 DPIRD trials	**11-Apr**	**25-Apr**	**11-May**	**21-May**	**08-Jun**
Mullewa	-	-	-12	-7	-3
Merredin	-	-12	-8	-	+1
Katanning	-18	-11	-10	-7	-
Grass Patch	-13	-8	-9	-	-4
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	-				
Falling number index	-				
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				

p = provisional assessment

LRPB HAVOC®

AH (N)

Comments

LPRB Havoc was released by Long Reach in 2017, as an AH and now an APWN. Over the last five years the variety has yielded slightly below Scepter in agzones 1, 2 and 4. Havoc is slightly quicker in maturity than Scepter. Havoc has a low falling number index rating. It is important for growers of Havoc to take note of this variety's stem and leaf rust ratings, as it is S to both rust types but MR to stripe rust. Havoc is now MS to powdery mildew, the highest rating amongst the quick-mid maturity group.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	93	102	96	93	104
Agzone 2	99	96	99	97	99
Agzone 3	92	101	100	94	94
Agzone 4	94	98	96	102	102
Agzone 5	91	93	96	100	94
Agzone 6	90	94	95	95	97
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MS				
Stem rust	S				
Stripe rust	MR				
Leaf rust	S				
Powdery mildew	MS				
Septoria tritici blotch	MRMS				
Flag smut	MS				
Common bunt	R				
RLN (*P. quasitereoides*)	MRMS*p*				
RLN (*P. neglectus*)	S				
CCN	S				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2020 & 2021 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				

p = provisional assessment

(N) denotes the supplementary classification of APWN

MACE(b)

AH (N)

Comments

Mace is a quick-mid maturity AH (N) variety with a Wyalkatchem background. Previously the benchmark variety for yield in WA, it has been very popular and was widely planted. Scepter has now superceded Mace as the dominant variety sown in WA with Mace yielding on average 95% of Scepter in agzones 1-5 or 91% in agzone 6. Mace is a relatively low risk for pre-harvest sprouting, as indicated by its falling number index rating of 5.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	95	96	94	93	94
Agzone 2	95	94	96	94	94
Agzone 3	91	94	96	93	93
Agzone 4	95	94	96	95	95
Agzone 5	93	94	96	95	91
Agzone 6	93	93	91	90	91
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MS				
Stem rust	MRMS				
Stripe rust	RMR*				
Leaf rust	S				
Powdery mildew	MSS				
Septoria tritici blotch	SVS				
Flag smut	S				
Common bunt	MRMS				
RLN (*P. quasitereoides*)	MRMS				
RLN (*P. neglectus*)	MS				
CCN	MRMS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
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	Medium				
Black point	MRMS				
Falling number index	5				
Maturity	Quick–mid				
Variety information					
Pedigree	Wyalkatchem/Stylet//Wyalkatchem				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.00				

* = some races in eastern Australia can attack these varieties

(N) denotes the supplementary classification of APWN

ROCKSTAR(b)

AH (N)

Comments

RockStar is a mid-slow AH (N) released in 2019 by InterGrain. It was included in the NVT for the first time in 2018, yielding similar to Scepter and higher than other mid-slow alternatives such as Catapult, Cutlass, Denison, LRPB Trojan and Magenta. RockStar is MRMS to *P. neglectus* and MRMS*p* to *P. quasitereoides* but S to leaf rust. RockStar was amongst the highest yielding varieties in the early season NVTs. RockStar has different maturity triggers from other mid-slow varieties such as Cutlass, hence, caution is recommended if sown in April. A falling number rating of 2, so a higher risk to pre-harvest sprouting.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	-	98	98	102	99
Agzone 2	-	101	96	98	100
Agzone 3	-	100	98	102	103
Agzone 4	-	99	94	95	98
Agzone 5	-	97	96	96	100
Agzone 6	-	102	104	104	102
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MR				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	MSS				
Septoria tritici blotch	S				
Flag smut	VS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MRMS*p*				
RLN (*P. neglectus*)	MRMS				
CCN	MSS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2020 & 2021 DPIRD trials	**early/ mid April**	**late April**	**early/ mid May**	**late May**	**early June**
Mullewa	+11	+9	+7	+5	+4
Merredin	+11	+6	+4	+4	-
Katanning	+8	+6	+6	+3	-
South East	+9	+7	+3	-	+3
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	MSS				
Falling number index	2				
Maturity	Mid–slow				
Variety information					
Pedigree	IGW3119/Mace/IGW3176				
Breeder/Seed licensee	InterGrain				
Access to seed	Intergrain Seed Club Members or Seed Retailers				
EPR ($/t, excl GST)	$3.50				

p = provisional assessment

(N) denotes the supplementary classification of APWN

SCEPTER(b)

AH

Comments

Scepter, released in 2015, remains the yield benchmark in WA NVT, although it is similiar in yield to Devil or slightly lower than Vixen in agzones 4 and 5. This variety is MSS to the latest strain of leaf rust, which is an advantage over the more susceptible varieties of Calibre, Devil, Vixen, LRPB Havoc, and Corack. 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 of this variety.

Yield (% of Mace)	2017	2018	2019	2020	2021
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)	MS				
Stem rust	MRMS				
Stripe rust	MR*				
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 /medium				
Black point	MS				
Falling number index	5				
Maturity	Quick–mid				
Variety information					
Pedigree	RAC1480//Mace				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.25				

* = some races in eastern Australia can attack these varieties

STING(b)

AH

Comments

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

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	-	-	101	99	100
Agzone 2	-	-	104	102	98
Agzone 3	-	-	101	97	97
Agzone 4	-	-	105	104	101
Agzone 5	-	-	104	104	98
Agzone 6	-	-	95	95	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	SVS				
Flag smut	SVS				
Common bunt	S				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	MRMS*p*				
CCN	MS				
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	-	-	-10	-7	-7
Merredin	-	-7	-6	-2	-
Katanning	-	-8	-6	-4	-
South East	-	-8	-4	-	-4
Agronomic traits					
Coleoptile group	Medium/long(*p*)				
Black point	S*p*				
Falling number index	-				
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				

p = provisional assessment

VALIANT CL PLUS®

AH

Comments

Valiant CL Plus is an AH imidazolinone tolerant variety released in 2021 by InterGrain. Valiant CL Plus was included in limited WA NVT for the first time in 2020 where it yielded 5 to 19% less than Scepter depending on the agzone. InterGrain suggest Valiant CL Plus to be slow maturity, offering unique traits of IMI tolerance and a long coleoptile (similiar to Magenta) for an April 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)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	92
Agzone 2	-	-	-	86	92
Agzone 3	-	-	-	94	94
Agzone 4	-	-	-	-	89
Agzone 5	-	-	-	82	89
Agzone 6	-	-	-	95	94
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS*p*				
Nodorum blotch (glume)	MRMS*p*				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	S*p*				
Septoria tritici blotch	MRMS*p*				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	-				
CCN	-				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2021 NVT					
Northern	13				
Great Southern	+10				
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	-				
Falling number index	-				
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				

p = provisional assessment

VIXEN®

AH (N)

Comments

Vixen is a quick, AH (N) variety released in 2018 by InterGrain. It is currently the highest yielding wheat variety, except in agzones 3 and 6. Vixen's quick maturity is ideally suited to the medium and low rainfall environments and sowing from mid-May onwards. 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)	2017	2018	2019	2020	2021
Agzone 1	90	106	104	99	104
Agzone 2	103	100	106	104	102
Agzone 3	96	102	104	98	98
Agzone 4	100	102	108	108	105
Agzone 5	100	103	106	108	100
Agzone 6	94	97	96	97	99
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
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*p*				
RLN (*P. neglectus*)	MRMS				
CCN	MSS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2020 & 2021 DPIRD trials	**early/ mid April**	**late April**	**early/ mid May**	**late May**	**early June**
Mullewa	-10	-12	-11	-8	-8
Merredin	-14	-12	-8	-4	-
Katanning	-13	-9	-7	-6	-
South East	-11	-11	-8	-	-6
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	MSS				
Falling number index	3				
Maturity	Quick				
Variety information					
Pedigree	Mace/IGW3119				
Breeder/Seed licensee	InterGrain				
Access to seed	Intergrain Seed Club Members or Seed Retailers				
EPR ($/t, excl GST)	$3.50				

p = provisional assessment

(N) denotes the supplementary classification of APWN

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. InterGrain suggest that Brumby has a maturity between Scepter and RockStar, however DPIRD 2021 data indicates the variety to be of similar maturity to RockStar. A key attribute of Brumby is its powdery mildew resistance of R*, with provisional ratings of RMR*p* for strip rust and MR*p* for stem rust but SVS*p* for leaf rust. InterGrain suggest that Brumby is likely to possess a pre-harvest sprouting tolerance similar to Mace.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	101
Agzone 2	-	-	-	-	99
Agzone 3	-	-	-	-	99
Agzone 4	-	-	-	-	99
Agzone 5	-	-	-	-	97
Agzone 6	-	-	-	-	100
Disease resistance	**Adult rating**				
Yellow spot	MRMS*p*				
Nodorum blotch (leaf)	-				
Nodorum blotch (glume)	-				
Stem rust	MR*p*				
Stripe rust	RMR*p*				
Leaf rust	SVS*p*				
Powdery mildew	R*				
Septoria tritici blotch	-				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	-				
CCN	-				
Crown rot	-				
Flowering	**Days after/before Scepter**				
2021 DPIRD trials	**11-Apr**	**25-Apr**	**11-May**	**21-May**	**08-Jun**
Mullewa	-	+7	+6	+3	+4
Merredin	+15	+5	+3	-	+5
Katanning	+10	+10	+9	+4	-
Grass Patch	+12	+7	+3	-	+2
Agronomic traits					
Coleoptile group	-				
Black point	-				
Falling number index	-				
Maturity	Mid-slow				
Variety information					
Pedigree	-				
Breeder/Seed licensee	InterGrain				
Access to seed	Intergrain Seed Club Members or Seed Retailers. No grower to grower trading permitted				
EPR ($/t, excl GST)	$3.50				

p = provisional assessment

* = 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 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)	2017	2018	2019	2020	2021
Agzone 1	100	94	91	92	97
Agzone 2	94	94	92	91	95
Agzone 3	92	96	95	93	93
Agzone 4	93	94	87	93	95
Agzone 5	88	88	88	89	90
Agzone 6	93	94	95	94	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	S				
Flag smut	SVS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	MRMS				
CCN	MS				
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	+4	+3	+2	+2	+4
Merredin	+7	+1	+0	+3	-
Katanning	+0	+2	+1	+1	-
South East	+4	+1	+1	-	+1
Agronomic traits					
Coleoptile group	Medium(*p*)				
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				

p = provisional assessment

* = some races in eastern Australia can attack these varieties

(N) denotes the supplementary classification of APWN

CUTLASS(N)

APW (N)

Comments

Cutlass provides growers with a later season APW option. Over the last five years, Cutlass has outyielded Yitpi, another mid-slow maturing variety commonly grown in WA. 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, MSS to yellow spot and S to powdery mildew. Appears to be at higher risk of pre-harvest sprouting than Yitpi.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	105	87	86	91	86
Agzone 2	90	91	86	85	88
Agzone 3	90	89	89	92	92
Agzone 4	94	89	83	83	85
Agzone 5	90	88	86	81	87
Agzone 6	99	93	91	90	87
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**				
2020 & 2021 DPIRD trials	**early/ mid April**	**late April**	**early/ mid May**	**late May**	**early June**
Mullewa	+26	+20	+13	+10	+8
Merredin	+24	+10	+8	+9	-
Katanning	+17	+14	+11	+7	-
South East	+29	+21	+12	-	+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	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.00				

p = provisional assessment

* = some races in eastern Australia can attack these varieties

(N) denotes the supplementary classification of APWN

DENISON(N)

APW

Comments

Denison is a slower maturing APW variety released by AGT in 2020. Denison yields similiar to Cutlass in agzones 4 and 5 and about 5% higher than Cutlass in agzones 1, 2, 3 and 6. Denison was one of the highest yielding varieties in the early season NVT in 2020 and 2021. Denison's maturity is slightly later than Cutlass or Yitpi in main season sowing but can be quicker than Cutlass when sown early to mid April in the central and northern areas. Denison is rated S to leaf rust and SVS to powdery mildew.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	95	94
Agzone 2	-	-	86	89	95
Agzone 3	-	-	92	97	96
Agzone 4	-	-	-	86	91
Agzone 5	-	-	85	83	92
Agzone 6	-	-	100	98	97
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MRMS				
Stem rust	MS				
Stripe rust	MR				
Leaf rust	S				
Powdery mildew	SVS				
Septoria tritici blotch	MS				
Flag smut	R*p*				
Common bunt	MR*p*				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	S				
CCN	MS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2020 & 2021 DPIRD trials	**early/ mid April**	**late April**	**early/ mid May**	**late May**	**early June**
Mullewa	-	+17	+17	+13	+11
Merredin	+18	+13	+11	+8	-
Katanning	+21	+16	+12	+9	-
South East	-	+21	+12	-	+8
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	MS*p*				
Falling number index	-				
Maturity	Mid-slow				
Variety information					
Pedigree	Complex cross with Mace and Corack as key parents				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.40				

p = provisional assessment

LRPB AVENGER(Þ)

APW (N)

Comments

LRPB Avenger is a quick maturing APW and APWN variety released by LongReach in 2021. LRPB Avenger has been included in the NVTs since 2019 where it is showing that it is better suited to the quick and hard finishes in agzones 1, 2, 4 and 5. LRPB Avenger has a longer coleoptile length similar to Yitpi and Magenta, it is MS to stem rust, MRMS to stripe rust, S to leaf rust, MS to yellow spot and S*p* to powdery mildew.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	-	-	101	93	-
Agzone 2	-	-	105	99	-
Agzone 3	-	-	104	95	-
Agzone 4	-	-	105	103	-
Agzone 5	-	-	104	104	-
Agzone 6	-	-	94	94	-
Disease resistance	**Adult rating**				
Yellow spot	MS				
Nodorum blotch (leaf)	MS*p*				
Nodorum blotch (glume)	MRMS*p*				
Stem rust	MS				
Stripe rust	MRMS				
Leaf rust	S				
Powdery mildew	S*p*				
Septoria tritici blotch	S*p*				
Flag smut	S				
Common bunt	S				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	MSS				
CCN	MSS				
Crown rot	S*p*				
Flowering	**Days after/before Scepter**				
2020 DPIRD trials	**early/ mid April**	**late April**	**early/ mid May**	**late May**	**early June**
Northern	-	-8	-11	-7	-6
Merredin	-	-9	-9	-8	-5
Katanning	-	-8	-9	-6	-
Gibson	-	-9	-9	-5	-4
Agronomic traits					
Coleoptile group	Long(*p*)				
Black point	MS*p*				
Falling number index	-				
Maturity	Quick				
Variety information					
Pedigree	Corack and Mace cross				
Breeder/Seed licensee	LongReach Plant Breeders				
Access to seed	Seed associate and farmer to farmer (WA)				
EPR ($/t, excl GST)	$4.00				

p = provisional assessment

(N) denotes the supplementary classification of APWN

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, similiar to Zen and outyields Calingiri (which is now classified as Feed). Kinsei is among the highest yielding varieties in the early season NVT, only outyielded by RockStar. Kinsei is S for blackpoint which may be an issue if sowing the variety in April. Kinsei's disease ratings are marginally better than Ninja and Zen.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	105	94	91	97	96
Agzone 2	95	96	89	93	95
Agzone 3	97	95	93	97	98
Agzone 4	94	94	84	91	94
Agzone 5	92	89	88	88	94
Agzone 6	99	97	99	98	98
Disease resistance	**Adult rating**				
Yellow spot	MS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MR				
Stem rust	MSS				
Stripe rust	MRMS				
Leaf rust	MSS				
Powdery mildew	SVS				
Septoria tritici blotch	MS				
Flag smut	RMR				
Common bunt	MR				
RLN (*P. quasitereoides*)	S*p*				
RLN (*P. neglectus*)	S				
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	+13	+10	+9	+7	+4
Merredin	+15	+8	+6	+6	-
Katanning	+10	+11	+9	+5	-
South East	+11	+10	+6	-	+5
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	S				
Falling number index	4				
Maturity	Mid-slow				
Variety information					
Pedigree	–				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$4.00				

p = provisional assessment

NINJA(b)

ANW

Comments

Ninja is a noodle wheat variety released by InterGrain in 2016 with a Calingiri and Wyalkatchem background. Ninja is the highest yielding ANW variety and has outyielded Mace in the last five years, yielding slightly behind Scepter. This variety is S to stem rust, powdery mildew and the new incursion of leaf rust. Rated MRMS to black point.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	101	95	94	101	96
Agzone 2	96	97	93	96	95
Agzone 3	98	95	94	98	99
Agzone 4	95	96	91	95	95
Agzone 5	96	92	92	92	96
Agzone 6	100	98	98	98	98
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MS				
Stem rust	S				
Stripe rust	MS				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	MSS				
Flag smut	MR				
Common bunt	RMR				
RLN (*P. quasitereoides*)	S*p*				
RLN (*P. neglectus*)	S				
CCN	MS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2020 & 2021 DPIRD trials	**early/ mid April**	**late April**	**early/ mid May**	**late May**	**early June**
Mullewa	+9	+10	+4	+4	+4
Merredin	+8	+5	+2	+2	-
Katanning	+4	+3	+1	+1	-
South East	+4	+4	+0	-	+1
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	MRMS				
Falling number index	4				
Maturity	Mid				
Variety information					
Pedigree	Calingiri/Wyalkatchem				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$4.00				

p = provisional assessment

ZEN(b)

ANW

Comments

Zen is a noodle variety with a Calingiri and Wyalkatchem background. Although Zen's yields are generally lower than Kinsei, they are not significantly different. Zen is S to leaf rust and SVS to stem rust and powdery mildew. It has a useful black point and RLN (*P.neglectus*) rating of MRMS but has a weaker falling number index rating than Ninja and Kinsei. Zen rates consistently low for small grain screenings in the NVT data.

Yield (% of Scepter)	2017	2018	2019	2020	2021
Agzone 1	100	95	91	93	99
Agzone 2	95	94	91	92	95
Agzone 3	93	97	95	94	94
Agzone 4	92	94	86	94	95
Agzone 5	88	87	88	90	91
Agzone 6	92	94	96	95	96
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	SVS				
Stripe rust	MRMS				
Leaf rust	S				
Powdery mildew	SVS				
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				

p = provisional assessment

BARLEY

Introduction

Blakely Paynter (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 the Barley Council of Grains Australia and selected varieties deliverable as feed to the WA bulk handling system (Tables 1–15; Figures 1–13).

International trade flows for barley continue to be significantly affected by China's ban on imports of Australian barley grain and geopolitical tensions between Ukraine and Russia. Argentina, Canada, France and, until recently, Ukraine have filled the void in Chinese barley imports from Australia. A tight global supply of quality malt barley has allowed Australian barley and malt exports to diversify. Over the past twelve months, sales of grain and malt to old and new markets, including Africa, Asia, Japan, Mexico and South America, have continued along with opportunistic sales of malt barley grain to maltsters in Europe and North America. With international malt plants running at maximum capacity and strong brewing demand for malt, South America is developing as a critical market for MALT1 grade barley.

Improved growing conditions in Canada and Europe mean competition for new brewing market opportunities in Mexico and South America will be determined by price, quality and international trade balances. High-quality malt barley is in strong demand from export customers of our malt barley grain and domestic processors for export as malt.

This demand has influenced the premium for malt over feed. Premiums for malt barley returned in late 2021, with premiums of at least $70/t offered during the last twelve months.

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 by including barley in animal feed rations. Such diversification opportunities enable feed barley sales to international animal feed markets outside China. 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.

Western Australian 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 highest yielding variety to be sown (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 better understand 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.

BARLEY VARIETY CHOICE IN 2023 – 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 (Figure 1). In 2021, Spartacus CL increased to just over 50% of the area planted to barley. Growers have continued to reduce the area sown to Bass, Flinders, La Trobe and Scope CL while increasing the area to Buff, Maximus CL and Rosalind.

With the change in market demand for WA malt barley, yield potential has become a primary driver of variety choice. Recently released varieties are a more attractive proposition because of the reduced importance of malt accreditation and premiums. However, evidence of consistent varietal performance over multiple seasons remains essential to limit risk when adopting a new variety. Where significant malt premiums are on offer, varieties with plump kernels and higher hectolitre weight, such as Bass, Flinders and Maximus CL, will become more competitive options.

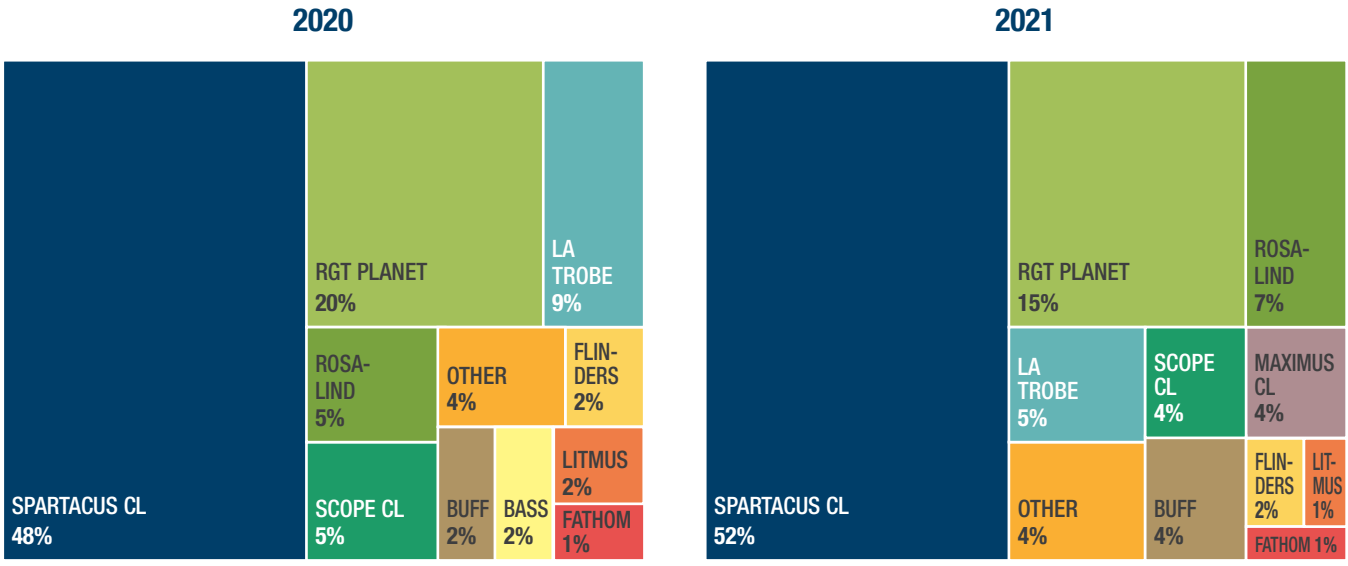

FIGURE 1. Relative popularity (percentage of barley area) of the top ten barley varieties plus the combined area sown to the other 20 varieties delivered in WA in 2020 and 2021. The top ten varieties occupied 96% of the area planted to barley in both seasons.

Source: grower estimates provided to CBH for 2020 and 2021

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. RGT Planet remains a good option, particularly in higher rainfall areas where it performs increasingly well as yield potential increases.

Based purely on yield potential, new varieties such as Beast, Buff, Combat, Cyclops, Leabrook, Laperouse, Maximus CL, Minotaur, Titan AX and Zena CL are plausible competitors to RGT Planet, Rosalind and Spartacus CL. However, sowing date, location, yield potential in different environments, disease pressure, soil type and herbicide systems will drive individual choices.

Growers targeting barley for sowing in an imidazolinone (IMI) herbicide management system now have a broader range of plant types available, including Commodus CL, Maximus CL and Zena CL. Spartacus CL remains the most popular variety grown in WA and a suitable option for delivery into malt segregations. Commodus CL offers greater early vigour at a similar yield potential but with increased lodging risk. Although Commodus CL is undergoing malt accreditation, Compass-type varieties (i.e. Compass, Leabrook and Commodus CL) have typically not been sought by the trade for grain and malt exports from WA. The future of Commodus CL outside delivery into a feed segregation is not guaranteed. Maximus CL has a similar plant type to Spartacus CL and has had a higher yield potential in WA barley National Variety Trials (NVT) over the past five years (2018–2021) with improved resistance to spot-form net blotch (SFNB) and better grain quality characteristics. The WA industry expects Maximus CL to quickly replace the areas sown to Spartacus CL. Zena CL is modelled on RGT Planet, offering the same plant type and similar agronomic performance but with the ability to be used in an IMI herbicide system where appropriate. Accreditation and receival in WA will likely make this an important variety subject to market sensitivities around herbicide residues in this well-known malt background.

There is strong demand for Bass and Flinders from malting and brewing customers in south-east Asia and Japan. Bass and Flinders can be malted without additives and are well-known by the market. However, they have been superseded for yield. End-user preference for the malt quality of Bass and Flinders means these varieties remain an option

TABLE 1. Summary of barley variety traits comparing six of the more popular varieties grown in WA and the new malting variety Maximus CL

Trait	Bass	Buff	Flinders	Maximus CL	RGT Planet	Rosalind	Spartacus CL
First year in variety trials in WA	2004	2016	2007	2018	2016	2014	2014
Statewide MET yield (% site mean)[1]	91%	104%	95%	107%	102%	109%	102%
Maturity (sown in late May)	Medium spring	Early spring	Late spring	Early spring	Medium spring	Early spring	Early spring
Deliverable as / accreditation stage[2]	Malt	Stage 2	Malt	Malt	Malt	Feed	Malt
Brewing demand (barley and malt)[3]	Preferred	-	Preferred	Acceptable	Preferred	-	Acceptable
Straw strength (excl. head loss)	Very good	Moderately good	Very good	Good	Good	Good	Good
Scald	MRMS	MS	MSS	MR	MR	S	MR
NFNB – Beecher virulent[4]	MS	MS	MRMS	MS	S	MS	MS
NFNB – Beecher avirulent	MSS	MRMS	MS	MRMS	MS	MR	MS
NFNB – Oxford virulent	S	MS	S	S	S	S	S
SFNB	S	S	S	MSS	S	S	SVS
Powdery mildew	MSS	S	R	RMR	R	MS	MRMS
Leaf rust	SVS	S	MRMS (late APR)	MSS	MRMS (late APR)	MR	MSS

Source: Blakely Paynter, Sanjiv Gupta, GIWA, Grains Australia – Barley Council 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 (2017–2021). Growers are directed to Tables 4 to 10 for a more precise estimate of variety performance in their region and Figures 2 to 7 for an indication of relative variety performance at different site yields.

[2]Varieties classed as malt have been accredited by the Barley Council of Grains Australia. Varieties classed as Stage 0, 1 or 2 are under evaluation for their malting and brewing end-use. Grains Australia now manages Barley Australia malt accreditation. However, all relevant information will continue to be available at **barleyaustralia.com.au**.

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

[4]Adult plant foliar disease abbreviations: NFNB = net-form net blotch, SFNB = spot-form net blotch and APR = adult plant resistance. Rosalind, Spartacus CL and other resistant varieties may show a variable reaction to strains of PM present in the southern regions of WA

TABLE 2. Summary of barley variety traits comparing six of the newer varieties and the most widely sown variety Spartacus CL

Trait	Beast	Combat	Commodus CL	Cyclops	Laperouse	Minotaur	Spartacus CL
First year in variety trials in WA	2019	2021	2020	2020	2016	2020	2014
Statewide MET yield (% site mean)[1]	108%	112%	101%	110%	107%	106%	102%
Maturity (sown in late May)	Early spring	Medium spring	Early spring	Early spring	Medium spring	Medium spring	Early spring
Deliverable as / accreditation stage[2]	Stage 1	Feed	Stage 2	Stage 1	Stage 2	Stage 1	Malt
Brewing demand (barley and malt)[3]	-	-	-	-	-	-	Acceptable
Straw strength (excl. head loss)	Fair	-	Fair	Good	Good	Good	Good
Scald	S	S*p*	S	MRMS	S	VS	MR
NFNB – Beecher virulent[4]	MRMS	MS*p*	MRMS	MRMS	MRMS	MRMS	MS
NFNB – Beecher avirulent	MS	MSS*p*	MRMS	MRMS	MS	MRMS	MS
NFNB – Oxford virulent	MSS	MSS*p*	S	S	MSS	MS	S
SFNB	MSS	MRMS*p*	MSS	MSS	MSS	S	SVS
Powdery mildew	MR	R*p*	MR	MR	MR	MSS	MRMS
Leaf rust	MSS	MRMS*p* (late APR)	S	S	MSS	S	MSS

Source: Blakely Paynter, Sanjiv Gupta, GIWA, Grains Australia – Barley Council 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 (2017–2021). Growers are directed to Tables 4 to 10 for a more precise estimate of variety performance in their region and Figures 2 to 7 for an indication of relative variety performance at different site yields.

[2]Varieties classed as malt have been accredited by the Barley Council of Grains Australia. Varieties classed as Stage 0, 1 or 2 are under evaluation for their malting and brewing end-use. Grains Australia now manages Barley Australia malt accreditation. However, all relevant information will continue to be available at **barleyaustralia.com.au**.

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

[4]Adult plant foliar disease abbreviations: NFNB = net-form net blotch, SFNB = spot-form net blotch and APR = adult plant resistance. Rosalind, Spartacus CL and other resistant varieties may show a variable reaction to strains of PM present in the southern regions of WA.

for growers where malt-grade barley is achievable and where the market premium (primarily in the Kwinana and Albany port zones) can cover their lower yield potential. If the domestic preference for Bass and Flinders is not reflected in a reasonable price premium offered over and above other malt barley options (i.e. Maximus CL, RGT Planet and Spartacus CL), they will be lost to WA end-users within a couple of seasons, if not earlier.

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; Beast, Combat, Fathom, Laperouse and Leabrook where a more prostrate growth habit for weed competition might be helpful; and Combat and Fathom 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), 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 (SFNB is an issue and yield), Cyclops (Rosalind replacement), Maximus CL (if MALT1 is the target or an IMI system is practised) and Titan AX (alternative to IMI system) are great options.

For higher rainfall areas, Bass (if premium over MALT1), Combat (SFNB is an issue and yield), Cyclops (Rosalind replacement), Flinders (if premium over MALT1), Maximus CL (if MALT1 is the target or an IMI system is practised), Laperouse (disease resistance and taller straw), 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 found in the 'What is New?' 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 2023

A suite of new barley varieties is available to growers for sowing in 2023. AGT has recently 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), Maximus CL (tested as IGB1705T) and Zena CL (tested as IGB20125T). SECOBRA Recherches, through Seednet partners, are progressing Laperouse (tested as WI4592) in malting and brewing evaluation.

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 the newly available barley varieties: Combat, Commodus CL, Cyclops, Laperouse, Maximus CL, Minotaur, 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.
- First evaluated in WA barley NVT in 2021, so limited public data is available on its long-term performance. Across 23 WA barley NVT in 2021, Combat was higher yielding than Rosalind in three of every five trials and yielded the same in two of every five trials.
- 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.

In the 2021 WA barley NVT series in WA, Combat matched Cyclops as the highest yielding variety at 111% of the site mean compared to Beast at 108%, Rosalind at 106% and RGT Planet at 105%. In a linear regression analysis, Combat had a yield advantage in 2021 over other varieties when the site yielded more than 4t/ha. Across 23 WA barley NVT (2021), Combat yielded less than RGT Planet in 4% of trials, the same in 30% and higher in 66% (Table 11). Relative to Rosalind, Combat yielded less in 0% of trials, the same in 43% of trials and higher in 57% of trials (Table 12).

According to the breeder, 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 provisionally rated as Sp to the Beecher and Oxford virulent strains of NTNB, with slightly better resistance as an adult (MS*p* and MSS*p*, respectively). It has better tolerance to the Beecher avirulent strain of NTNB, being MS*p* as a seedling and MSS*p* as an adult.

Seed is available for planting in 2023 from Seedclub members and resellers.

Commodus CL

Key points:

- In Stage Two assessment for malt accreditation in 2022, with the earliest accreditation date March 2023.
- Targeted for sowing in low to medium rainfall zones and lighter soil types.
- Commodus CL has been tested in WA barley NVT for two seasons (2020 and 2021) and yielded 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.
- Scald, NFNB (Oxford avirulent) and BLR need management.

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.

Across 50 WA barley NVT (2020–2021), Commodus CL yielded less than Compass in 42% of trials, the same in 58% and higher in 0%. Relative to Spartacus CL, Commodus CL yielded less in 28% of 50 WA barley NVT, the same in 48% and higher in 24% (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 at sites with high yield potential. Head loss risk is expected to be like Compass.

Commodus CL has useful resistance to NFNB (Beecher virulent and avirulent) and PM but may need management for scald, NFNB (Oxford virulent) and BLR. 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 2023 from Seedclub members and resellers. It is not legal to acquire Commodus CL via farmer-to-farmer trading.

Cyclops

Key points:

- As there was insufficient grain in specification from the 2021 season, Stage Two assessment for malt accreditation will commence in 2023, with the earliest accreditation date delayed to March 2024.
- Targeted for sowing in all rainfall zones.
- Tested in WA barley NVT for two seasons (2020 and 2021).
- Statewide performance comparable to Rosalind in 2020 but higher in 2021. Yield advantage in environments that yielded more than 3t/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.

Across 50 WA barley NVT (2020–2021), Cyclops yielded more than RGT Planet in three of every four WA barley NVT (Table 11), with an advantage at all levels of yield potential (Figure 3). Relative to Rosalind, Cyclops was lower yielding in 18% of 50 WA barley NVT (2020–2021), the same in 42% of trials and higher yielding in 40% of trials, with the yield advantage apparent in environments producing more than 3t/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 akin to that displayed in varieties with similar dwarfing genes, like La Trobe 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.

Seed is available for planting in 2023 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:

- As there was insufficient grain in specification from the 2021 season, Stage Two assessment for malt accreditation will commence in 2023, with the earliest accreditation date delayed to 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, except for 2019 and when the site yield was below 4t/ha.
- 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.

Laperouse has been in WA barley NVT since 2016 and is a potential agronomic alternative to Bass, Flinders, RGT Planet and other non-IMI varieties in high-yielding environments. Laperouse has the potential for early sowing opportunities, with good straw strength and head retention.

Across 103 WA barley NVT (2017–2021), Laperouse yielded more than Spartacus CL in three of every five trials (Table 11). Across these trials, the overall yield advantage of Laperouse was 5% over Spartacus CL (however, relative yield is subject to regional and seasonal variation) (Table 10) and superior at sites where yield was above 3t/ha. Across 103 WA barley NVT (2017–2021), Laperouse yielded more than RGT Planet at three of every five sites (Table 11). Laperouse has a yield advantage over RGT Planet at sites where the yield is below 4.5t/ha. Across 103 WA barley NVT (2017–2021), Laperouse yielded less than Rosalind in 34% of trials, the same in 47% and higher in 19% (Table 12), with Rosalind having an advantage below 4t/ha. Rosalind generally has out-yielded Laperouse at sites where yield potential is below 3.5t/ha. Above a 3.5t/ha yield potential, Rosalind and Laperouse have yielded similarly.

When grown under the same management in NVT trials, Laperouse grain tends to have a slightly lower hectolitre weight than Spartacus CL (Figure 9), with fewer screenings (Figure 12) and a lower grain protein concentration (at the same grain yield).

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 slight 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 2023 from Seednet partners. It is not legal to acquire Laperouse via farmer-to-farmer trading.

Maximus CL

Key points:

- Accredited for malting and brewing use in March 2021.
- Targeted for sowing in all rainfall zones.
- Maximus CL has been tested in WA barley NVT since 2018.
- Statewide yield potential sits between Rosalind and Spartacus CL.
- Maximus CL, like Commodus CL, Spartacus CL and Zena CL, possesses the gene conferring tolerance to label application rates of registered IMI products.
- Later flowering than Spartacus CL when sown in mid-April, but similar when sown in May.
- Improved SFNB compared to Spartacus CL but requires management for NFNB (Oxford virulent).

Maximus CL (tested as IGB1705T) is an IMI-tolerant, medium height, early spring, two-row barley bred by InterGrain and was registered as a variety in November 2019. Maximus CL possesses a short coleoptile and has a plant architecture like Spartacus CL. Avoid deep planting of Maximus CL seed.

Maximus CL is yield competitive with all varieties except on acidic soils with Buff and Litmus. Maximus CL is quickly replacing the area sown to Spartacus CL. Across 91 WA barley NVT (2018–2021), Maximus CL yielded the same as Spartacus CL in 38% of trials and higher in 68% and is yet to yield less than Spartacus CL in any WA barley NVT trials (Table 11). Maximus CL has a yield advantage at all levels of yield potential above 1t/ha, with the advantage increasing as the site yield increases (Figures 5 and 6). Across 90 WA barley NVT (2018–2021), Maximus CL had yielded more than RGT Planet in three out of every five WA barley NVT (Table 11), with this yield advantage apparent when the site yield was below 4t/ha (Figures 4 and 5). Maximus CL is often not competitive with Rosalind, yielding less than Rosalind in half of the WA barley NVT since 2018 (Table 12). The probability of delivering as MALT1, location of receival sites, the scale of the premium for delivery as MALT1 and the need for a variety suitable for an IMI herbicide system will determine the balance of the barley area sown to Rosalind versus Maximus CL.

The grain quality of Maximus CL is an improvement on Spartacus CL for grain plumpness (Figures 11 and 12), similar for grain protein concentration (at the same grain yield) with slightly lower hectolitre weight (Figures 8 and 9).

The main disease advantage of Maximus CL over Spartacus CL is with SFNB and PM. Maximus CL is rated as MS as a seedling and MSS as an adult plant to SFNB. In contrast, Spartacus CL is rated as S as a seedling and SVS as an adult plant (Tables 13 and 14). Maximus CL appears to have some additional genes for resistance to PM than Spartacus CL, as it is not compromised in the presence of the new *MlLa* virulence detected in southern cropping regions. It also had stronger PM resistance when screened at South Perth.

Lodging data collected in WA suggests that the straw strength of Maximus CL is comparable to Spartacus CL. There is not enough data to be definitive about the risk of head loss in Maximus CL, but preliminary findings suggest it could be considered low risk. Likewise, there is insufficient evidence to determine if Maximus CL has the same germ-end staining risk as Spartacus CL.

Seed is available for planting in 2023 from Seedclub members and resellers. It is not legal to acquire Maximus CL via farmer-to-farmer trading.

Minotaur

Key points:

- Passed Stage One assessment for malt accreditation in 2022, with Stage Two scheduled for 2023 and the earliest accreditation date now being March 2024.
- Targeted for sowing in medium to high rainfall zones.
- Only tested in WA barley NVT for two seasons (2020 and 2021).
- Statewide performance is an improvement over RGT Planet in environments that yield less than 4t/ha but has not matched Rosalind in those environments.
- Requires management for scald, SFNB 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.

Across 50 WA barley NVT (2020–2021), Minotaur yielded less than RGT Planet in 12% of trials, a similar amount in 42% of trials and higher in 46% of trials (Table 11), with an advantage at sites yielding less than 4t/ha (Figure 3). Relative to Rosalind, it yielded the same as Rosalind in two out of every five WA barley NVT (2020–2021) (Table 12) but looks to have an advantage in environments that produce more than 5t/ha (Figure 3).

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. Grain plumpness is slightly better than RGT Planet but not as good as Spartacus CL (data not shown).

Minotaur has excellent resistance to NFNB (Beecher virulent and avirulent) and limited resistance to NFNB (Oxford avirulent) but may need 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 2023 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**).

Titan AX

Key points:

- Released as a feed barley.
- AGT indicated it will submit the variety for accreditation with the Barley Council of Grains Australia in 2023.
- Targeted for sowing in low to medium rainfall zones.
- Tested in WA barley NVT for only one season (2021) at a limited number of sites and only in Agzone 5.
- 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.

Titan AX has only been tested in five WA barley NVT (all in Agzone 5 in 2021), where it yielded the same as Compass in four trials and higher in one trial.

According to the breeder, Titan AX is best suited to low and medium rainfall or Mallee-style 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 at sites with high yield potential. Head loss risk is expected to be like Compass.

Titan AX is the first barley variety in the world to carry tolerance to 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 excellent resistance to NFNB (Beecher virulent) and PM and useful resistance to NFNB (Beecher avirulent and Oxford virulent) but may need management for scald and BLR. It is provisionally rated as MRMS*p* as a seedling and MSS*p* as an adult plant to SFNB.

Seed is available for planting in 2023 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:

- Stage One assessment for malt accreditation occurred in 2022, with the earliest accreditation date being March 2024.
- Targeted for sowing in medium to high rainfall zones.
- Zena CL has been tested in WA barley NVT for one season (2021).
- Statewide yields in 2021 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 avirulent) 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 a similar genetic background to RGT Planet but possesses the Clearfield® herbicide tolerance trait developed by Agriculture Victoria Services, which is currently exclusively licensed to InterGrain.

Across 23 WA barley NVT (2021), Zena CL yielded the same as RGT Planet in all trials (Table 11).

Zena CL is best suited to medium and high rainfall environments. 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, PM and BLR but may need management for NFNB (Oxford virulent) and SFNB. It is rated provisionally as MS*p* to NFNB (Beecher virulent and avirulent) as an adult plant and MR*p* as a seedling to NFNB (Beecher virulent) and S*p* to NFNB (Beecher avirulent), potentially limiting disease expression.

Seed is available for planting in 2023 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, Leabrook and Rosalind).

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 both 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 Flinders, 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. Overall, ensuring adequate and appropriate N supply is the most critical factor 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 rate of seeds to be planted, it is essential to think about 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 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:

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

TABLE 3. Western Australian malt barley variety segregation recommendations by port zone for the 2023–2024 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	With declining hectares sown, Bass production is limited to domestic processing and exporting as malt.
Flinders	NO	NO	NO	NO	NO	Limited	NO	Works well as a variety for post-malt blending and sugar-adjunct brewing. Production destined for domestic processing and export as malt.
Maximus CL	NO	YES	YES	Limited	YES	Limited	YES	International markets are still evaluating the malting and brewing fit for Maximus CL.
RGT Planet	NO	YES	YES	NO	YES	YES	YES	Strong market pull due to its global availability.
Spartacus CL	YES	YES	YES	YES	YES	YES	YES	Large volumes are available to the market with increasing acceptance internationally.

Source: GIWA Barley Council

Market feedback

Grain Industry Association of Western Australia (GIWA)

For the 2023–2024 harvest, the following observations are relevant:

- Barley is still popular among growers. While the area sown to barley has contracted since the record acreage of 2019, it is on par with that sown to barley in 2018, 2020 and 2021, which is 37% higher than the average area sown from 2010 to 2017 (source: GIWA Crop Report). The popularity of barley in the rotation is expected to remain in 2023, subject to comparative pricing against wheat and canola.
- International trade flows for barley are still significantly affected by China's ban on Australian barley imports. A tight global supply of quality malt barley has allowed diversification of Australian exports of malt barley grain and malt to Africa, Asia, Mexico and South America, with opportunistic malt barley grain sales to maltsters in Europe and North America.
- With international malt plants running at high utilisation levels and structural demand for malt strong, South America is developing as a key market for MALT1 grade barley.
- As production levels in Canada and Europe bounce back, the new market opportunities in Mexico and South America will be won on price, quality and the balance between supply and demand. Demand will influence the premium for malt over feed, with premiums of at least $70/t offered during the last twelve months.
- High-quality malt barley is required to meet the demands of current and new export customers and the strong domestic market.

- Perth's Boortmalt and Barrett Burston malthouses are the largest customers of WA malt barley grain. The two Perth plants currently procure over 300,000t of malt barley grain annually from growers in the Kwinana and parts of the Albany Port zones. Barrett Burston has recently upgraded kiln capacity to increase malt production from its Perth plant in the coming years.
- The future of Bass and Flinders is limited beyond the 2023–2024 harvest. There is strong demand in domestic markets, which prefer Bass and Flinders to meet the premium, additive-free malt markets of south-east Asia and Japan. While there is still solid international demand for Bass and Flinders grain, grower production of these varieties has declined, making it challenging to offer segregations and achieve commercially viable export quantities.
- Spartacus CL and RGT Planet dominate the production area sown to barley in WA.
- There is a solid demand for RGT Planet from global malting and brewing customers.
- Spartacus CL has increased its international market recognition since last year, with export market opportunities in Asia, Mexico, South Africa and South America.
- Maximus CL is still new to the market and is being assessed by international customers. Customer demand for Maximus CL from the 2023–2024 harvest will depend on processor experience with this variety from the 2022–2023 harvest – this is a typical situation for new varieties, with malt premiums usually lower until they have become established in the market.
- The Barley Council of Grains Australia accredited Bottler in March 2022. Production volumes are extremely limited in WA. It is possible that Bottler could be grown under contract to supply a domestic processor for export as malt. Bottler is unlikely to become a widely sown variety in the Kwinana Port Zone, given its relative agronomic performance against established malt varieties.
- Prices for malt barley in Albany to meet the domestic market demand may be limited. Growers, particularly those planting Flinders, should compare Kwinana bid prices with the local Albany price and consider freight costs to relevant delivery sites.
- Segregation opportunities for Bass, Flinders, Maximus CL, RGT Planet and Spartacus CL vary by port zone across WA and within the 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 on offer 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 trade unwilling to risk buying small, unsaleable parcels.

At the same time, it is vital to have a spread of varieties that differ in their management and malt characteristics to enable processed malt to be blended to customer specifications and to spread agronomic risk. Treating malt barley crops with some chemicals may limit market access, as not all markets have import residue 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 segregation if they become regular and not opportunistic.

The Grain Industry Association of Western Australia (GIWA) Inc (through the GIWA Barley Council) developed these recommendations in consultation with the WA barley supply chain. They aim to guide growers and consultants when planning the 2023 barley cropping program. A plan review will occur in autumn 2023 and any changes in demand will be presented to growers. This document's malt variety recommendations may differ from those for 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 old malt varieties are phased out, 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 further malt segregation adding to

storage and handling costs. The GIWA barley variety rationalisation plan attempts to balance the benefits new malt varieties provide to growers with the customer demand for 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 on which malt variety or varieties to sow in 2023. Market demand, pricing signals and segregation locations should be considered when determining the choice of malt variety, along with the agronomic management required and the risk associated with delivering malt-grade barley. Varieties listed as PREFERRED are more likely than ACCEPTABLE varieties to attract higher premiums. As these industry recommendations are a guide, the actual segregations implemented at the 2023–2024 harvest may differ from those proposed in this document. Growers should regularly liaise with their bulk handlers to confirm segregation.

The malt barley recommendations for the 2023 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 with stable demand. Until there is a replacement, Bass is a critical malt variety to maintain WA's supply of premium malt to key customers.
- Suitable for additive-free malting, which is a growing sector of the international malt market. Sales to these markets are currently limited by the low supply of Bass (and Flinders).
- Frequently used when blending malt to customer specifications.
- Bass malt has excellent extract, filterability, and its quality profile matches the needs of brewers using high levels of starch adjuncts. Bass grain generally has a higher grain protein concentration than other malt varieties received, enhancing its preference from starch-adjunct brewers, but not all brewers we service.
- Bass, like Flinders, has a higher selection rate for malt than RGT Planet and Spartacus CL but is now outclassed for grain yield.
- Target production zones in 2023 are Kwinana-North (Midlands) and Kwinana-South. Limited segregation opportunities will be offered due to limited production.

Flinders

- Flinders is acceptable for export as grain and preferred for export as malt. As with Bass, production volumes do not support segregations for export.
- Not suitable for the manufacture of shochu in Japan.
- Suitable for additive-free malting, which is a growing sector of the international malt market. Sales to those markets are currently limited by the low supply of Flinders (and Bass).
- Frequently used when blending malt to customer specifications.
- Flinders malt has excellent malt extract and filterability but at a lower enzyme potential than Bass malt.
- Flinders performs well in markets where sugar-adjunct brewing is practiced and when blended post-malting for starch-adjunct brewing markets.
- Flinders, like Bass, has a higher selection rate for malt than RGT Planet and Spartacus CL but is now outclassed for grain yield.
- Target production zones in 2023 are Albany-South. Niche segregation opportunities will be subject to end-user demand.

Maximus CL

- Maximus CL grain is acceptable for export and the variety is also being assessed for export as malt and 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).

- The industry expects Maximus CL to replace Spartacus CL on-farm, but the market demand for Maximus CL will depend on how it processes from the 2022 cropping season. In the short term, supply could exceed demand while evaluation occurs. Expect the premium for Maximus CL to match Spartacus CL over time as customers become familiar with the variety.
- Use recommended imidazolinone herbicides and be aware of market advice regarding grain deliveries from paddocks sprayed with an imidazolinone herbicide.
- Target production zones in 2023 are Geraldton, Kwinana, Albany and Esperance Port Zones. There will likely be more segregation opportunities in Kwinana-North (Midlands), Kwinana-South, Albany-North and Esperance than in Geraldton and Albany-South.

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 used extensively in European and South American brewing markets and is gaining acceptance in south-east Asian brewing markets.
- There is currently insufficient MALT1 grade RGT Planet supply to meet demand, resulting in premiums above Spartacus CL in some cases.
- Following shifts in global supply, Europe became a new, opportunistic market during 2021–2022. Given that Europe does not accept imidazolinone-treated barley, RGT Planet was the only variety with sufficient grain available for export to the new European market without the establishment of separate segregations for non-IMI-treated barley of Spartacus CL. The small volumes of Bass and Flinders were primarily absorbed by the domestic market and were not available for export to Europe.
- Target production zones in 2023 are Kwinana-North (Midlands), Kwinana-South, Albany and Esperance Port Zones.

Spartacus CL

- Spartacus CL is acceptable for export as grain and malt and is suitable for manufacturing shochu in Japan.
- Spartacus CL malt has a high extract with very good enzyme potential and is suitable for starch-adjunct brewing.
- Use recommended imidazolinone herbicides and be aware of market advice regarding grain deliveries from paddocks sprayed with an imidazolinone herbicide.
- Target production zones in 2023 are Geraldton, 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 provide an independent means of assessing varietal performance across Australia. 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 (2017–2021) 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.

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 2017 to 2021 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 and uses data extracted from the 'Statewide tables of yield and grain quality' available at **nvtonline.com.au**. Figures 2 to 7 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 was significant ($p<0.05$), a quadratic polynomial was fitted to the data. 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 which years and locations are analysed, the relative performance of varieties may 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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		2.08	4.22	0.62	4.96	3.41	3.06
Variety	(No. trials)	(2)	(2)	(2)	(1)	(2)	(9)
Deliverable as a malt variety							
Bass	(9)	92	90	83	92	91	**89**
Flinders	(7)	92	89	79	95	-	**90**
Maximus CL	(7)	-	104	119	101	117	**110**
RGT Planet	(9)	96	100	86	107	95	**96**
Spartacus CL	(9)	102	100	109	99	109	**104**
Stage Two malt accreditation							
Buff	(8)	119	115	138	99	111	**118**
Commodus CL	(3)	-	-	-	101	100	**-**
Laperouse	(7)	-	107	116	104	109	**109**
Deliverable as a feed variety							
Beast	(5)	-	-	124	105	111	**112**
Bottler	(4)	-	94	87	-	-	**95**
Combat	(2)	-	-	-	-	119	**-**
Compass	(9)	105	110	123	102	103	**109**
Cyclops	(3)	-	-	-	105	113	**-**
Fathom	(9)	109	109	125	98	105	**110**
La Trobe	(9)	103	103	112	101	107	**106**
Leabrook	(9)	105	111	118	106	103	**109**
LG Alestar	(5)	-	-	75	96	89	**87**
Litmus	(7)	111	-	113	99	95	**106**
Minotaur	(3)	-	-	-	107	107	**-**
Mundah	(7)	99	100	98	96	-	**96**
Rosalind	(9)	110	110	125	106	116	**114**
Scope CL	(9)	103	100	107	93	96	**101**
Titan AX	(0)	-	-	-	-	-	**-**
Zena CL	(2)	-	-	-	-	96	**-**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		4.21	4.29	2.21	3.24	4.25	3.64
Variety	(No. trials)	(5)	(7)	(7)	(6)	(7)	(32)
Deliverable as a malt variety							
Bass	(32)	93	92	93	92	90	**92**
Flinders	(25)	96	92	91	95	-	**94**
Maximus CL	(27)	-	104	109	110	106	**107**
RGT Planet	(31)	101	101	96	100	104	**100**
Spartacus CL	(32)	99	101	105	105	100	**102**
Stage Two malt accreditation							
Buff	(31)	108	107	110	104	105	**107**
Commodus CL	(13)	-	-	-	102	98	**101**
Laperouse	(32)	104	106	106	107	107	**106**
Deliverable as a feed variety							
Beast	(20)	-	-	113	111	104	**108**
Bottler	(18)	99	96	95	-	-	**97**
Combat	(7)	-	-	-	-	111	**112**
Compass	(32)	100	108	111	105	99	**105**
Cyclops	(13)	-	-	-	110	110	**109**
Fathom	(32)	102	105	109	103	99	**104**
La Trobe	(32)	100	103	107	105	100	**103**
Leabrook	(32)	103	109	109	106	104	**106**
LG Alestar	(20)	-	-	90	91	94	**92**
Litmus	(25)	97	-	107	94	90	**98**
Minotaur	(13)	-	-	-	106	107	**104**
Mundah	(23)	93	98	101	93	-	**95**
Rosalind	(32)	104	108	113	111	106	**109**
Scope CL	(32)	97	97	101	94	91	**96**
Titan AX	(0)	-	-	-	-	-	**-**
Zena CL	(7)	-	-	-	-	102	**100**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		4.49	3.69	4.26	4.76	5.50	4.54
Variety	(No. trials)	(2)	(4)	(4)	(6)	(5)	(21)
Deliverable as a malt variety							
Bass	(21)	88	94	91	92	90	**91**
Flinders	(21)	94	97	95	97	92	**95**
Maximus CL	(19)	-	102	107	108	98	**104**
RGT Planet	(21)	110	103	104	102	107	**105**
Spartacus CL	(21)	96	99	103	103	95	**100**
Stage Two malt accreditation							
Buff	(19)	-	103	101	101	104	**102**
Commodus CL	(11)	-	-	-	100	100	**100**
Laperouse	(21)	105	104	106	107	107	**106**
Deliverable as a feed variety							
Beast	(15)	-	-	108	107	106	**106**
Bottler	(10)	101	99	99	-	-	**98**
Combat	(5)	-	-	-	-	110	**110**
Compass	(21)	98	101	102	101	104	**102**
Cyclops	(11)	-	-	-	110	110	**109**
Fathom	(21)	97	100	99	99	100	**99**
La Trobe	(21)	98	100	103	102	98	**100**
Leabrook	(21)	105	104	105	104	110	**106**
LG Alestar	(15)	-	-	93	93	94	**94**
Litmus	(13)	98	-	-	88	93	**93**
Minotaur	(11)	-	-	-	107	103	**106**
Mundah	(14)	91	94	92	88	-	**91**
Rosalind	(21)	107	103	110	107	102	**106**
Scope CL	(21)	90	95	91	91	92	**92**
Titan AX	(0)	-	-	-	-	-	**-**
Zena CL	(5)	-	-	-	-	105	**103**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		1.46	3.36	0.78	2.55	4.20	2.47
Variety	(No. trials)	(1)	(2)	(1)	(5)	(3)	(12)
Deliverable as a malt variety							
Bass	(12)	95	91	88	96	93	**94**
Flinders	(9)	93	93	83	93	-	**93**
Maximus CL	(11)	-	100	108	111	112	**111**
RGT Planet	(12)	88	102	87	96	97	**96**
Spartacus CL	(12)	129	96	102	109	107	**107**
Stage Two malt accreditation							
Buff	(12)	98	122	150	105	101	**110**
Commodus CL	(8)	-	-	-	107	104	**104**
Laperouse	(11)	-	101	103	104	110	**106**
Deliverable as a feed variety							
Beast	(9)	-	-	105	114	113	**112**
Bottler	(8)	-	101	95	97	-	**97**
Combat	(3)	-	-	-	-	111	**-**
Compass	(12)	119	99	112	112	106	**109**
Cyclops	(8)	-	-	-	106	113	**108**
Fathom	(11)	109	106	125	107	103	**108**
La Trobe	(12)	123	98	105	109	105	**107**
Leabrook	(12)	109	100	105	107	107	**106**
LG Alestar	(9)	-	-	85	91	90	**90**
Litmus	(10)	100	-	151	112	82	**108**
Minotaur	(8)	-	-	-	104	105	**104**
Mundah	(9)	99	102	114	106	-	**101**
Rosalind	(12)	137	108	121	116	109	**115**
Scope CL	(12)	96	104	121	102	92	**101**
Titan AX	(0)	-	-	-	-	-	**-**
Zena CL	(3)	-	-	-	-	98	**-**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		3.67	2.92	1.95	2.43	4.21	3.04
Variety	(No. trials)	(4)	(3)	(4)	(6)	(5)	(22)
Deliverable as a malt variety							
Bass	(22)	91	89	91	92	90	**91**
Flinders	(17)	96	95	93	91	-	**93**
Maximus CL	(18)	-	107	126	121	105	**113**
RGT Planet	(22)	106	105	94	91	103	**99**
Spartacus CL	(22)	99	102	119	114	101	**108**
Stage Two malt accreditation							
Buff	(22)	99	104	105	101	103	**102**
Commodus CL	(11)	-	-	-	112	104	**105**
Laperouse	(22)	107	107	109	116	109	**110**
Deliverable as a feed variety							
Beast	(15)	-	-	122	128	113	**117**
Bottler	(18)	-	99	98	89	94	**95**
Combat	(5)	-	-	-	-	112	**115**
Compass	(22)	101	101	111	119	109	**110**
Cyclops	(11)	-	-	-	121	113	**114**
Fathom	(22)	97	99	107	110	103	**104**
La Trobe	(22)	100	102	115	113	103	**107**
Leabrook	(22)	106	105	106	116	112	**110**
LG Alestar	(15)	-	-	85	81	90	**88**
Litmus	(4)	85	-	-	-	-	**89**
Minotaur	(11)	-	-	-	104	104	**108**
Mundah	(17)	88	89	97	89	-	**91**
Rosalind	(22)	104	111	131	118	108	**115**
Scope CL	(4)	89	-	-	-	-	**92**
Titan AX	(5)	-	-	-	-	109	**110**
Zena CL	(5)	-	-	-	-	102	**99**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		2.98	4.88	4.06	4.04	6.02	4.40
Variety	(No. trials)	(1)	(2)	(3)	(3)	(1)	(10)
Deliverable as a malt variety							
Bass	(10)	88	89	88	89	90	**89**
Flinders	(10)	108	97	97	97	94	**98**
Maximus CL	(9)	-	99	106	107	98	**103**
RGT Planet	(10)	126	111	107	108	110	**110**
Spartacus CL	(10)	88	95	99	100	96	**97**
Stage Two malt accreditation							
Buff	(9)	-	105	104	96	100	**100**
Commodus CL	(4)	-	-	-	99	99	**95**
Laperouse	(10)	95	103	107	110	104	**106**
Deliverable as a feed variety							
Beast	(7)	-	-	103	108	104	**101**
Bottler	(10)	116	103	101	99	100	**102**
Combat	(1)	-	-	-	-	107	**-**
Compass	(10)	70	94	96	99	101	**94**
Cyclops	(4)	-	-	-	113	106	**109**
Fathom	(10)	75	95	96	94	97	**93**
La Trobe	(10)	87	96	99	100	99	**98**
Leabrook	(10)	87	101	103	106	106	**102**
LG Alestar	(7)	-	-	94	93	96	**96**
Litmus	(1)	91	-	-	-	-	**-**
Minotaur	(4)	-	-	-	112	108	**112**
Mundah	(9)	79	90	83	80	-	**84**
Rosalind	(10)	98	104	107	106	105	**105**
Scope CL	(1)	77	-	-	-	-	**-**
Titan AX	(0)	-	-	-	-	-	**-**
Zena CL	(1)	-	-	-	-	107	**-**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		3.55	3.93	2.63	3.42	4.51	3.61
Variety	(No. trials)	(15)	(20)	(21)	(27)	(23)	(106)
Deliverable as a malt variety							
Bass	(106)	91	91	91	92	91	**91**
Flinders	(89)	96	94	94	95	94	**95**
Maximus CL	(91)	-	103	110	110	105	**107**
RGT Planet	(105)	105	103	101	100	104	**102**
Spartacus CL	(106)	99	99	105	105	100	**102**
Stage Two malt accreditation							
Buff	(101)	104	108	106	101	104	**104**
Commodus CL	(50)	-	-	-	103	101	**101**
Laperouse	(103)	105	105	107	108	107	**107**
Deliverable as a feed variety							
Beast	(71)	-	-	111	112	108	**108**
Bottler	(68)	100	98	98	97	97	**98**
Combat	(23)	-	-	-	-	111	**112**
Compass	(106)	99	103	105	106	104	**104**
Cyclops	(50)	-	-	-	111	111	**110**
Fathom	(105)	99	103	103	102	101	**102**
La Trobe	(106)	100	101	105	105	101	**103**
Leabrook	(106)	103	106	106	107	107	**106**
LG Alestar	(71)	-	-	91	91	92	**92**
Litmus	(60)	95	-	99	89	91	**95**
Minotaur	(50)	-	-	-	107	105	**106**
Mundah	(79)	91	96	94	91	-	**93**
Rosalind	(106)	105	107	114	111	106	**109**
Scope CL	(79)	93	96	94	92	92	**93**
Titan AX	(5)	-	-	-	-	107	**107**
Zena CL	(23)	-	-	-	-	102	**101**

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: RGT Planet						
Bass	69%	26%	6%	105	2017–2021	Bass < RGT Planet
Beast	15%	14%	70%	71	2019–2021	Beast > RGT Planet
Bottler	57%	37%	6%	68	2017–2021	Bottler ≤ RGT Planet
Buff	29%	22%	50%	101	2017–2021	Buff = RGT Planet
Combat	4%	30%	65%	23	2021–only	Combat ≥ RGT Planet
Commodus CL	38%	18%	44%	50	2020–2021	Commodus CL = RGT Planet
Compass	30%	21%	49%	105	2017–2021	Compass = RGT Planet
Cyclops	8%	18%	74%	50	2020–2021	Cyclops > RGT Planet
Fathom	35%	18%	47%	104	2017–2021	Fathom = RGT Planet
Flinders	66%	28%	6%	88	2017–2021	Flinders ≤ RGT Planet
La Trobe	34%	18%	48%	105	2017–2021	La Trobe = RGT Planet
Laperouse	17%	24%	60%	102	2017–2021	Laperouse ≥ RGT Planet
Leabrook	19%	21%	60%	105	2017–2021	Leabrook ≥ RGT Planet
LG Alestar	80%	18%	1%	71	2019–2021	LG Alestar < RGT Planet
Litmus	57%	8%	35%	60	2017, 2019–2021	Litmus = RGT Planet
Maximus CL	24%	17%	59%	90	2018–2021	Maximus CL ≥ RGT Planet
Minotaur	12%	42%	46%	50	2020–2021	Minotaur ≥ RGT Planet
Mundah	56%	18%	27%	79	2017–2020	Mundah = RGT Planet
Rosalind	17%	22%	61%	105	2017–2021	Rosalind ≥ RGT Planet
Scope CL	50%	28%	22%	78	2017–2021	Scope CL ≤ RGT Planet
Spartacus CL	38%	14%	48%	105	217–2021	Spartacus CL = RGT Planet
Titan AX	0%	40%	60%	5	2021–only	*not enough data to compare*
Zena CL	0%	100%	0%	23	2021–only	Zena CL = RGT Planet
Variety B: Spartacus CL						
Bass	94%	6%	0%	106	2017–2021	Bass < Spartacus CL
Beast	6%	25%	69%	71	2019–2021	Beast > Spartacus CL
Bottler	57%	24%	19%	68	2017–2021	Bottler ≤ Spartacus CL
Buff	30%	30%	41%	101	2017–2021	Buff = Spartacus CL
Combat	0%	13%	87%	23	2021-only	Combat > Spartacus CL
Commodus CL	28%	48%	24%	50	2020–2021	Commodus CL = Spartacus CL
Compass	22%	37%	42%	106	2017–2021	Compass ≥ Spartacus CL
Cyclops	6%	24%	70%	50	2020–2021	Cyclops > Spartacus CL
Fathom	35%	35%	30%	105	2017–2021	Fathom = Spartacus CL
Flinders	75%	21%	3%	89	2017–2021	Flinders < Spartacus CL
La Trobe	4%	82%	14%	106	2017–2021	La Trobe = Spartacus CL
Laperouse	10%	29%	61%	103	2017–2021	Laperouse ≥ Spartacus CL
Leabrook	17%	29%	54%	106	2017–2021	Leabrook ≥ Spartacus CL
LG Alestar	82%	15%	3%	71	2019–2021	LG Alestar < Spartacus CL
Litmus	53%	25%	22%	60	2017, 2019–2021	Litmus ≤ Spartacus CL
Maximus CL	0%	38%	62%	91	2018–2021	Maximus CL ≥ Spartacus CL
Minotaur	22%	36%	42%	50	2020–2021	Minotaur ≥ Spartacus CL
Mundah	80%	15%	5%	79	2017–2020	Mundah < Spartacus CL
RGT Planet	48%	14%	38%	105	2017–2021	RGT Planet = Spartacus CL
Rosalind	1%	21%	78%	106	2017–2021	Rosalind > Spartacus CL
Scope CL	67%	22%	11%	79	2017–2021	Scope CL < Spartacus CL
Titan AX	0%	20%	80%	5	2021–only	*not enough data to compare*
Zena CL	35%	22%	43%	23	2021–only	Zena CL = Spartacus CL

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	99%	1%	0%	106	2017–2021	Bass < Rosalind
Beast	24%	44%	32%	71	2019–2021	Beast = Rosalind
Bottler	90%	9%	1%	68	2017–2021	Bottler < Rosalind
Buff	58%	15%	27%	101	2017–2021	Buff = Rosalind
Combat	0%	43%	57%	23	2021–only	Combat ≥ Rosalind
Commodus CL	68%	32%	0%	50	2020–2021	Commodus CL < Rosalind
Compass	57%	31%	12%	106	2017–2021	Compass ≤ Rosalind
Cyclops	18%	42%	40%	50	2020–2021	Cyclops ≥ Rosalind
Fathom	71%	23%	6%	105	2017–2021	Fathom < Rosalind
Flinders	94%	4%	1%	89	2017–2021	Flinders < Rosalind
La Trobe	80%	20%	0%	106	2017–2021	La Trobe < Rosalind
Laperouse	34%	47%	19%	103	2017–2021	Laperouse ≤ Rosalind
Leabrook	47%	31%	22%	106	2017–2021	Leabrook ≤ Rosalind
LG Alestar	99%	1%	0%	71	2019–2021	LG Alestar < Rosalind
Litmus	77%	17%	7%	60	2017, 2019–2021	Litmus < Rosalind
Maximus CL	47%	44%	9%	91	2018–2021	Maximus CL ≤ Rosalind
Minotaur	46%	44%	10%	50	2020–2021	Minotaur ≤ Rosalind
Mundah	96%	4%	0%	79	2017–2020	Mundah < Rosalind
RGT Planet	61%	22%	17%	105	2017–2021	RGT Planet ≤ Rosalind
Scope CL	87%	13%	0%	79	2017–2021	Scope CL < Rosalind
Spartacus CL	78%	21%	1%	106	2017–2021	Spartacus CL < Rosalind
Titan AX	0%	80%	20%	5	2021–only	*not enough data to compare*
Zena CL	48%	35%	17%	23	2021–only	Zena CL ≤ Rosalind

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

GRAIN YIELD – COMPARISONS

The benchmark varieties for grain yield in WA are Rosalind and RGT Planet. RGT Planet is the benchmark at sites with a yield potential above 5t/ha, while Rosalind is the benchmark at yield potentials below 4t/ha on non-acidic soils (Figures 2 to 7, Tables 1, 2, 4 to 12). Buff is, however, the benchmark on soils with an acidic profile (pH_{Ca} below 4.8). When chasing yield per se, many new options challenge Rosalind and RGT Planet for yield supremacy. The newer varieties worth considering include Beast, Combat, Cyclops, Laperouse, Maximus CL, Minotaur, Titan AX and Zena CL. Where early vigour and weed competitiveness are primary factors in the variety choice in sub-3t/ha environments, Commodus CL, Compass and Titan AX are considerations. Above 3.5t/ha, Laperouse and Leabrook are higher-yielding and more effective weed-suppressive options 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 commercial release in WA in 2016. Since 2017 it has been higher yielding in nearly seven of every ten comparisons with Bass and Flinders and two in every five comparisons with Spartacus CL (Table 11). Maximus CL is a more competitive yield option than Bass, Flinders and Spartacus CL against RGT Planet, yielding higher than RGT Planet in 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. Since 2018, Maximus CL has had a clear yield advantage over RGT Planet at sites with a yield potential below 4t/ha, while Spartacus CL has had a yield advantage below 3t/ha (Figure 5). The industry expects Maximus CL to replace the area sown to Spartacus CL quickly.

Beast, Buff, Commodus CL, Cyclops, Laperouse, Minotaur and Zena CL are in various stages of malting and brewing accreditation with the Barley Council of Grains Australia. Buff and Commodus CL are the most advanced of these seven varieties in accreditation trials, with a decision likely on these varieties in March 2023. A decision on Laperouse has been delayed until March 2024 due to flooding in eastern Australia damaging grain destined for accreditation trials in 2022. Regardless of whether the seven varieties receive malt and brewing accreditation, each variety has a good fit in specific systems:

- Beast – has matched Rosalind at many WA barley NVT (Figure 2, 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.
- Buff – has higher genetic tolerance to low soil pH and high soil Al than all varieties except Litmus. While it may not yield as high as the other new options on non-acidic soils (Figures 2, 6 and 8, Tables 4–12), it does have a unique role on acidic soils. It is expected, however, to be restricted mainly to the eastern and northern wheatbelt due to its limited disease resistance (Tables 13 and 14). Buff has been widely adopted by growers in the Geraldton and Kwinana Port Zones, accounting for 7% of plantings in those two port zones in 2021.
- Commodus CL – is not yield competitive with Rosalind but comparable in its yield to Compass and Spartacus CL (Figures 3 and 8). It offers growers a more vigorous plant type for early season weed suppression than Spartacus CL and Maximus CL in an IMI-tolerant background. Potentially the 2% of the Kwinana Port Zone sown to Compass and Leabrook could be sown to Commodus CL if IMI herbicide activity is justified. It could also replace Spartacus CL where longer straw or a longer coleoptile are needed or there is a low probability of going malt. 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 – had a yield advantage over Rosalind and most varieties in 2020 and 2021 at sites that yielded more than 3t/ha (Figure 3). It has the same plant type as Spartacus CL and Maximus CL but cannot be sown in IMI herbicide systems. The feed variety Combat performed well in 2021 and showed a yield advantage over Cyclops above 4t/ha. However, more years of data are needed to determine whether Combat and Cyclops will become the new yield benchmarks in WA.
- Laperouse – competes well with Rosalind as the site potential rises above 5t/ha and with Maximus CL above 4t/ha (Figures 2 and 7). Since 2016, Laperouse has performed better than RGT Planet, where the site yield was less than 4t/ha. While RGT Planet may have a yield advantage at higher-yielding sites, Laperouse is a lower-cost (fungicide) option to grow, given its enhanced tolerance to NFNB (Beecher virulent and Oxford virulent) and SFNB.
- Minotaur – a semi-dwarf alternative to Bass, Flinders and RGT Planet. In 2020 and 2021, this variety showed a clear advantage over RGT Planet at sites that yielded less than 5t/ha. Minotaur, however, was outclassed by Cyclops across most of the environments in which they have been compared (Figure 3).

More years of data are needed to confirm the yield relativity of Beast, Combat, Commodus CL, Cyclops, Minotaur, Titan AX and Zena CL in WA barley NVT. Beast is potentially a benchmark in the sub-2t/ha environments. Based on limited data, Combat looks promising in the above 4t/ha environments (and where SFNB is a concern), while Cyclops looks impressive in the 2–4t/ha environments. With only five sites of WA barley NVT data available for Titan AX from the 2021 season, caution is urged in ranking the yield potential of that variety. Buff, Maximus CL and Laperouse have sufficient years of data to be confident in their relative yield performance in WA.

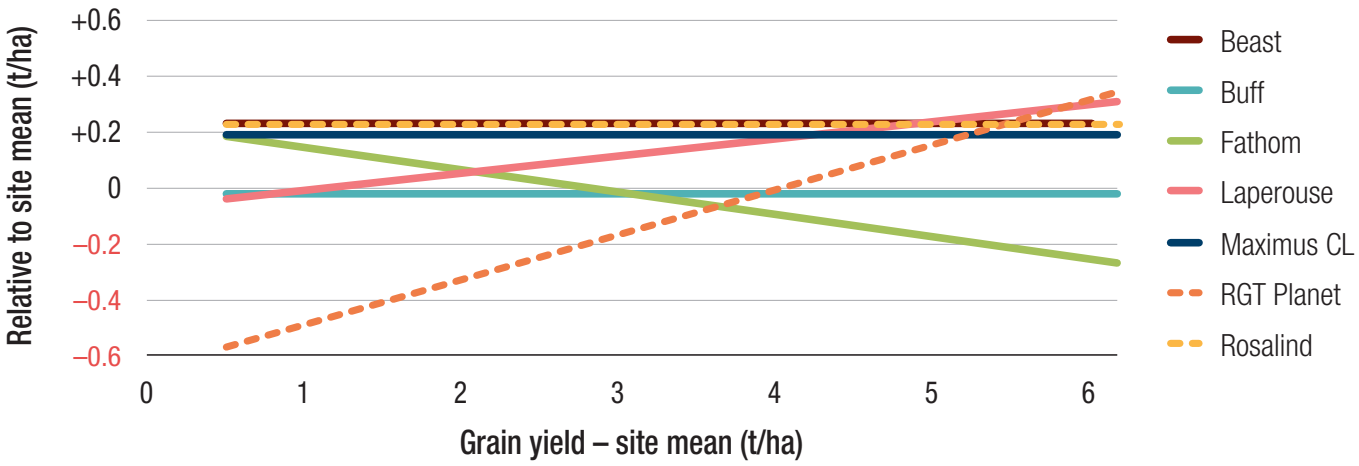

FIGURE 2. Fitted grain yield of Beast, Buff, Fathom, Laperouse, Maximus CL, RGT Planet and Rosalind at different site means.

Source: based on NVT statewide tables of yield and grain quality (2019–2021). Each variety sown in all 70 trial-years of data, NVT Online **nvtonline.com.au**

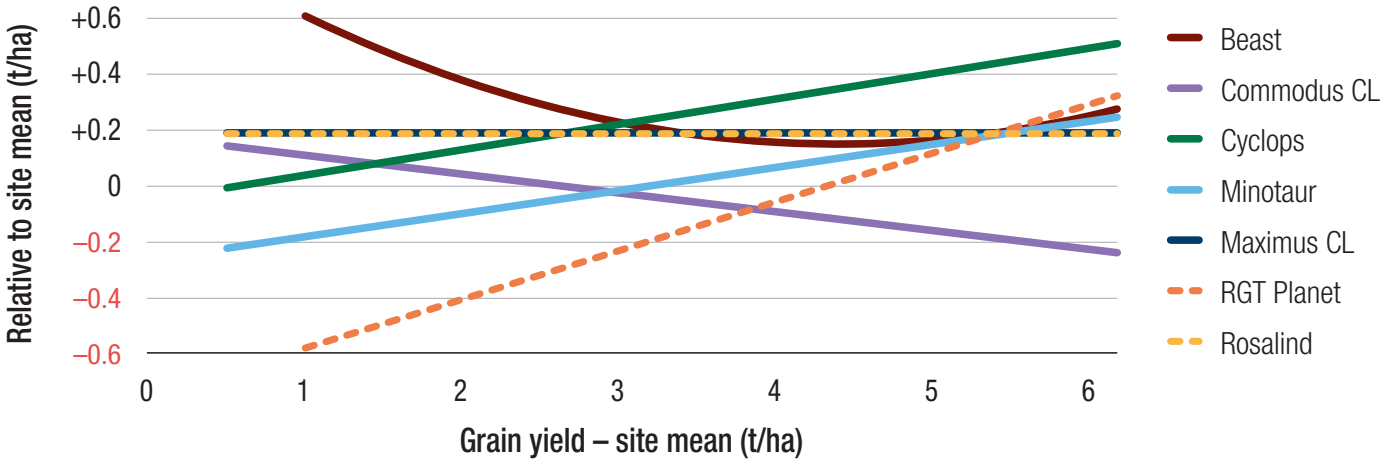

FIGURE 3. Fitted grain yield of Beast, Commodus CL, Cyclops, Maximus CL, Minotaur, RGT Planet and Rosalind at different site means.

Source: based on NVT statewide tables of yield and grain quality (2020–2021). Each variety sown in all 50 trial-years of data, NVT Online **nvtonline.com.au**

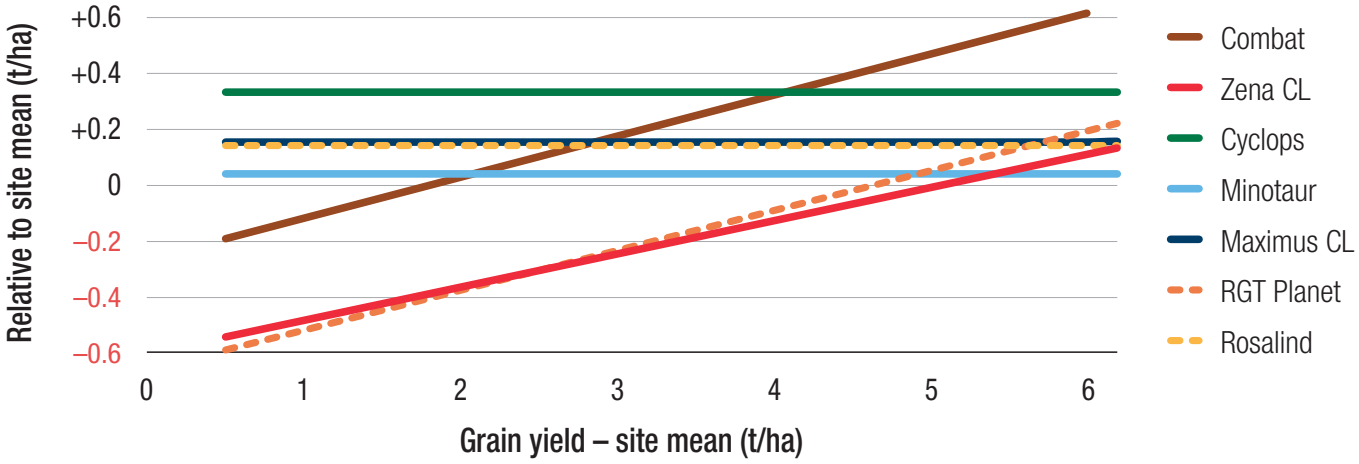

FIGURE 4. Fitted grain yield of Combat, Cyclops, Maximus CL, Minotaur, RGT Planet, Rosalind and Zena CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2021-only). Each variety sown in all 23 trial-years of data, NVT Online **nvtonline.com.au**

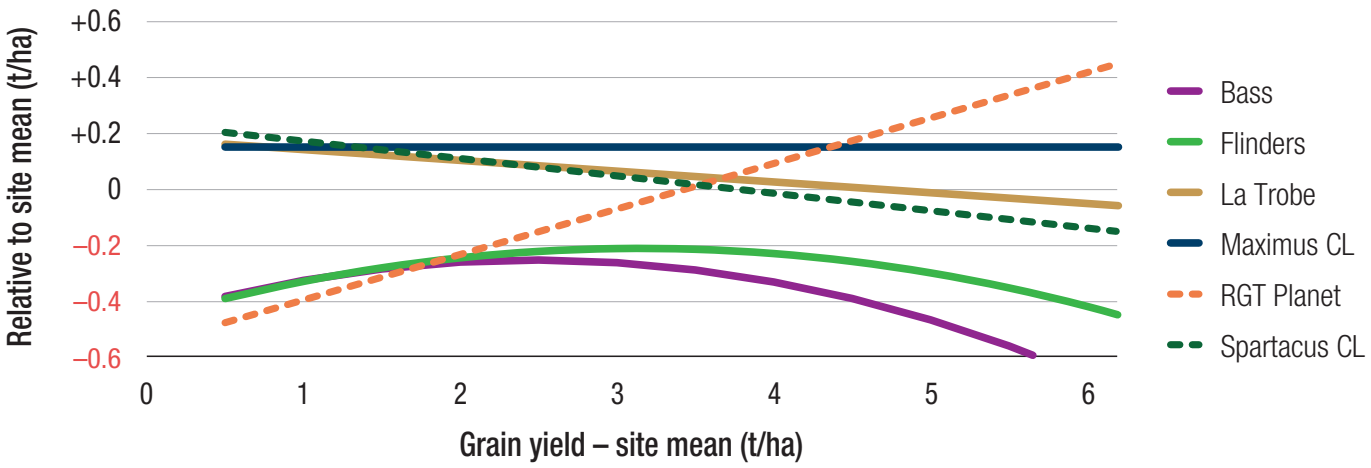

FIGURE 5. Fitted grain yield of Bass, Flinders, La Trobe, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2018–2021). Each variety sown in all 72 trial-years of data, NVT Online **nvtonline.com.au**

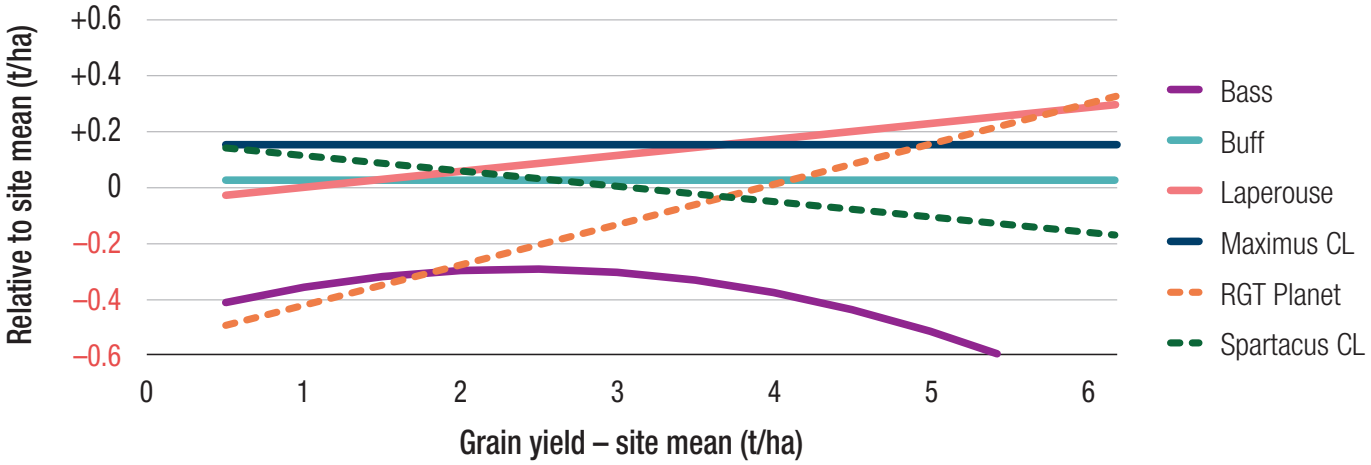

FIGURE 6. Fitted grain yield of Bass, Buff, Laperouse, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2018–2021). Each variety sown in all 87 trial-years of data, NVT Online **nvtonline.com.au**

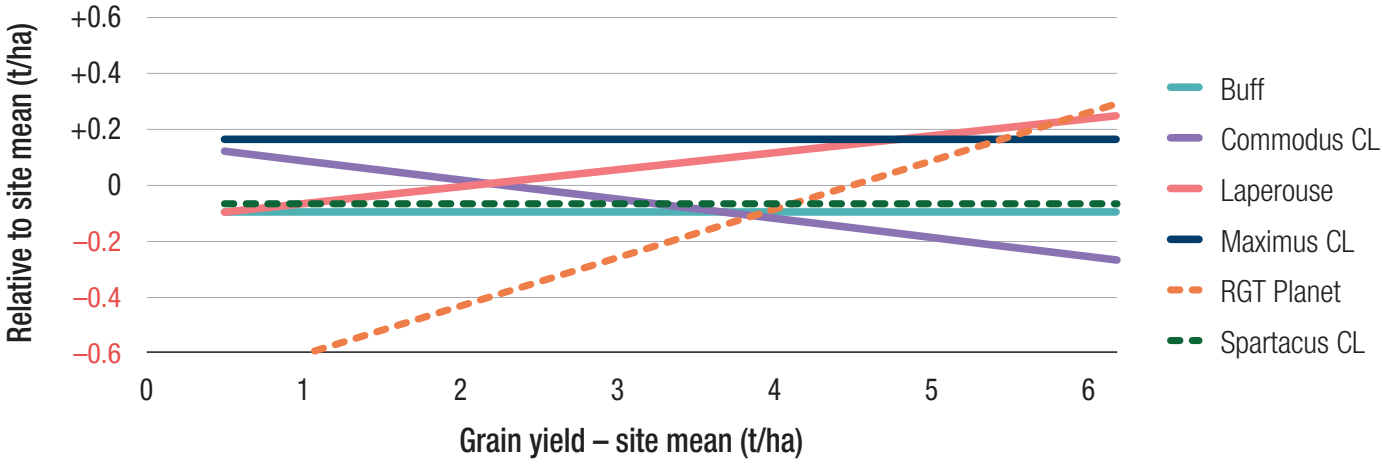

FIGURE 7. Fitted grain yield of Buff, Commodus CL, Laperouse, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2020–2021). Each variety sown in all 50 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 on offer 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 to 7, the physical grain qualities (hectolitre weight and screenings through a 2.5mm slotted sieve) of a variety have been plotted relative to the site mean as the site mean increases (Figures 8–13). 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. In previous years, grain brightness comparisons have been presented. As grain brightness will no longer be part of the GIWA Barley receival standards assessed at CBH and Bunge bulk handling sites at the 2023–2024 harvest, these comparisons have been removed.

Figures 8 to 10 compare the hectolitre weight of varieties segregated for malt in WA (except for La Trobe, which will no longer be segregated after the 2022–2023 harvest) and those under Stage Two malting and brewing evaluation (Buff, Commodus CL and Laperouse). Figures 11 to 13 present grain plumpness comparisons (percentage through a 2.5mm sieve).

GRAIN QUALITY – HECTOLITRE WEIGHT COMPARISONS

Bass has been the benchmark variety for hectolitre weight for varieties segregated for malt in WA. Flinders, La Trobe and Spartacus CL displayed a similar hectolitre weight to Bass from 2018 to 2021 (Figure 8). The hectolitre weight of the recently accredited variety, Maximus CL, was also similar to Bass, indicating that hectolitre weight is not likely to be a limiting factor in the receival of Maximus CL. However, the hectolitre weight of RGT Planet was 2–3kg/hL lower ($p<0.05$) than Bass. RGT Planet has the highest risk of not meeting MALT1 hectolitre specifications in WA. Conditions that favour 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.

Of the three varieties in Stage Two malting and brewing accreditation trials, the hectolitre weight of Buff was lower than Bass by 2kg/hL (like RGT Planet) in WA barley NVT sown since 2018

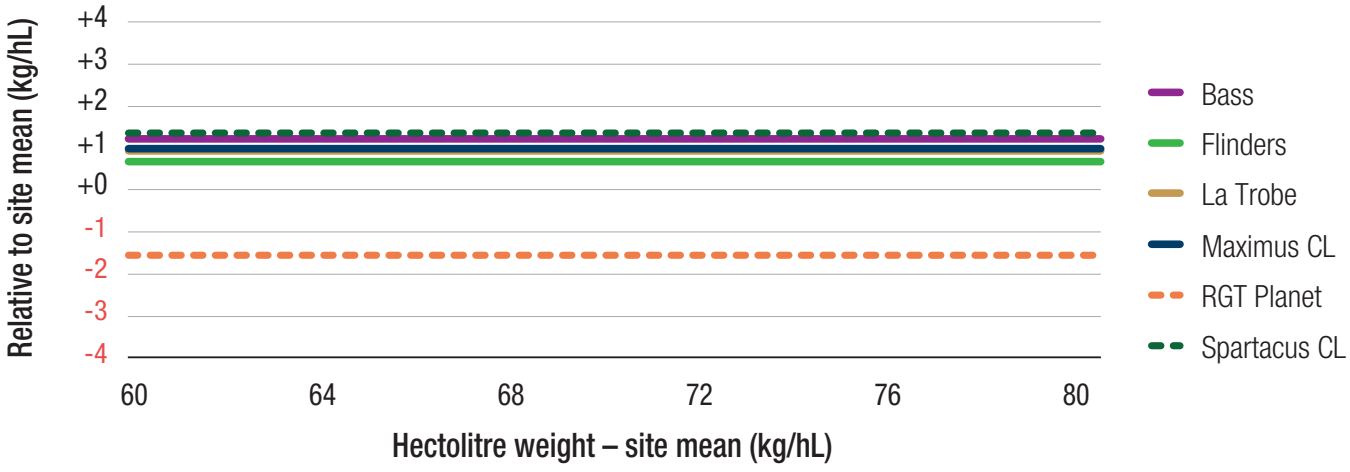

FIGURE 8. Fitted hectolitre weight of Bass, Flinders, La Trobe, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2018–2021). Each variety sown in all 72 trial-years of data, NVT Online nvtonline.com.au

(Figure 9). Laperouse was between Bass and RGT Planet in the same trials and 0.9kg/hL lower than Bass (Figure 9, $p<0.05$). Laperouse has an improved hectolitre weight to Compass and Leabrook (data not shown), which both have Commander in their pedigree. The hectolitre weight of Commodus CL is similar to Buff and RGT Planet (Figure 10), like Compass (data not shown), but lower than Bass (Figure 10, $p<0.05$). While poor hectolitre weight in some seasons may limit the receival potential of Buff and Commodus CL, it should not be a limitation should the industry accredit and receive Laperouse into the bulk handling system.

GRAIN QUALITY – GRAIN PLUMPNESS COMPARISONS

The benchmark malt variety for grain plumpness is Bass (Figure 11), which has lower screenings (percentage through a 2.5mm sieve) over a range of screenings levels than all other varieties segregated for malt in WA, except Maximus CL. Although generally less plump than Bass, Flinders showed improved plumpness compared to La Trobe and RGT Planet and was comparable to Spartacus CL from 2018 to 2021. Maximus CL has an improved grain shape over La Trobe and Spartacus CL, resulting in lower screenings in WA barley NVT (2018–2021). In those trials, Maximus CL screenings were 5% below Spartacus CL. Being plump like Bass, 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 or Flinders, with screenings generally higher than Spartacus CL and Maximus CL. At very low screenings, most varieties are similar. Genetic differences are notable around the MALT1 limit of 20% screenings, which may influence MALT1 selection rates across paddocks and seasons and in response to management.

If accredited and received into the WA bulk handling system, grain plumpness should not be a significant factor limiting Buff, Commodus CL or Laperouse uptake and delivery. Of the three varieties in Stage Two malting and brewing accreditation trials, the grain plumpness of Buff was comparable to Spartacus CL but exhibited higher screenings than Bass and Maximus CL in WA barley NVT sown since 2018 (Figure 12). The grain plumpness of Laperouse tracked similarly to that of Bass as the site mean increased (Figure 12). Unlike Compass and Leabrook, Laperouse maintains its grain plumpness without compromising its hectolitre weight (data not shown). Commodus CL has a plump kernel like Laperouse (Figure 13) but not as plump as Bass (data not shown).

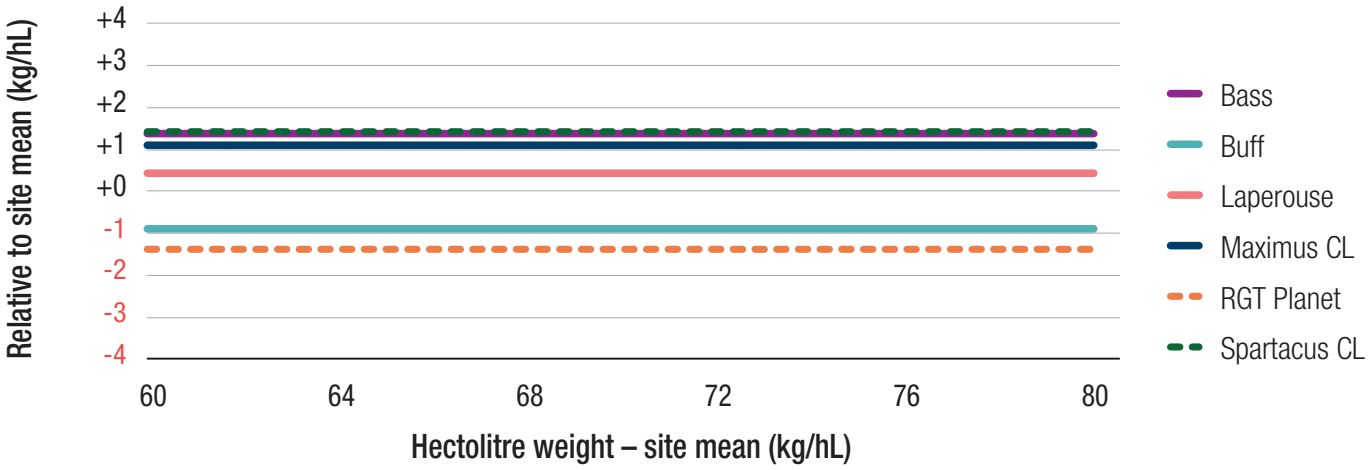

FIGURE 9. Fitted hectolitre weight of Bass, Buff, Laperouse, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2018–2021). Each variety sown in all 89 trial-years of data, NVT Online **nvtonline.com.au**

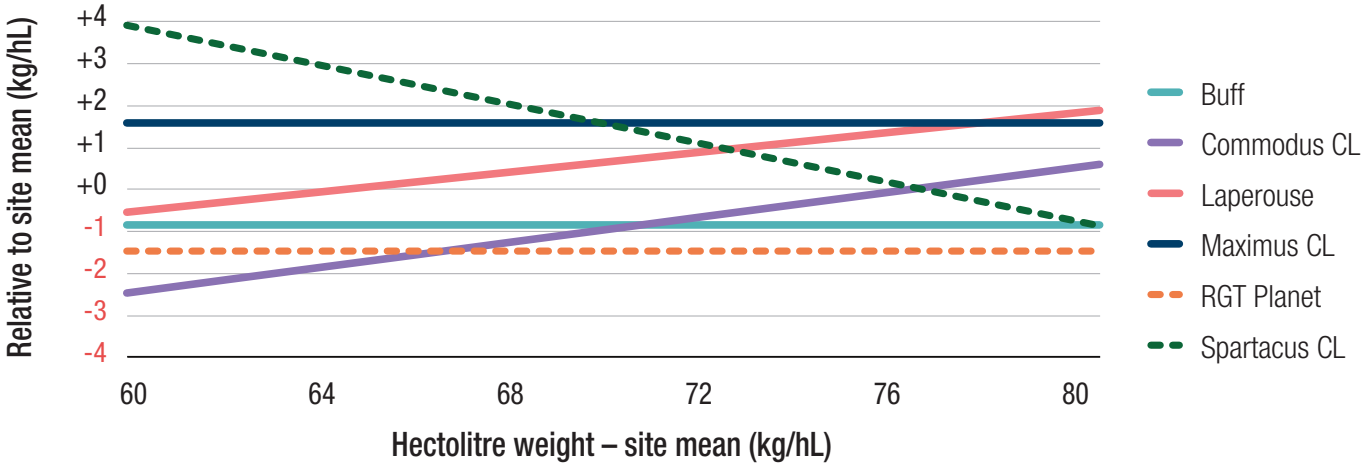

FIGURE 10. Fitted hectolitre weight of Buff, Commodus CL, Laperouse, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2020–2021). Each variety sown in all 50 trial-years of data, NVT Online **nvtonline.com.au**

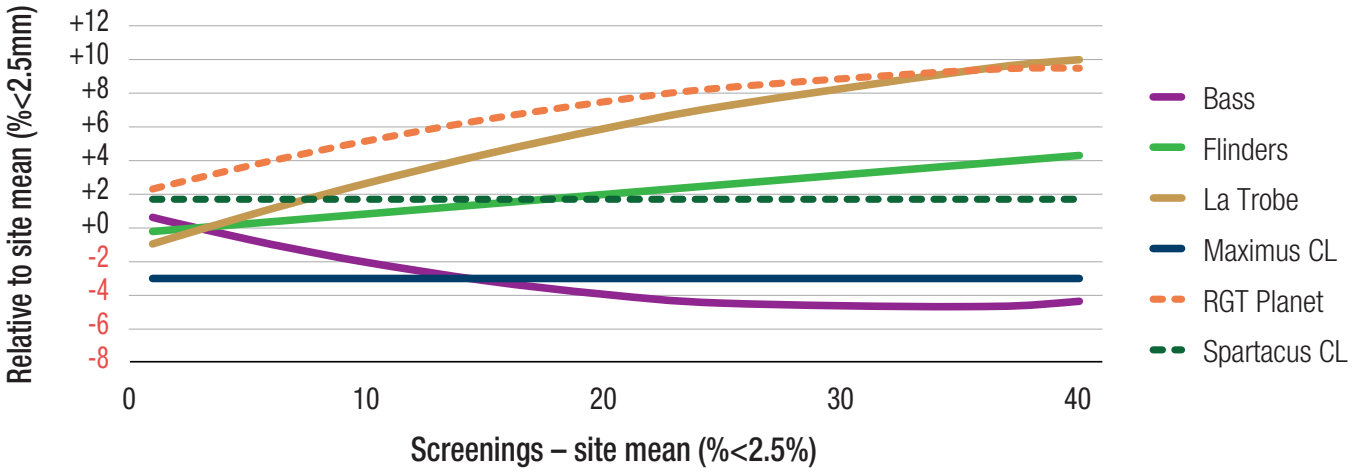

FIGURE 11. Fitted grain plumpness of Bass, Flinders, La Trobe, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2018–2021). Each variety sown in all 72 trial-years of data, NVT Online **nvtonline.com.au**

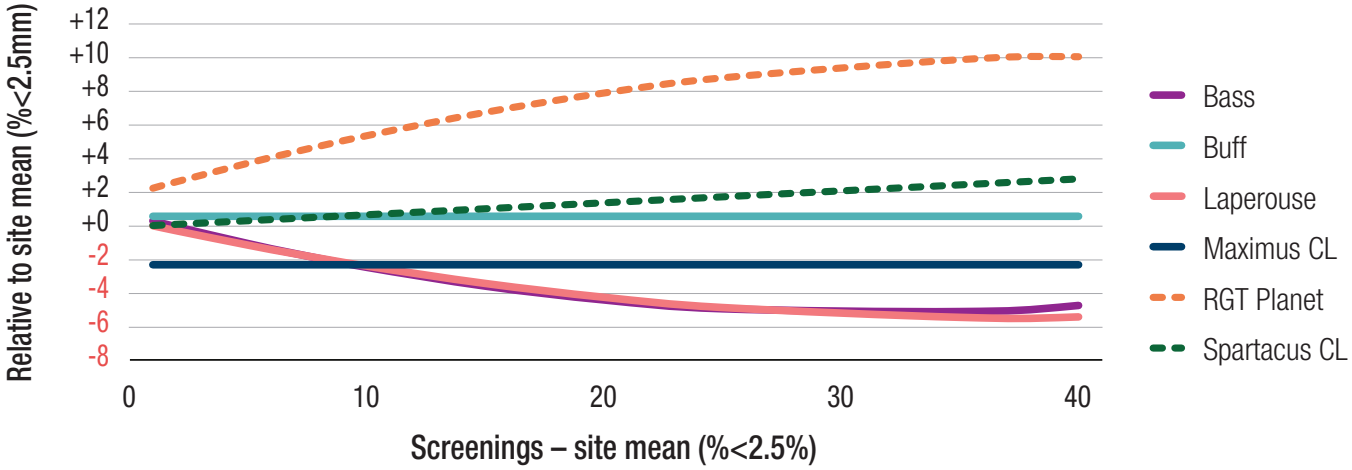

FIGURE 12. Fitted grain plumpness of Bass, Buff, Laperouse, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2018–2021). Each variety sown in all 89 trial-years of data, NVT Online **nvtonline.com.au**

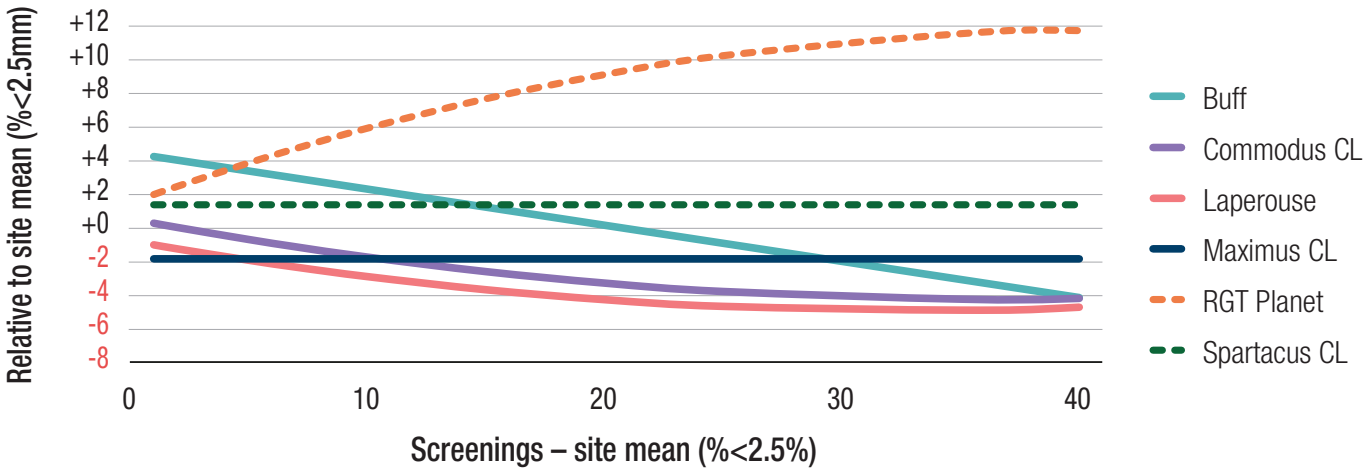

FIGURE 13. Fitted grain plumpness of Buff, Commodus CL, Laperouse, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yield and grain quality (2020–2021). Each variety sown in all 50 trial-years of data, NVT Online **nvtonline.com.au**

Disease and pest resistance

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

Foliar disease abbreviations:

- NFNB = net-form net blotch (previously labelled as net-type net blotch).
- SFNB = spot-form net blotch (previously labelled as spot-type net blotch).
- PM = powdery mildew.
- RLS = ramularia leaf spot.
- BLR = barley leaf rust.
- APR = adult plant resistance.

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.

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

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 if there is 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). Still, 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 2023 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 south coast. NFNB surveys in 2020 and 2021 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. While not included in the sowing guide, Banks and Granger have the best overall resistance to this new Oxford pathotype, being rated as MRMS as seedlings and MS as adult plants. Bottler, Buff and Minotaur (MS as seedling and adult) have the best resistance of the varieties included in this sowing guide. Beast, Combat and Titan AX have some

tolerance as an adult (MSS) but less as a seedling (SVS for Beast and S*p* for Combat and Titan AX).

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 the Albany and Esperance port zones of WA, following detection in northern NSW and Queensland. Other potentially impacted varieties include Beast, Commodus CL, Compass, Leabrook and Spartacus CL. Close monitoring of these varieties is recommended in mildew favourable environments, particularly in the southern coastal regions of WA. Growers should report a suspected breakdown in varietal resistance for varieties rated as MRMS and above to PM.

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 scald, 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 need to be arranged before sampling and, therefore, before spraying.

Send scald, 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 **+61 (0)8 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 **+61 (0)2 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 SFNB expressing resistance to SDHI fungicides are present in WA. In situations where disease response to fungicide control in barley crops is of concern, samples can be sent to the Fran Lopez-Ruiz, CCDM, Curtin University, PO Box U1987, Perth, WA 6845. Contact the Fungicide Resistance Group via email 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 **+61 (0)8 9368 3982**.

SCALD

Scald 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. Scald is potentially very damaging in barley as infection can kill leaves prematurely and reduce seed weight. Increased plantings of varieties with a susceptible rating increase scald'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 with associated quality defects. Scald can survive between seasons on infested stubble and barley grass and is also carried through infected seeds.

Scald hot spots are starting to appear in WA. Varieties with the highest scald risk are Beast (S), Bottler (S), Combat (S*p*), Commodus CL (S), Laperouse (S), Leabrook (S), LG Alestar (S), Litmus (SVS), Minotaur (VS), Mundah (S), Rosalind (S) and Titan AX (S*p*). A concern for the future is that the widespread adoption of susceptible varieties could see the prevalence of scald 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 scald.

NET-FORM NET BLOTCH (NFNB)

NFNB (previously labelled as net-type net blotch, NTNB) 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 Albany Port Zone. In 2021, CCDM also found NFNB with reduced sensitivity to SDHI. 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).

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 isolate is prevalent throughout the state. In contrast, the Beecher virulent isolate is now relatively uncommon. Another pathotype, Oxford virulent, has become evident in recent seasons, particularly in the Albany and Esperance port zones. A survey from 2020 and 2021 indicated 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 variety to NFNB, susceptible to all three major NFNB pathotypes present in WA. In the presence of the Oxford virulent pathotype, Bottler, Buff and Minotaur (MS) have slighter better resistance as adult plants than other varieties (S or MSS). If the Oxford virulent pathotype moves further north and becomes the dominant pathotype, then fungicide and rotation become critical tools in reducing the annual risk of NFNB.

SPOT-FORM NET BLOTCH (SFNB)

SFNB (previously labelled as spot-type net blotch, STNB) 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 QoI (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, Leabrook, 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 seedling disease.

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 (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 can potentially show variable responses across WA, including Beast, Commodus CL, Compass, Leabrook and Spartacus CL.

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 on leaf sheaths in heavy infections. As the crop matures, pustules darken and produce black spores embedded in leaf tissue. BLR can reduce grain yield by more than 30% in severe infections.

Since the detection of new BLR pathotypes in WA with virulence for the major resistance gene *Rph3* (5457 P- in 2013, 5457 P+ in 2014 and 5656 P+ in 2016), most of the barley varieties grown in WA have become susceptible (except Rosalind) to BLR. Pathotype 5457 P- is now the dominant BLR pathotype across WA. The new pathotype 5656 P+ migrated from eastern Australia following detection in South Australia in 2011. Only varieties with genes different from *Rph3* or APR genes have some resistance. APR genes usually provide moderate levels of resistance.

Several varieties, including Bottler, Combat, Flinders, LG Alestar, RGT Planet and Zena CL, have MRMS ratings with a late expression of APR. 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. There may still be a need to protect those varieties with APR genes at early growth stages from the initial infection. Temperature and varietal background influence the effectiveness of the *Rph20* gene. 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. LG Alestar can also possess additional APR genes, but these are not yet characterised. Fungicide response might still occur in varieties with APR resistance under high disease pressure through maintenance of green leaf area. The APR resistance in Fathom only confers late-season protection, so this variety will remain vulnerable to rust infection before heading.

RAMULARIA LEAF SPOT (RLS)

Growers should be watchful 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 in 2020 and 2021 suggests the disease is not widespread.

Where established, RLS can commonly cause yield losses up to 25%. In extreme cases, up to 70% yield losses have been reported concurrently with a significant decrease in kernel size and quality. 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.

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.

There are no specific management recommendations for the disease in WA, although 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 have recently been 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

Crown rot (*Fusarium pseudograminearum*) is a fungal, soil-borne disease most common in cereal rotations. It affects 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 in colour, 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 crown rot, 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 crown rot. However, no fungicide options exist to control crown rot 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 crown rot are limited. Recent research in WA suggests that varietal differences in barley exist, but most barley varieties are susceptible and suffer yield loss to crown rot. Litmus has the lowest yield loss of the varieties tested in the presence of high crown rot.

BARLEY AND CEREAL YELLOW DWARF (BYD/CYD)

Both barley yellow dwarf (BYD) and cereal yellow dwarf (CYD) viruses occur in 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 need to 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 in 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*). WA paddocks are often infested with mixed species of

RLN and nematode populations, potentially limiting yield in more than 50% of infested paddocks. The RLN species *P. neglectus* and *P. quasitereoides* can cause barley yield losses of up to 18%.

The key to managing RLN is identifying paddocks with yield-limiting nematode numbers and incorporating resistant crops and varieties 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 this guide, *P. neglectus* and *P. quasitereoides* nematode resistance scores are from WA glasshouse and field trials. Varieties with fewer than five observations, or where there has been no field trial verification of the glasshouse rating, 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 wheatbelt. 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 of subsequent crops. 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	-	MR	S	SVS	MRMS	S	SVS
Flinders	-	MRMS	MSS	S	MS	R	MS
Maximus CL	-	MRMS	MRMS	S	MS	MR	S
RGT Planet	-	MRMS	MS	S	S	R	MSS
Spartacus CL	-	MRMS	MRMS	S	S	MS	S
Stage Two malt accreditation							
Buff	-	MS	MRMS	MS	MS	S	SVS
Commodus CL	-	MRMS	MRMS	S	MRMS	MR	S
Laperouse	-	MS	MS	S	MRMS	MR	MS
Deliverable as a feed variety							
Beast	-	MRMS	MRMS	SVS	MS	MRMS	S
Bottler	-	MR	MR	MS	MS	R	S
Combat	-	S*p*	MS*p*	S*p*	MR*p*	R*p*	S*p*
Compass	-	MRMS	MS	S	MRMS	MR	S
Cyclops	-	MR	MRMS	S	MSS	MR	S
Fathom	-	SVS	MS	S	MR	MRMS	MSS
La Trobe	-	MRMS	MRMS	S	S	MSS	MSS
Leabrook	-	MRMS	MSS	S	MS	RMR	S
LG Alestar	-	MR	MS	S	MS	RMR	MSS
Litmus	-	S	MSS	S	MSS	RMR	S
Minotaur	-	MRMS	MRMS	MS	S	SVS	S
Mundah	-	S	MSS	MSS	MSS	SVS	S
Rosalind	-	MR	MR	S	MSS	MSS	MRMS
Scope CL	-	MR	MR	S	MS	MR	S
Titan AX	-	MRMS*p*	MS*p*	S*p*	MRMS*p*	R*p*	S*p*
Zena CL	-	MR*p*	S*p*	S*p*	MSS*p*	MR*p*	S*p*

Source: Sanjiv Gupta and NVT Online, **nvtonline.com.au**

[1] Resistance rating: VS = very susceptible, SVS = susceptible - very susceptible, S = susceptible, MSS = moderately susceptible - susceptible, MS = moderately susceptible, MRMS = moderately resistant - moderately susceptible, MR = moderately resistant, RMR = resistant - moderately resistant, R = resistant, *p* = provisional rating, - = no data 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. While the Beecher avirulent (97NB1) pathotype is dominant in the state, the Beecher virulent (95NB100) can be present north of the Great Eastern Highway. In contrast, an Oxford pathotype is present in the southern regions. 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 Mundah) should be treated with a seed dressing active against powdery mildew to prevent early infection during the tillering phase. Rosalind, Spartacus CL and other resistant varieties may show a variable reaction to strains of PM present in the southern regions of WA.

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	SVS
Flinders	MSS	MRMS	MS	S	S	R	MRMS (late APR)
Maximus CL	MR	MS	MRMS	S	MSS	RMR	MSS
RGT Planet	MR	S	MS	S	S	R	MRMS (late APR)
Spartacus CL	MR	MS	MS	S	SVS	MRMS	MSS
Stage Two malt accreditation							
Buff	MS	MS	MRMS	MS	S	S	S
Commodus CL	S	MRMS	MRMS	S	MSS	MR	S
Laperouse	S	MRMS	MS	MSS	MSS	MR	MSS
Deliverable as a feed variety							
Beast	S	MRMS	MS	MSS	MSS	MR	MSS
Bottler	S	MRMS	MRMS	MS	S	R	MRMS (APR)
Combat	S*p*	MS*p*	MSS*p*	MSS*p*	MRMS*p*	R*p*	MRMS*p* (late APR)
Compass	MS	MRMS	MS	S	MSS	MR	S
Cyclops	MRMS	MRMS	MRMS	S	MSS	MR	S
Fathom	MR	S	MS	SVS	MRMS	MRMS	MRMS (late APR)
La Trobe	MR	MS	MS	MSS	S	MS	S
Leabrook	S	MRMS	MS	S	MSS	MR	MSS
LG Alestar	S	MRMS	MRMS	S	S	RMR	MRMS
Litmus	SVS	S	SVS	S	S	MR	S
Minotaur	VS	MRMS	MRMS	MS	S	MSS	S
Mundah	S	S	MSS	S	S	MSS	S
Rosalind	S	MS	MR	S	S	MS	MR
Scope CL	MS	MRMS	MRMS	S	S	MR	MSS
Titan AX	S*p*	MR*p*	MS*p*	MSS*p*	MSS*p*	R*p*	S*p*
Zena CL	R*p*	MS*p*	MS*p*	S*p*	S*p*	R*p*	MRMS*p* (late APR)

Source: Sanjiv Gupta and NVT Online, **nvtonline.com.au**

[1] Resistance rating: VS = very susceptible, SVS = susceptible - very susceptible, S = susceptible, MSS = moderately susceptible - susceptible, MS = moderately susceptible, MRMS = moderately resistant - moderately susceptible, MR = moderately resistant, RMR = resistant - moderately resistant, R = resistant, *p* = provisional rating, - = no data 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 adult resistance score reflects resistance after flag leaf emergence.

[4] Net-form net blotch: three pathotypes (95NB100, 97NB1 and Oxford) of NFNB are present in WA. While the Beecher avirulent (97NB1) pathotype is dominant in the state, the Beecher virulent (95NB100) can be present north of the Great Eastern Highway. In contrast, the Oxford pathotype is present in the southern regions. New NFNB pathotypes have been detected and their impact on varietal resistance is being surveyed.

[5] Powdery mildew: Rosalind, Spartacus CL and other resistant varieties may show a variable reaction to strains of PM present in the southern regions of WA.

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
Flinders	High	MS	MS*p*	MSS*p*	S
Maximus CL	-	MRMS	-	S*p*	R
RGT Planet	-	MRMS	MSS	MS*p*	R*p*
Spartacus CL	Moderate	MS	MSS	MSS*p*	R
Stage Two malt accreditation					
Buff	-	MRMS	-	MSS*p*	S*p*
Commodus CL	-	MRMS	-	MS*p*	R
Laperouse	-	MRMS	-	MSS*p*	S
Deliverable as a feed variety					
Beast	-	MS	-	MS*p*	MR
Bottler	-	MS*p*	-	-	-
Combat	-	MS*p*	-	-	R
Compass	High	MS	MSS	S	R
Cyclops	-	MSS*p*	-	-	S
Fathom	Moderate	MRMS	MS*p*	MSS	R
La Trobe	Moderate	MSS	MS	S	R
Leabrook	-	MS	-	MS	RMR
LG Alestar	-	MRMS	-	-	R*p*
Litmus	Low	S	-	MSS*p*	MS
Minotaur	-	MSS*p*	-	-	MSS
Mundah	Moderate	MS	-	MS*p*	S
Rosalind	Moderate	MRMS	-	MS*p*	R
Scope CL	High	MRMS	MSS	MS*p*	S
Titan AX	-	MRMS*p*	-	-	-
Zena CL	-	MS*p*	-	-	-

Source: crown rot – Daniel Huberli, viruses – Sanjiv Gupta, nematodes – Sarah Collins & Carla Wilkinson and NVT Online, **nvtonline.com.au**

[1] Crown rot yield loss: Low = <10% yield loss, Moderate = 10–20% yield loss, High = >20% yield loss, - = no data available. Nematode and virus resistance rating: VS = very susceptible, SVS = susceptible - very susceptible, S = susceptible, MSS = moderately susceptible - susceptible, MS = moderately susceptible, MRMS = moderately resistant - moderately susceptible, MR = moderately resistant, RMR = resistant - moderately resistant, R = resistant, *p* = provisional rating, - = no data 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. *Pratylenchus teres* has been renamed *Pratylenchus quasitereoides*. 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, Flinders, Maximus CL, RGT Planet and Spartacus CL) that can be delivered into malt segregations in WA at the 2023–2024 harvest (as per the GIWA Western Australian malt barley variety receival recommendations for the 2023–2024 harvest).
- three varieties undergoing Stage Two malt accreditation with the Barley Council of Grains Australia (Buff, Commodus CL and Laperouse).
- sixteen varieties that can only be delivered into bulk handling feed segregations (Beast, Bottler, Combat, Compass, Cyclops, Fathom, La Trobe, Leabrook, LG Alestar, Litmus, Minotaur, Mundah, Rosalind, Scope CL, Titan AX and Zena CL).

The comment section in each snapshot describes essential varietal characteristics, including their 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 Spartacus CL) rather than the site mean yield (as shown in Tables 4 to 10) for each year in the period 2017 to 2021. 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 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. 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.
- Target plant density in plants/m^2 when weeds are present. Data from DPIRD-GRDC agronomy trials.
- 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 agronomy trials.
- Straw strength is based on lodging scores taken at maturity and ranked relative to control varieties. Data from DPIRD-GRDC and DPIRD 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 agronomy trials.
- Grain protein deviation (relative to average) as calculated and ranked using NVT trials (2005–2021) 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. There is a typical relationship 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(Þ)

DELIVERABLE AS A MALT VARIETY

Comments

Bass (tested as WABAR2315) is a short height, medium spring, malt barley acceptable for export as grain, preferred for export as malt but not for shochu. Bass has strong market demand from domestic maltsters and international brewing customers, often resulting in a price premium. Best suited to environments with a yield potential above 3t/ha. Across 105 WA barley NVT (2017–2021), Bass yielded less than RGT Planet in 69% of trials, the same in 26% and higher in 5%. Along with Flinders and Maximus CL, Bass has a better physical grain quality package than RGT Planet and Spartacus CL (resulting in a higher strike rate into MALT1 segregations), with a good hectolitre weight, high grain plumpness and a higher grain protein potential. It can show a moderate head loss risk in the Esperance port zone but not in other port zones. 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 is continuing to decline despite solid market demand, and it accounted for just under 1% of the state's barley acreage in 2021 and is almost exclusively planted in the Kwinana Port Zone. Target production zones in 2023 are Kwinana-North (Midlands) and Kwinana-South. Limited segregation opportunities will be offered due to limited production.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	90	90	76	93	83
Agzone 2	94	91	89	88	90
Agzone 3	92	95	88	89	95
Agzone 4	74	95	86	88	87
Agzone 5	92	87	76	81	89
Agzone 6	100	94	89	89	94
Statewide	92	92	87	88	91

Disease resistance	Seedling	Adult
Scald	-	MRMS
NFNB (Beecher virulent)	MR	MS
NFNB (Beecher avirulent)	S	MSS
NFNB (Oxford virulent)	SVS	S
SFNB	MRMS	S
Powdery mildew	S	MSS
Leaf rust (5457P-)	SVS	SVS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	MSS	MSS
CCN	S	S
Crown rot	High yield loss (>20%)	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+5	+2	+1	+2
Cunderdin	+8	+4	+4	+5
Katanning	+11	+7	+7	+7
Grass Patch	+8	+5	+4	+5

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

FLINDERS(Þ)

DELIVERABLE AS A MALT VARIETY

Comments

Flinders (tested as WABAR2537) is a short height, medium spring, malt barley acceptable for export as grain and preferred for export as malt but not for shochu. Well suited to customers wanting gibberellic acid-free malt and is useful as a post-malt blending variety to manage malt specifications to end-user requirements. Best suited to environments with a yield potential above 3t/ha and environments where short, stiff straw and good head retention are essential. Across 88 WA barley NVT (2017–2021), Flinders yielded less than RGT Planet in 66% of trials, the same in 28% and higher in 6%. Has good physical grain characteristics, being an improvement over RGT Planet and Spartacus CL with malt receival similar to Bass. 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 1.5% of the state's barley acreage in 2021 with production predominantly in the Albany and Esperance Port Zones. Target production zones in 2023 are Albany-South. Niche segregation opportunities will be subject to end-user demand.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	90	89	72	96	-
Agzone 2	97	91	87	90	-
Agzone 3	98	98	92	94	97
Agzone 4	72	97	81	85	-
Agzone 5	97	93	78	80	-
Agzone 6	123	102	98	97	98
Statewide	97	95	90	90	94

Disease resistance	Seedling	Adult
Scald	-	MSS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	S	S
SFNB	MSS	S
Powdery mildew	R	R
Leaf rust (5457P-)	MS	MRMS (late APR)
BYD and CYD	MS	MS
RLN (*P. neglectus*)	MS*p*	MS*p*
RLN (*P. quasitereoides*)	MSS*p*	MSS*p*
CCN	S	S
Crown rot	High yield loss (>20%)	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+10	+8	+8	+9
Cunderdin	+9	+7	+7	+9
Katanning	+12	+9	+9	+11
Grass Patch	+10	+8	+8	+9

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

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

p = provisional assessment

MAXIMUS CL(ↁ)

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 under assessment for export as malt and for the manufacture of shochu in Japan. Maximus CL has a short coleoptile and should not be sown deep. Across 90 WA barley NVT (2018–2021), Maximus CL yielded less than RGT Planet in 24% of trials, the same in 17% and higher in 59%, performing better in environments that yield less than 4t/ha. It was competitive above 4t/ha. The WA NVT MET (2017–2021) suggests that Maximus CL has a yield advantage of 5% over Spartacus CL. Maximus CL grain is plumper than Spartacus CL grain with a similar hectolitre weight resulting in a higher probability of receival as MALT1. Maximus CL is a general improvement over Spartacus CL for NFNB (Beecher avirulent) as an adult, SFNB and PM (even in the presence of *MlLa* virulence). Fungicides may be required to manage NFNB (Oxford virulent) and BLR. Maximus CL appears to have a low risk of head loss. Maximus CL was sown on just under 4% of the barley acreage in 2021 with a significant uptake in the Kwinana Port Zone. Target production zones in 2023 are Geraldton, Kwinana, Albany, and Esperance Port Zones. There will likely be more segregation opportunities in Kwinana-North (Midlands), Kwinana-South, Albany-North, and Esperance than in Geraldton and Albany-South.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	104	109	102	107
Agzone 2	-	103	104	105	106
Agzone 3	-	103	104	105	103
Agzone 4	-	104	106	102	105
Agzone 5	-	105	106	106	104
Agzone 6	-	104	107	107	102
Statewide	-	104	105	105	105

Disease resistance	Seedling	Adult
Scald	-	MR
NFNB (Beecher virulent)	MRMS	MS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	S
SFNB	MS	MSS
Powdery mildew	MR	RMR
Leaf rust (5457P-)	S	MSS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	S*p*	S*p*
CCN	R	R
Crown rot	–	

'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

p = provisional assessment

RGT PLANET(ↁ)

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 3t/ha, and more specifically, paddocks with a year-in-year-out potential above 5t/ha. It is suited to mixed farms practising grain and graze due to its early vigour. Across 105 WA barley NVT (2017–2021), RGT Planet yielded less than Rosalind in 61% of trials, the same in 22% and higher in 17%. The physical grain quality package of RGT Planet is inferior to Bass, Flinders, Maximus CL, and Spartacus CL often resulting in a lower frequency of delivery as MALT1. Excellent resistance in WA to scald and PM (due to *mlo* gene). Fungicides may be required to manage NFNB (Beecher virulent and Oxford virulent), SFNB and BLR (under high pressure). It appears to have a similar level of weed competitiveness (tested against oats) to Compass and Fathom. RGT Planet was the second most popular barley variety in 2021, accounting for just under 16% of the state's barley acreage, a decline from 2020. Target production zones in 2023 are Kwinana-North (Midlands), Kwinana-South, Albany, and Esperance Port Zones.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	94	100	79	108	87
Agzone 2	102	100	91	95	104
Agzone 3	115	104	101	99	113
Agzone 4	68	106	85	88	91
Agzone 5	107	103	79	80	102
Agzone 6	143	117	108	108	115
Statewide	106	104	96	95	104

Disease resistance	Seedling	Adult
Scald	-	MR
NFNB (Beecher virulent)	MRMS	S
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	S	S
SFNB	S	S
Powdery mildew	R	R
Leaf rust (5457P-)	MS	MRMS (late APR)
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	R*p*	R*p*
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	+5	+4	+5	+7
Katanning	+7	+5	+6	+8
Grass Patch	+5	+4	+5	+8

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	Seed Force
EPR ($/t, excl. GST)	$4.00

p = provisional assessment

SPARTACUS CL(ᵖ)

DELIVERABLE AS A MALT VARIETY

Comments

Spartacus CL (tested as IGB1334T) is an IMI tolerant, medium height, early spring, malt barley acceptable for export as grain and malt, and now for shochu. Across 105 WA barley NVT (2017–2021), Spartacus CL yielded less than RGT Planet in 33% of trials, the same in 14% and higher in 48%. Spartacus CL has a yield advantage over RGT Planet in the environments that yield less than 3t/ha. Spartacus CL has a short coleoptile. 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). Spartacus CL was the most popular barley variety in 2021, accounting for just under 52% of the state's barley acreage. Maximus CL will quickly replace Spartacus CL over coming seasons as growers recognise the agronomic advantages of Maximus CL and the market becomes familiar with the malting and brewing advantages of Maximus CL. Target production zones in 2023 are Geraldton, Kwinana, Albany, and Esperance Port Zones.

Yield (% RGT Planet)	2017	2018	2019	2020	2021
Agzone 1	106	100	127	93	115
Agzone 2	98	100	109	105	96
Agzone 3	87	96	99	101	89
Agzone 4	147	94	117	114	110
Agzone 5	93	97	127	125	98
Agzone 6	70	86	93	93	87
Statewide	94	96	104	105	96

Disease resistance	Seedling	Adult
Scald	-	MR
NFNB (Beecher virulent)	MRMS	MS
NFNB (Beecher avirulent)	MRMS	MS
NFNB (Oxford virulent)	S	S
SFNB	S	SVS
Powdery mildew	MS	MRMS
Leaf rust (5457P-)	S	MSS
BYD and CYD	MS	MS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	MSS*p*	MSS*p*
CCN	R	R
Crown rot	Moderate yield loss (10-20%)	

'FlowerPower' predicted flowering date (days to Z49)	Relative to RGT Planet			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	-5	-4	-5	-7
Katanning	-7	-5	-6	-8
Grass Patch	-5	-4	-5	-8

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

p = provisional assessment

BUFF(ᵖ)

STAGE TWO MALT ACCREDITATION

Comments

Buff (tested as IGB1506) is a medium height, medium spring barley under evaluation by Barley Australia that supersedes Litmus. Buff has similar Al tolerance genetics to Litmus, but unlike Litmus, it has a white aleurone. Unlike Litmus, Buff is also a competitor to feed and malt varieties on non-acidic soils, except where IMI chemistry is used. Across 57 WA barley NVT trials (2017, 2019–2021), Buff has yielded less than Litmus in 8%, the same in 25% and higher in 67%. The grain quality package of Buff is okay, but not great, having a lower hectolitre weight, with a similar screenings risk as Spartacus CL. Buff's overall disease resistance profile is similar to Litmus, with improvements in tolerance to scald and NFNB. Fungicides may be required to manage SFNB, PM and BLR. Its weed competitiveness has not been tested. Straw strength is an improvement over Litmus. Preliminary evidence suggests that Buff may be at a medium risk of head loss and has a short coleoptile. Buff has passed Stage One of the Barley Council of Grains Australia's accreditation process. Currently undergoing evaluation in Stage Two, with the earliest accreditation date being March 2023. Buff was the seventh most popular barley variety in 2021, accounting for 3.5% of the state's barley acreage, predominantly in the Geraldton and Kwinana Port Zone.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	117	115	127	100	102
Agzone 2	109	106	105	99	105
Agzone 3	-	104	98	98	109
Agzone 4	76	127	147	96	94
Agzone 5	100	102	88	89	102
Agzone 6	-	111	105	96	104
Statewide	105	109	101	96	104

Disease resistance	Seedling	Adult
Scald	-	MS
NFNB (Beecher virulent)	MS	MS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	MS	MS
SFNB	MS	S
Powdery mildew	S	S
Leaf rust (5457P-)	SVS	S
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MSS*p*	MSS*p*
CCN	S*p*	S*p*
Crown rot	–	

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

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

p = provisional assessment

COMMODUS CL

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 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. Lodging risk is similar to Compass. Commodus CL possesses the same tolerance to IMI herbicides as Spartacus CL but with greater early vigour. It has only been in public trials since 2020. Across 50 WA barley NVT (2020–2021), Commodus CL yielded less than Spartacus CL in 28% of trials, the same in 48% and higher in 24%. Relative to Compass in those same trials, Commodus CL yielded less than Compass in 42% of trials, the same in 58% and higher in 0%. Commodus CL appears to have useful resistance to NFNB (Beecher virulent and avirulent), SFNB and PM but may need management for scald, NFNB (Oxford avirulent) and BLR. Commodus CL is in Stage Two of the Barley Council of Grains Australia's accreditation but has been released as a feed barley while under evaluation for its malting and brewing end-use. The earliest accreditation date is March 2023.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	102	92
Agzone 2	-	-	-	97	98
Agzone 3	-	-	-	97	105
Agzone 4	-	-	-	98	97
Agzone 5	-	-	-	98	103
Agzone 6	-	-	-	99	103
Statewide	-	-	-	98	101

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	S
SFNB	MRMS	MSS
Powdery mildew	MR	MR
Leaf rust (5457P-)	S	S
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	R	R
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	+5	+1	+0	+3
Katanning	+7	+2	+2	+4
Grass Patch	+5	+0	+0	+3

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

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

p = provisional assessment

LAPEROUSE

STAGE TWO MALT ACCREDITATION

Comments

Laperouse (tested as WI4952) is a medium height, medium spring barley under evaluation by the Barley Council of Grains Australia for its malting and brewing potential. Performs well in a range of environments, better than RGT Planet when the site yield is below 4.5t/ha. Across 102 WA barley NVT (2016–2020), Laperouse yielded less than RGT Planet in 16% of trials, the same in 24% and higher in 60%. 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. Fungicides may be required to manage scald, NFNB (Oxford virulent) and BLR. At higher yielding sites, while RGT Planet may have a yield advantage, Laperouse is a lower cost (fungicide) option to grow than RGT Planet given its enhanced tolerance to NFNB (Beecher virulent and Oxford virulent) and SFNB. Its weed competitiveness has not been evaluated. It appears to have good straw strength and a low head loss risk. The accreditation of Laperouse has been delayed again, this time due to flooding in eastern Australia affecting parcels of grain destined for malting and brewing trials. Laperouse is currently in Stage Two of the Barley Council of Grains Australia's accreditation process, with the earliest accreditation date now being March 2024.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	107	106	105	100
Agzone 2	105	105	101	102	107
Agzone 3	109	105	103	104	113
Agzone 4	-	105	101	95	103
Agzone 5	108	105	92	102	108
Agzone 6	108	108	108	110	108
Statewide	106	106	102	103	107

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	MS	MRMS
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	S	MSS
SFNB	MRMS	MSS
Powdery mildew	MR	MR
Leaf rust (5457P-)	MS	MSS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MSS*p*	MSS*p*
CCN	S	S
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+4	+0	-1	-1
Cunderdin	+8	+5	+4	+4
Katanning	+12	+8	+7	+7
Grass Patch	+9	+5	+4	+5

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	SECOBRA Recherches / Seednet
Access to seed	Seednet Partners
EPR ($/t, excl. GST)	$3.80

p = provisional assessment

BEAST(b)

DELIVERABLE AS A FEED VARIETY

Comments

Beast (tested as AGTB0113) is a tall height, early spring barley. 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 71 WA barley NVT (2019–2021), Beast yielded less than Rosalind in 24% of trials, the same in 44% and higher in 32%. The primary advantage over Rosalind will be the sub-2t/ha environments where taller straw at harvest and a longer coleoptile at seeding are beneficial. Beast appears to have useful resistance to NFNB (except Oxford virulent as a seedling), SFNB and PM but may need management for scald and BLR. Beast is rated MR for CCN. Beast grain has good grain plumpness (better than Spartacus CL), but a lower hectolitre weight than Spartacus CL. Lodging risk is similar to Compass. Beast has been released as a feed variety pending an outcome of malting and brewing evaluation trials. Beast has passed Stage One. Stage Two accreditation has been delayed due to insufficient grain in specification available for malting in 2022. The earliest accreditation date is March 2024.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	-	114	106	102
Agzone 2	-	-	108	106	104
Agzone 3	-	-	105	104	112
Agzone 4	-	-	103	105	106
Agzone 5	-	-	103	112	112
Agzone 6	-	-	104	108	108
Statewide	-	-	106	107	108

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MRMS	MS
NFNB (Oxford virulent)	SVS	MSS
SFNB	MS	MSS
Powdery mildew	MRMS	MR
Leaf rust (5457P-)	S	MSS
BYD and CYD	MS	MS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	MR	MR
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	+4	+0	-1	+0
Katanning	+7	+3	+2	+2
Grass Patch	+4	+0	-1	+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	AGT
Access to seed	Free to trade
EPR ($/t, excl. GST)	$4.00

p = provisional assessment

BOTTLER(b)

DELIVERABLE AS A FEED VARIETY

Comments

Bottler (tested as HV16) is a medium height, medium spring barley bred in Europe. Across 68 WA barley NVT (2017–2021), Bottler yielded less than Spartacus CL in 57% of trials, the same in 24% and higher in 19%. Relative to RGT Planet, Bottler yielded less in 57% of trials, the same in 37% and higher in 6%. Bottler has useful resistance to NFNB (all three pathotypes), and PM, but may need management for scald, SFNB, and BLR (despite having APR). Bottler was accredited as a malt variety in March 2022. It is a high fermentability variety suited to brewing markets using high levels of starch adjuncts. Bottler is only deliverable into feed stacks in WA. It is possible that Bottler could be grown under contract in coming seasons to supply a domestic processor for export as malt. Bottler has not been grown in variety trials in the regions serviced by the domestic market since 2019, so there is limited data available on its comparative performance in the Kwinana Port Zone in recent years.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	94	80	-	-
Agzone 2	100	95	90	-	-
Agzone 3	105	100	96	-	-
Agzone 4	-	105	93	89	-
Agzone 5	-	97	82	78	93
Agzone 6	132	108	102	99	104
Statewide	101	99	93	92	97

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	MR	MRMS
NFNB (Beecher avirulent)	MR	MRMS
NFNB (Oxford virulent)	MS	MS
SFNB	MS	S
Powdery mildew	R	R
Leaf rust (5457P-)	S	MRMS (APR)
BYD and CYD	MS	MS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	-	-
Crown rot	–	

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

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

Variety information	
Breeder / Seed licensee	Sejet Planteforaedling / Seednet
Access to seed	Seednet Partners
EPR ($/t, excl. GST)	$4.00

COMBAT(Þ)

DELIVERABLE AS A FEED VARIETY

Comments

Combat (IGB1944) is a medium height, medium spring, feed variety. According to the breeder (InterGrain) it has a semi-prostrate growth habit that is expected to provide a more weed competitive behaviour than Rosalind that is moderately susceptible to lodging and head loss. Combat has only been in public trials since 2021. Growers should be cautious in their expectations, due to the lack of public field trial data. Across 23 WA barley NVT (2021), yielded lower than Rosalind in 0%, the same in 43% and higher in 57% of trials. Combat appeared to have a yield advantage over other varieties when the site yielded more than 4t/ha. While provisionally rated, Combat appears to have useful resistance to NFNB and BLR (APR) and excellent resistance to SFNB and PM, but may need management for scald. Combat is rated R for CCN. Combat is not being submitted for malting and brewing evaluation, and has been released as a feed-only variety.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	109
Agzone 2	-	-	-	-	111
Agzone 3	-	-	-	-	116
Agzone 4	-	-	-	-	104
Agzone 5	-	-	-	-	111
Agzone 6	-	-	-	-	111
Statewide	-	-	-	-	111

Disease resistance	Seedling	Adult
Scald	-	S*p*
NFNB (Beecher virulent)	S*p*	MS*p*
NFNB (Beecher avirulent)	MS*p*	MSS*p*
NFNB (Oxford virulent)	S*p*	MSS*p*
SFNB	MR*p*	MRMS*p*
Powdery mildew	R*p*	R*p*
Leaf rust (5457P-)	S*p*	MRMS*p* (late APR)
BYD and CYD	MS*p*	MS*p*
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	R	R
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus 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

p = provisional assessment

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 106 WA barley NVT (2017–2021), Compass yielded less than Rosalind in 57% of trials, the same in 31% and higher in 12%. Compass is susceptible to lodging, particularly in high yielding situations. It has good tolerance to NFNB (Beecher virulent and avirulent) and PM (except in presence of MILa virulence). Fungicides may be required to control NFNB (Oxford virulent) and BLR. While it was accredited as a malt variety by Barley Australia in March 2018, no malt segregations are available in WA. Therefore, Compass is received as a feed variety in WA. Compass was the eleventh most popular barley variety in 2021 but only accounted for just under 1% of the state's barley acreage. Compass is superseded by new varieties including Beast, Combat, Commodus CL, Cyclops, Laperouse, and Titan AX - depending on the farming system.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	103	110	113	103	94
Agzone 2	101	107	106	100	99
Agzone 3	102	102	99	98	109
Agzone 4	92	103	110	103	99
Agzone 5	102	99	93	104	108
Agzone 6	80	99	97	99	105
Statewide	100	104	100	101	104

Disease resistance	Seedling	Adult
Scald	-	MS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	S	S
SFNB	MRMS	MSS
Powdery mildew	MR	MR
Leaf rust (5457P-)	S	S
BYD and CYD	MS	MS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	S	S
CCN	R	R
Crown rot	High yield loss (>20%)	

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

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

CYCLOPS

DELIVERABLE AS A FEED VARIETY

Comments

Cyclops (tested as AGTB0200) is a medium height, early spring barley. It has agronomic attributes (i.e. lodging and head loss risk) in line with varieties with similar dwarfing genetics (i.e. La Trobe and Spartacus CL). While Cyclops has a short coleoptile like Spartacus CL and Maximus CL, it is not tolerant of IMI herbicides. It has only been in public field trials since 2020. Growers should be cautious in their expectations, due to the lack of public field trial data. Across 50 WA barley NVT (2020-2021), Cyclops yielded less than Rosalind in 18% of trials, the same in 42% and higher in 40%. It looks to be a higher-yielding option in environments that yield more than 3t/ha. Cyclops appears to have excellent resistance to scald, NFNB (Beecher virulent and avirulent) and PM, some tolerance to SFNB but may need NFNB (Oxford avirulent) and BLR management. Grain plumpness is similar to Spartacus CL with a lower hectolitre weight. Cyclops has been released as a feed variety pending an outcome of malting and brewing evaluation trials. Cyclops has passed Stage One. Stage Two accreditation has been delayed due to insufficient grain in specification available for malting in 2022. The earliest accreditation date is March 2024.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	106	104
Agzone 2	-	-	-	105	110
Agzone 3	-	-	-	107	116
Agzone 4	-	-	-	97	106
Agzone 5	-	-	-	106	112
Agzone 6	-	-	-	113	110
Statewide	-	-	-	106	111

Disease resistance	Seedling	Adult
Scald	-	MRMS
NFNB (Beecher virulent)	MR	MRMS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	S
SFNB	MSS	MSS
Powdery mildew	MR	MR
Leaf rust (5457P-)	S	S
BYD and CYD	MS*p*	MS*p*
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	S	S
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus 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

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

p = provisional assessment

FATHOM

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 105 WA barley NVT (2017–2021), Fathom yielded less than Rosalind in 71% of trials, the same in 23% and higher in 6%. It has excellent tolerance to scald and SFNB, useful 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 tenth most popular barley variety in 2021, accounting for just under 1% of the state's barley acreage. Fathom is superseded by Combat.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	107	109	115	99	96
Agzone 2	103	104	104	98	99
Agzone 3	101	101	96	96	105
Agzone 4	84	110	123	98	96
Agzone 5	98	97	90	96	102
Agzone 6	85	100	97	94	101
Statewide	100	104	98	97	101

Disease resistance	Seedling	Adult
Scald	-	MR
NFNB (Beecher virulent)	SVS	S
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	S	SVS
SFNB	MR	MRMS
Powdery mildew	MRMS	MRMS
Leaf rust (5457P-)	MSS	MRMS (late APR)
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MS*p*	MS*p*
RLN (*P. quasitereoides*)	MSS	MSS
CCN	R	R
Crown rot	Moderate yield loss (10-20%)	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+17	+9	+6	+6
Cunderdin	+14	+7	+4	+4
Katanning	+15	+7	+4	+4
Grass Patch	+15	+7	+4	+5

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

p = provisional assessment

LA TROBE(ϕ)

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 106 WA barley NVT (2017–2021), La Trobe yielded less than Rosalind in 80% of trials, the same in 20% and higher in 0%. Has useful 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 fourth most popular barley variety in 2021, accounting for 5% of the state's barley acreage. La Trobe is superseded by Maximus CL where malt is a target and by Beast, Combat, Cyclops, Laperouse, and Titan AX when growing barley for a feed outcome.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	101	103	103	102	98
Agzone 2	101	102	102	100	100
Agzone 3	102	101	100	99	103
Agzone 4	95	102	103	100	98
Agzone 5	101	100	97	99	102
Agzone 6	99	101	100	100	103
Statewide	101	102	100	100	101

Disease resistance	Seedling	Adult
Scald	-	MR
NFNB (Beecher virulent)	MRMS	MS
NFNB (Beecher avirulent)	MRMS	MS
NFNB (Oxford virulent)	S	MSS
SFNB	S	S
Powdery mildew	MSS	MS
Leaf rust (5457P-)	MSS	S
BYD and CYD	MSS	MSS
RLN (*P. neglectus*)	MS	MS
RLN (*P. quasitereoides*)	S	S
CCN	R	R
Crown rot	Moderate yield loss (10-20%)	

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

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

LEABROOK(ϕ)

DELIVERABLE AS A FEED VARIETY

Comments

Leabrook (tested as WI4896) is a tall height, early spring barley. Leabrook is a sister line to Compass with a yield advantage of 2% in the statewide MET. Its yield advantage over Compass is expressed in environments that yield more than 3t/ha. It possesses many of the same agronomic characteristics (i.e. weed competitive) and risks (i.e. lodging and head loss) as Compass. Across 106 WA barley NVT (2017–2021), Leabrook yielded less than Rosalind in 47% of trials, the same in 31% and higher in 22%. It has useful tolerance to NFNB (Beecher virulent and avirulent) and PM. Fungicides may be required to control scald, NFNB (Oxford virulent) and BLR. While it was accredited as a malt variety by Barley Australia in March 2021, no malt segregations are available in WA. Therefore, Leabrook is received as a feed variety in WA. Leabrook is superseded by new varieties including Beast, Combat, Commodus CL, Cyclops, Laperouse, and Titan AX - depending on the farming system.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	103	111	108	107	94
Agzone 2	104	108	104	101	104
Agzone 3	109	105	102	101	116
Agzone 4	84	104	103	98	100
Agzone 5	107	103	89	102	111
Agzone 6	99	106	104	106	110
Statewide	104	107	101	102	107

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MSS	MS
NFNB (Oxford virulent)	S	S
SFNB	MS	MSS
Powdery mildew	RMR	MR
Leaf rust (5457P-)	S	MSS
BYD and CYD	MS	MS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS	MS
CCN	RMR	RMR
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	+2	+0	+0	+3
Katanning	+5	+2	+3	+6
Grass Patch	+2	+0	+0	+4

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Short
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

p = provisional assessment

LG ALESTAR(þ)

DELIVERABLE AS A FEED VARIETY

Comments

LG Alestar (tested as SMBA11-2341) is a medium height, medium spring barley. Best suited to environments above 3t/ha where both PM and BLR are a problem. Across 71 WA barley NVT (2019–2021), LG Alestar yielded less than Rosalind in 99% of trials, the same in 1% and higher in 0%. LG Alestar has many agronomic attributes similar to Granger. LG Alestar has durable resistance to PM (based on the *mlo* gene) and resistance to BLR (seedling and adult). Fungicides may be required to manage scald, NFNB (Oxford virulent) and SFNB. Its weed competitiveness has not been tested. It appears to have good straw strength, but there is not have enough data to assess its head loss risk. While it was accredited as a malt variety by Barley Australia in March 2021, no malt segregations are available in WA. Therefore, LG Alestar is received as a feed variety in the WA bulk handling system. Elders has, however, commenced commercialisation of LG Alestar following domestic interest. LG Alestar is to be grown under contract in coming seasons to supply a domestic processor for export as malt or supply to craft brewers.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	-	69	97	82
Agzone 2	-	-	86	87	94
Agzone 3	-	-	90	90	99
Agzone 4	-	-	83	83	84
Agzone 5	-	-	71	71	89
Agzone 6	-	-	95	93	100
Statewide	-	-	87	87	92

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	MR	MRMS
NFNB (Beecher avirulent)	MS	MRMS
NFNB (Oxford virulent)	S	S
SFNB	MS	S
Powdery mildew	RMR	RMR
Leaf rust (5457P-)	MSS	MRMS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	R*p*	R*p*
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-	-	-	-
Cunderdin	+12	+7	+7	+10
Katanning	+14	+9	+9	+11
Grass Patch	+12	+7	+7	+10

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

Variety information	
Breeder / Seed licensee	Limagrain / Elders
Access to seed	Elders
EPR ($/t, excl. GST)	$3.80

p = provisional assessment

LITMUS(þ)

DELIVERABLE AS A FEED VARIETY

Comments

Litmus (tested as WABAR2625) is a tall height, early spring, feed barley with improved tolerance to low soil pH and high soil Al that Buff supersedes. Best suited to environments where the soil at 10–30cm has a pH_{Ca} below 4.8. Across 57 WA barley NVT (2017, 2019–2021), Litmus yielded less than Buff in 67% of trials, the same in 25% and higher in 9%. Litmus has fair straw strength, 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 occurring. Litmus was the ninth most popular barley variety in 2021, accounting for under 1.5% 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 (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	109	-	104	100	87
Agzone 2	98	-	102	90	90
Agzone 3	102	-	-	85	98
Agzone 4	78	-	148	103	77
Agzone 5	86	-	-	-	-
Agzone 6	103	-	-	-	-
Statewide	96	-	94	85	91

Disease resistance	Seedling	Adult
Scald	-	SVS
NFNB (Beecher virulent)	S	S
NFNB (Beecher avirulent)	MSS	SVS
NFNB (Oxford virulent)	S	S
SFNB	MSS	S
Powdery mildew	RMR	MR
Leaf rust (5457P-)	S	S
BYD and CYD	S	S
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MSS*p*	MSS*p*
CCN	MS	MS
Crown rot	Low yield loss (<10%)	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-9	-6	-4	-3
Cunderdin	-9	-6	-4	-2
Katanning	-7	-5	-2	-1
Grass Patch	-9	-6	-3	-2

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

p = provisional assessment

MINOTAUR(ϕ)

DELIVERABLE AS A FEED VARIETY

Comments

Minotaur (tested as AGTB0213) is a medium height, medium spring barley. According to the breeder, Minotaur is adapted to a broader range of environments than RGT Planet. It has been in public trials since 2020. Growers should be cautious in their expectations, due to the lack of public field trial data. Across 50 WA barley NVT (2020-2021), Minotaur yielded less than Rosalind in 46% of trials, the same in 44% and higher in 10%. As an alternative to RGT Planet, it yielded less in 12% of trials, the same in 42% and higher in 46% of trials, with a yield advantage below 4t/ha. Hectolitre weight and grain plumpness is an improvement over RGT Planet but not as good as Bass, Maximus CL or Spartacus CL. Minotaur has useful resistance to NFNB (Beecher virulent and avirulent, and Oxford virulent), but may need management for SFNB, PM and BLR, and is very sensitive to scald. Minotaur has been released as a feed variety pending an outcome of malting and brewing evaluation trials. Passed Stage One assessment for malt accreditation in 2022, with Stage Two scheduled for 2023. The earliest accreditation date is March 2024.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	108	98
Agzone 2	-	-	-	101	107
Agzone 3	-	-	-	104	108
Agzone 4	-	-	-	95	98
Agzone 5	-	-	-	91	103
Agzone 6	-	-	-	112	113
Statewide	-	-	-	102	105

Disease resistance	Seedling	Adult
Scald	-	VS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	MS	MS
SFNB	S	S
Powdery mildew	SVS	MSS
Leaf rust (5457P-)	S	S
BYD and CYD	MS*p*	MS*p*
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	MSS	MSS
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus 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	Medium
Straw strength	-
Head loss risk	-

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

p = provisional assessment

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 79 WA barley NVT (2017–2020), Mundah yielded less than Rosalind in 96% of trials, the same in 4% 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 twelfth most popular barley variety in 2021, accounting for just under 1% of the state's barley acreage. Mundah is no longer being sown in WA barley NVT. Mundah is superseded by new varieties including Beast, Combat, Commodus CL, Cyclops, Laperouse, and Titan AX - depending on the farming system.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	97	100	90	97	-
Agzone 2	94	97	96	89	-
Agzone 3	95	95	89	85	-
Agzone 4	77	106	112	97	-
Agzone 5	89	87	82	78	-
Agzone 6	90	95	84	80	-
Statewide	92	97	90	87	-

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	S	S
NFNB (Beecher avirulent)	MSS	MSS
NFNB (Oxford virulent)	MSS	S
SFNB	MSS	S
Powdery mildew	SVS	MSS
Leaf rust (5457P-)	S	S
BYD and CYD	MS	MS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	S	S
Crown rot	Moderate yield loss (10-20%)	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-11	-10	-9	-6
Cunderdin	-9	-9	-7	-4
Katanning	-6	-6	-4	-2
Grass Patch	-9	-9	-7	-4

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

p = provisional assessment

ROSALIND(Þ)

DELIVERABLE AS A FEED VARIETY

Comments

Rosalind (tested as IGB1302) is a medium height, early spring, feed barley. It suits all environments where there is a low probability of delivering malt grade barley. Rosalind has been the yield benchmark for barley in WA, but is now being challenged by new varieties such as Combat and Cyclops. Across 106 WA barley NVT (2016–2020), Rosalind yielded less than Spartacus CL in 1% of trials, the same in 21% and higher in 78%, with an overall yield advantage of 7% in the statewide MET. Rosalind appears to be inferior to RGT Planet at yields above 5t/ha but is higher-yielding below 4t/ha and in shorter growing seasons. Across 105 WA barley NVT (2017–2021), Rosalind yielded less than RGT Planet in 17% of trials, the same in 22% and higher in 61%, with an overall advantage of 7% in the statewide MET. 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 third most popular barley variety in 2021, accounting for 7% of the state's barley acreage, being more prevalent in southern cropping areas than northern cropping areas.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	108	110	115	107	106
Agzone 2	105	107	108	106	106
Agzone 3	111	104	107	104	107
Agzone 4	106	113	119	106	102
Agzone 5	105	109	110	104	107
Agzone 6	111	109	108	106	109
Statewide	106	108	109	106	106

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	MR	MS
NFNB (Beecher avirulent)	MR	MR
NFNB (Oxford virulent)	S	S
SFNB	MSS	S
Powdery mildew	MSS	MS
Leaf rust (5457P-)	MRMS	MR
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	R	R
Crown rot	Moderate yield loss (10-20%)	

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

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

p = provisional assessment

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. It is suited to environments where Intercept®, Intervix® and Sentry® are useful for controlling brome and barley grass or where there are IMI residues. Better adapted than Spartacus CL to April sowing opportunities when sowing into non-Clearfield® wheat stubble (allowing control of in-crop wheat volunteers). Across 79 WA barley NVT (2017–2021), Scope CL yielded less than Spartacus CL in 67% of trials, the same in 22% and higher in 11%. 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 fifth most popular barley variety across WA in 2021, accounting for 4% of the state's barley acreage.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	101	100	98	94	88
Agzone 2	98	96	96	90	91
Agzone 3	94	96	88	88	97
Agzone 4	74	108	119	94	86
Agzone 5	90	-	-	-	-
Agzone 6	88	-	-	-	-
Statewide	94	97	90	88	92

Disease resistance	Seedling	Adult
Scald	-	MS
NFNB (Beecher virulent)	MR	MRMS
NFNB (Beecher avirulent)	MR	MRMS
NFNB (Oxford virulent)	S	S
SFNB	MS	S
Powdery mildew	MR	MR
Leaf rust (5457P-)	S	MSS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	MS*p*	MS*p*
CCN	S	S
Crown rot	Moderate yield loss (>20%)	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+15	+10	+8	+9
Cunderdin	+11	+6	+5	+5
Katanning	+14	+8	+7	+7
Grass Patch	+12	+6	+5	+6

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

p = provisional assessment

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 possesses tolerance to the Aggressor herbicide (Group 1, quizalofop-P-ethyl), that allows in-crop control of grass weeds including barley grass, brome grass, and wild oats. According to the breeder, 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. It has only been in public trials since 2021 and only in Agzone 5. Growers should be cautious in their expectations, due to the lack of public field trial data. In five WA barley NVT (2021), Titan AX yielded the same as Compass and Rosalind in four and higher in one trial. Provisional disease data suggests that Titan AX may have useful resistance to NFNB (Beecher virulent and avirulent) and PM but may need management for scald and BLR. It is rated as MSS*p* as an adult plant to NFNB (Oxford virulent) and SFNB, which may limit disease expression. Titan AX has been released as a feed variety with the intent to develop accreditation for malt quality in the coming seasons.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	-	-	-	-	-
Agzone 3	-	-	-	-	-
Agzone 4	-	-	-	-	-
Agzone 5	-	-	-	-	108
Agzone 6	-	-	-	-	-
Statewide	-	-	-	-	107

Disease resistance	Seedling	Adult
Scald	-	S*p*
NFNB (Beecher virulent)	MRMS*p*	MR*p*
NFNB (Beecher avirulent)	MS*p*	MS*p*
NFNB (Oxford virulent)	S*p*	MSS*p*
SFNB	MRMS*p*	MSS*p*
Powdery mildew	R*p*	R*p*
Leaf rust (5457P-)	S*p*	S*p*
BYD and CYD	MRMS*p*	MRMS*p*
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	-	-
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus 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
EPR ($/t, excl. GST)	$4.55

p = provisional assessment

ZENA CL(Þ)

DELIVERABLE AS A FEED VARIETY

Comments

Zena CL (tested as IGB202125T) is an IMI tolerant, medium height, medium spring barley modelled on RGT Planet. According to the breeder it is agronomically similar to RGT Planet but with the addition of the gene conferring IMI herbicide tolerance. It has only been in public trials since 2021. Growers should be cautious in their expectations, due to the lack of public field trial data. Across 23 WA barley NVT (2021), Zena CL yielded the same as RGT Planet in all 23 trials. Provisional disease data suggest it may be a slight improvement over RGT Planet for NFNB (Beecher virulent), but similar for other diseases. Fungicides maybe required to manage NFNB (Oxford virulent) and SFNB. Zena CL is in Stage One of malting and brewing accreditation but has been released as a feed barley while under evaluation. The earliest accreditation date is March 2024.

Yield (% Spartacus CL)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	88
Agzone 2	-	-	-	-	102
Agzone 3	-	-	-	-	111
Agzone 4	-	-	-	-	92
Agzone 5	-	-	-	-	101
Agzone 6	-	-	-	-	111
Statewide	-	-	-	-	102

Disease resistance	Seedling	Adult
Scald	-	R*p*
NFNB (Beecher virulent)	MR*p*	MS*p*
NFNB (Beecher avirulent)	S*p*	MS*p*
NFNB (Oxford virulent)	S*p*	S*p*
SFNB	MSS*p*	S*p*
Powdery mildew	MR*p*	R*p*
Leaf rust (5457P-)	S*p*	MRMS*p* (late APR)
BYD and CYD	MS*p*	MS*p*
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	-	-
Crown rot	–	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus 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	Medium
Straw strength	Good
Head loss risk	Low

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

p = provisional assessment

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- **GRDC:** National Variety Trials (plant pathology, grain yield and grain quality data) and their service providers.

Photo: Megan Hele

Notes

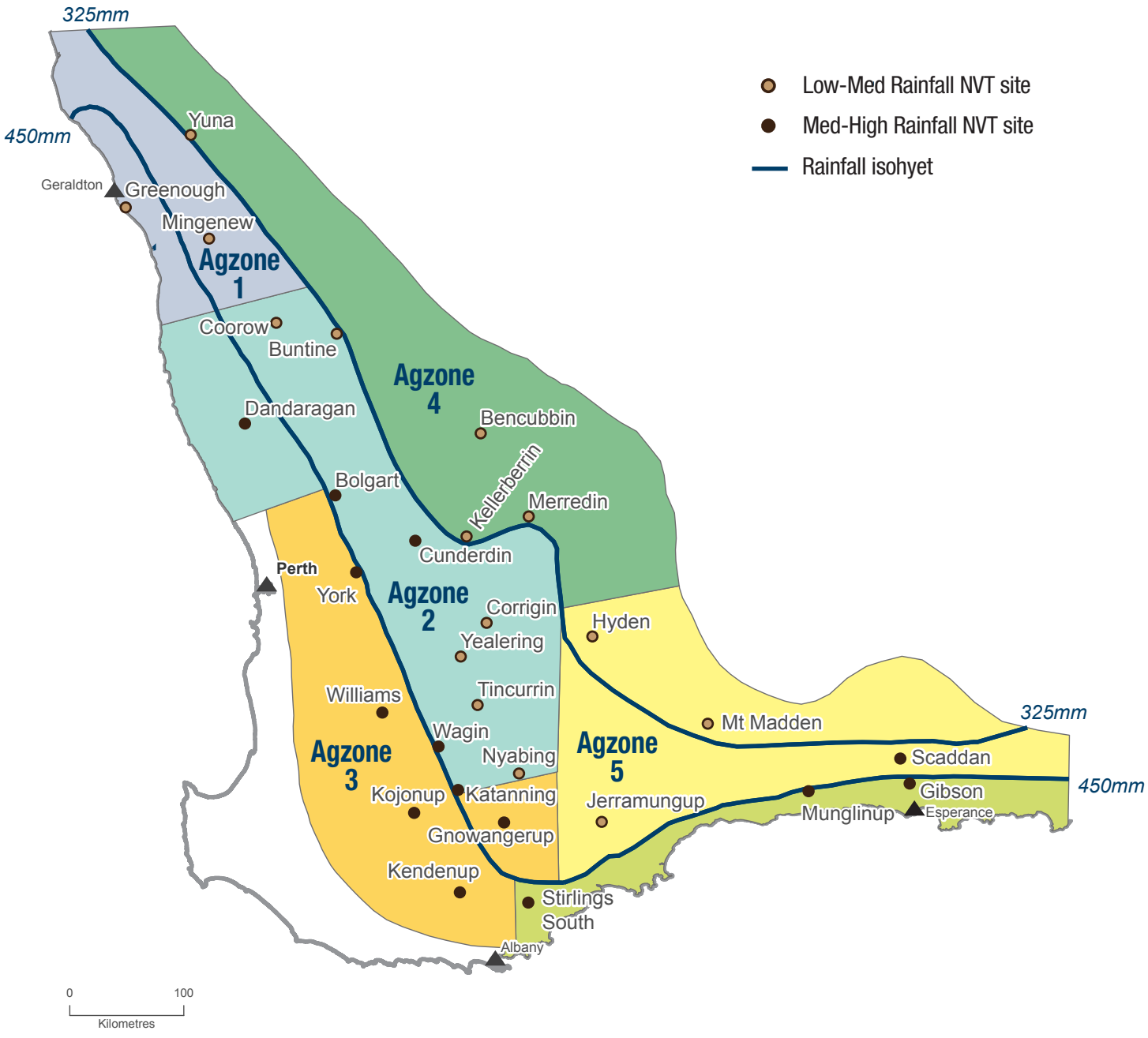

FIGURE 1. Location of Low-Med Rainfall and Med-High Rainfall canola NVT across Western Australian Agzones

CANOLA

By Jackie Bucat, DPIRD

Introduction

The past two seasons have been highly productive canola years across WA starting with the early breaks brought about by cyclone Seroja in 2021 and cyclone Charlotte in 2022. These excellent seasons, combined with high canola prices, have resulted in a large expansion of canola area. For the 2023 season, it will be important to stick to robust rotations to deal with any build-up of blackleg and sclerotinia and choose varieties with good blackleg resistance, where necessary.

In this edition of the canola sowing guide, GRDC/NVT are now referring to the NVT trial locations as either 'Low-Med Rainfall' or 'Med-High Rainfall'. Previously, these trials were known as the 'Early' and 'Mid' trial series. The locations of the canola variety trials are shown in Figure 1.

NEW FOR 2023

AGT has entered the canola market, releasing three OP varieties for 2023: Bandit TT and Renegade TT and a conventional OP variety, Outlaw. Other new TT OP varieties include DG Torrens TT and ATR Bluefin. These join the 2021 TT OP releases of DG Bidgee TT and DG Murray TT to bring the total of recently released TT OP varieties to six.

Most of these new OP varieties are higher yielding than ATR Bonito (Bandit TT 12% higher in Low-Med Rainfall NVT and DG Torrens TT and DG Bidgee TT 7% higher in Med-High Rainfall NVT). Some OP varieties also have higher blackleg resistance than ATR Bonito (e.g., DG Bidgee TT has a resistant (R) blackleg rating). However even the highest yielding OP varieties are still significantly lower yielding than the top five hybrids (by about 12%) in both Low-Med Rainfall and Med-High Rainfall NVT. Good OP agronomy may reduce this yield difference, but the yield gap will still often be significant. With 18% of the 2022 canola area sown to ATR Bonito, the new OP varieties will offer more competitive alternatives in WA. The cheaper OP systems are best suited to high risk or low yield situations and comparison strips with a hybrid variety are recommended.

Ensure good OP agronomy when using retained OP seed. Sieve to get the largest seed size possible (ideally over a 2mm sieve) to provide some insurance for establishment in tough conditions. It is also important to keep seed rates high to achieve the highest yields. For example, OP seed rates should be over 4.5kg/ha when seed has been graded over a 2mm sieve to meet the optimum target density of 45 plants/m² in the medium rainfall zone (with expected 50% field establishment for reasonable seeding conditions). For more details refer to 'Canola seeding rate information' at **https://www.agric.wa.gov.au/canola/canola-seeding-rate-information**.

Hybrid varieties are driving ever increasing canola yields, and the new GT varieties Nuseed Eagle TF and Nuseed Hunter TF continue this trend. Some varieties with dual herbicide tolerance are achieving yields similar to some single tolerance hybrids. For example, Pioneer PY520 TC (TT+CL) yields as well as some TT hybrids, and Hyola Regiment XC (GT+CL) yields as well or better than some TruFlex and Roundup Ready hybrids.

TT OP varieties

- **DG Torrens TT** is an early-mid maturity variety from Nutrien Ag Solutions. It was the highest yielding OP variety in Med-High Rainfall NVT, 7.5% higher than ATR Bonito with a higher blackleg resistance rating (RMR) and a similar high oil content.
- **Bandit TT** is an early maturity variety released by AGT. It was the highest yielding OP in Low-Med Rainfall NVT, more than 10% higher yielding than ATR Bonito. Bandit TT is suited to low pressure blackleg situations.
- **Renegade TT** is an early-mid maturity variety released by AGT. It out-yielded ATR Bonito by 7% in Low-Med Rainfall NVT and by 4% in Med-High Rainfall NVT. It has a higher blackleg rating (MRMS bare seed) than ATR Bonito.
- **ATR Bluefin** is an early maturity variety released by Nuseed in late 2021. Its yield is behind ATR Bonito, but it has a blackleg resistance rating of RMR, and an oil content 1% above the TT average (44.6%).

TT hybrids

- **HyTTec Velocity** is an early maturity release from Nuseed. It was the third highest yielding variety in the Low-Med Rainfall NVT.
- **InVigor T 4511** has similar early-mid maturity and comparable yields to InVigor T4510. However, InVigor T4511 has a higher blackleg resistance rating (R vs MR), and a higher oil content than InVigor T 4510.
- **RGT Baseline TT** is a mid-late maturity variety from SeedForce.

TT+CL

- **Pioneer PY520 TC** is a mid-maturity variety and was the highest yielding TT+CL variety of the Low-Med Rainfall NVT, with similar yields to many TT hybrids.

GT

- **Nuseed Eagle TF** is a mid-maturity TruFlex variety. It was the highest yielding variety in the Med-High Rainfall NVT. It has an excellent blackleg resistance rating (R) and an oil yield 1.8% above the average for GT varieties (45.4%).
- **Nuseed Hunter TF** is an early-mid maturity TruFlex variety and achieved the highest yields of the Low-Med Rainfall NVT.
- **DG Hotham TF** is a mid-maturity TruFlex variety from Nutrien Ag Solutions with excellent blackleg resistance rating (R).

GT+CL

- **Hyola Regiment XC** is a mid-maturity TruFlex + Clearfield Dual Tolerant variety. It was the highest yielding dual GT+CL variety in both Low-Med and Med-High Rainfall NVT.

CL

- **Hyola Solstice CL** is a mid-maturity variety. It was 7% higher yielding than Hyola Equinox CL in the Med-High Rainfall NVT.
- **RGT Clavier CL** is a new grain and graze variety from Seed Force, with longer maturity than RGT Nizza CL.

Conventional

- **Outlaw** is an early maturity conventional OP variety released by AGT.

WITHDRAWN VARIETIES

- **TT:** SF Ignite, InVigor T3510
- **TT+GT:** BASF 3000TR
- **GT:** InVigor R 3520, InVigor R 5520P, Nuseed GT-53, Nuseed Condor TF

Current canola varieties available for 2023

Canola varieties are available with TT, GT and CL single herbicide tolerance, and dual or 'stacked' combinations of TT+LL, TT+CL, GT+CL (Table 1). With the withdrawal of BASF 3000TR, the dual herbicide tolerance of TT+GT is no longer available.

Very little (0.05%) conventional canola is grown in WA due to a lack of chemical options for radish control. Ryegrass control is difficult due to its widespread resistance to Group A grass herbicides in the WA wheatbelt. Despite this, AGT has released a new OP conventional variety, Outlaw. Conventional varieties are no longer tested in WA NVT trials, but NVT results are available for New South Wales, South Australia and Victoria online at nvtonline.com.au.

The GT herbicide tolerance group includes TruFlex and Roundup Ready types (Table 1). The TruFlex® trait has an extended spray window until the start of flowering and allows greater flexibility of herbicide applications compared with Roundup Ready® types. Always check herbicide suitability by referring to the herbicide label. All GT canola varieties were developed using single gene genetic modification (GM), licensed from Bayer. Some GT varieties have the PodGuard® trait (Table 1). PodGuard® reduces seed shatter at maturity, which can reduce seed loss from shattering during direct heading and reduces seed loss risk from later harvesting.

Some longer maturity 'winter types' with Clearfield herbicide tolerance are available for dual purpose use (Graze and Grain) (Table 1). 'Graze n Grain' varieties are not included in the NVT trials, so are not reported in this guide. Information on the management and yields of winter canola types are available from private company websites.

Photo: Megan Hele

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

Herbicide tolerance	Variety	Harvest maturity	Oil content (diff. to mean)	Blackleg resistance rating (bare seed)	Blackleg group	PodGuard®	EPR $/t delivere	Release year	Seed access
TT (OP)	AFP Cutubury	4	-0.9	MRMS	AB	-	4	2020	Agronomy for Profit
TT (OP)	ATR Bluefin	3	1.0	RMR	AB	-	5	2021	Nuseed
TT (OP)	ATR Bonito	4	0.7	MS	A	-	5	2013	Nuseed
TT (OP)	ATR Mako	4	-1.8	MRMS	A	-	5	2015	Nuseed
TT (OP)	ATR Stingray	3	0.3	MRMS	C	-	-	2011	Nuseed
TT (OP)	ATR Wahoo	6	0.3	MRMS	A	-	5	2013	Nuseed
TT (OP)	Bandit TT	3	-1.0	MS	A	-	10	2022	AGT
TT (OP)	DG Bidgee TT	4.5	0.1	R	H	-	5	2021	Nutrien Ag solutions
TT (OP)	DG Murray TT	6	0.8	R	H	-	5	2021	Nutrien Ag solutions
TT (OP)	DG Torrens TT	4.5	0.8	RMR	H	-	5	2022	Nutrien Ag solutions
TT	Hyola® Blazer TT	4.5	0.0	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	-0.2	R	AD	-	5	2017	Nuseed
TT	HyTTec® Velocity	3	-0.9	MRMS	AB	-	5	2022	Nuseed
TT	InVigor® T 4510	4	-0.8	MR	BF	-	-	2016	BASF
TT	InVigor® T 4511	4	0.5	R	?	-	-	2022	BASF
TT	InVigor® T 6010	6	-0.1	MRMS	BC	-	-	2020	BASF
TT (OP)	Renegade TT	4	-0.9	MRMS	A	-	10	2022	AGT
TT	RGT Baseline TT	6	1.1	MRMS	B	-	10	2022	Seed Force
TT	RGT Capacity TT	4	-0.5	MRMS	B	-	10	2021	Seed Force
TT	SF Dynatron TT	5	0.7	MRMS	BC	-	10	2020	Seed Force
TT	SF Spark TT	3	0.7	MR	ABDS	-	10	2018	Seed Force
TT (OP)	Yetna	4	-	-	-	-	4	2015	Agronomy for Profit
TT+CL	Hyola® Enforcer CT	5	-0.2	R	ADF	-	-	2020	Pacific Seeds
TT+CL	Pioneer PY520 TC	5	-	MR	BC	-	-	2022	Pioneer
TT+LL	InVigor® LT 4530P	4.5	-0.9	RMR	BF	P	-	2021	BASF

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

OP = Open pollinated

Herbicide tolerance: TT =Triazine Tolerant, CL= Clearfield® (Imidazolinone tolerant), LL = LibertyLink (glufosinate tolerant), GT = Glyphosate Tolerant (RR = Roundup Ready type, TF = TruFlex® type), CC = Conventional canola

Harvest maturity key: 3 = early, 4 = early-mid and mid-early, 5 = mid, 6 = mid-late (provided by seed companies).

Oil content averages (%): TT = 44.6, GT = 45.4 and CL = 44.7 (data from 2017–2021 NVT).

Blackleg information from GRDC Blackleg Management Guide 2022 Spring Fact Sheet, see further information at **grdc.com.au/GRDC-FS-BlacklegManagementGuide**

Blackleg resistance rating key: R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible.

[Table 2. continued following page...]

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

Herbicide tolerance	Variety	Harvest maturity	Oil content (diff. to mean)	Blackleg resistance rating (bare seed)	Blackleg group	PodGuard®	EPR $/t delivere	Release year	Seed access
GT (TF)	DG Bindo TF	4.5	-0.1	MRMS	AB	-	-	2021	Nutrien Ag solutions
GT (TF)	DG Lofty TF	3	0.1	R	ABH	-	-	2021	Nutrien Ag solutions
GT (TF)	DG Hotham TF	5	0.0	R	ABH	-	-	2022	Nutrien Ag solutions
GT (TF)	Hyola® 410XX	4.5	0.8	MR	ABD	-	-	2018	Pacific Seeds
GT (TF)	InVigor® R 4022P	4	-0.2	MR	ABC	P	-	2019	BASF
GT (TF)	InVigor® R 4520P	4.5	-1.1	MRMS	B	P	-	2020	BASF
GT (TF)	Nuseed Eagle TF	5	1.8	R	ABD	-	-	2022	Nuseed
GT (TF)	Nuseed Emu TF	3	0.0	MR	AB	-	-	2021	Nuseed
GT (TF)	Nuseed Hunter TF	4	0.0	RMR	AB	-	-	2022	Nuseed
GT (TF)	Nuseed Raptor TF	4	0.0	R	AD	-	-	2019	Nuseed
GT (RR)	Pioneer® 44Y27 RR	4	-0.4	RMR	B	-	-	2017	Pioneer
GT (RR)	Pioneer® 44Y30 RR	4	0.0	MR	AB	-	-	2021	Pioneer
GT (RR)	Pioneer® 45Y28 RR	5	1.0	RMR	BC	-	-	2018	Pioneer
GT (RR)	Pioneer 45Y28 RR	5	1.0	MR	BC	-	-	2018	Pioneer
GT(TF)+CL	Hyola® Battalion XC	3.5	-1.3	R	ADF	-	-	2021	Pacific Seeds
GT(TF)+CL	Hyola® Garrison XC	4	-0.2	R	ADF	-	-	2020	Pacific Seeds
GT(TF)+CL	Hyola® Regiment XC	5	0.3	R	ADFH	-	-	2022	Pacific Seeds
CL	Hyola® Equinox CL	5	0.4	R	ADF	-	-	2021	Pacific Seeds
CL	Hyola® Solstice CL	5	0.5	RMR	AFDH	-	-	2022	Pacific Seeds
CL	Pioneer® 43Y92 CL	3	-0.6	RMR	B	-	-	2017	Pioneer
CL	Pioneer® 44Y94 CL	4	0.4	RMR	BC	-	-	2020	Pioneer
CL	Pioneer® 45Y93 CL	5	0.5	R	BC	-	-	2018	Pioneer
CL	Pioneer® 45Y95 CL	5	0.3	RMR	C	-	-	2021	Pioneer
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	?	-	12	2022	Seed Force
CL Graze n Grain	RGT Nizza CL	8	-	R	B	-	12	2021	Seed Force
CC(OP)	Outlaw	3	-	-	-	-	10	2022	AGT

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

OP = Open pollinated

Herbicide tolerance: TT =Triazine Tolerant, CL= Clearfield® (Imidazolinone tolerant), LL = LibertyLink (glufosinate tolerant), GT = Glyphosate Tolerant (RR = Roundup Ready type, TF = TruFlex® type), CC = Conventional canola

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Oil content averages (%): TT = 44.6, GT = 45.4 and CL = 44.7 (data from 2017–2021 NVT).

Blackleg information from GRDC Blackleg Management Guide 2022 Spring Fact Sheet, see further information at **grdc.com.au/GRDC-FS-BlacklegManagementGuide**

Blackleg resistance rating key: R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible.

[Table 2. continued following page...]

National Variety Trials (NVT) results 2017–2021

This guide presents predicted yields from the long-term Multi-Environment Trial (MET) analysis of all WA National Variety Trials (NVT) from 2017–2021. There were 211 canola trials in WA during this period: 97 TT trials, 80 GT trials and 34 CL trials.

Locations of canola variety trials are shown in Figure 1. The two trial series previously identified as 'Early' and 'Mid' are now known as 'Low-Med Rainfall' and 'Med-High Rainfall' NVT respectively.

All NVT MET results are available online, at **nvtonline.com.au** or via the NVT long-term yield app.

LOW-MED RAINFALL NVT

HyTTec Trident was the highest yielding TT variety in the Low-Med Rainfall NVT (Table 2). The next highest yielding varieties were Hyola Blazer TT and HyTTec Velocity. HyTTec Trident and Hyola Blazer have a resistant (R) blackleg rating.

InVigor T4511 achieved similar yields to InVigor T4510 but has a better blackleg resistance rating (R) and higher oil content.

New OP variety Bandit TT outyielded ATR Bonito by 12%, while Renegade TT was 7% higher than ATR Bonito. Bandit TT should be grown in areas of low blackleg pressure, as its blackleg resistance rating is the same as ATR Bonito (MS, bare seed). This might limit its distribution in 2023, after large canola areas in the favourable 2021 and 2022 seasons. Renegade TT has a higher blackleg resistance rating (MRMS), so should be the favoured OP variety in areas of higher blackleg pressure.

Nuseed Hunter TF was the highest yielding variety in the GT NVT MET analysis. It was 4% higher yielding than Nuseed Emu TF and has a higher blackleg rating (RMR).

MED-HIGH RAINFALL NVT

HyTTec Trifecta was the highest yielding TT variety in each year of the Med-High Rainfall NVT MET analysis. HyTTec Trifecta is mid maturity. Varieties with competitive yields were the earlier maturing varieties, Hyola Blazer TT, HyTTec Trident and HyTTec Trophy. All these varieties have a resistant (R) blackleg resistance rating. SF Dynatron TT yielded slightly more than InVigor T4511. While InVigor T4511 had a comparable yield to InVigor T4510, it has a better blackleg resistance rating (R) and a higher oil content.

DG Torrens TT and DG Bidgee TT were the highest yielding OP TT varieties in the Med-High Rainfall NVT, at 7.5% higher than ATR Bonito. Both varieties have better blackleg resistance rating than ATR Bonito, with R for DG Bidgee TT and RMR for DG Torrens. Other OP varieties, Renegade TT and DG Murray TT were also higher yielding than ATR Bonito. DG Murray TT has a mid-late maturity with a blackleg rating of R, making it a suitable choice for long season environments with some blackleg pressure.

The new mid maturity variety, Nuseed Eagle TF, achieved the highest yield in the GT Med-High NVT, and was 2% ahead of Nuseed Condor TF (withdrawn). Nuseed Eagle TF has a R rating for blackleg resistance and an oil content 1.8% higher than the GT average. InVigor R 4520P and Nuseed Hunter TF were the second and third highest yielding varieties followed by Hyola Regiment XC (GT+CL variety), Pioneer 44Y30RR and Pioneer 45Y28RR. Of this group, Hyola Regiment XC has the highest blackleg resistance rating of R, followed by Nuseed Hunter TF and Pioneer 45Y28 RR with RMR.

TABLE 2. Yield of canola yields in the LOW-MED RAINFALL NVT, expressed as a percentage of site mean yield for each trial yield (2017–2021), and the weighted average over the five-year period

Low-Med Rainfall — TT, TT+CL, TT+LL									
Herbicide tolerance	Variety	Year		2017	2018	2019	2020	2021	2017–2021
		Site mean yield (t/ha)		1.57	1.51	1.02	1.80	2.31	
		Maturity	No. trials	(8)	(7)	(8)	(9)	(12)	(44)
TT	HyTTec Trident	3	(37)	127	121	117	116	119	**120**
TT	Hyola Blazer TT	4.5	(13)	136	125	115	100	115	**117**
TT	HyTTec Velocity	3	(5)	112	118	118	116	117	**116**
TT	InVigor T 4511	4	(12)	112	117	114	107	112	**112**
TT	HyTTec Trophy	4	(26)	113	110	111	111	111	**111**
TT	InVigor T 4510	4	(44)	109	112	113	111	111	**111**
TT	SF Dynatron TT	5	(20)	112	111	112	107	110	**110**
TT	RGT Capacity TT	4	(15)	95	99	106	111	105	**104**
TT(OP)	Bandit TT	3	(12)	113	108	102	95	103	**104**
TT	SF Spark TT	3	(30)	98	100	102	105	102	**102**
TT(OP)	Renegade TT	4	(10)	100	96	97	102	99	**99**
TT(OP)	ATR Bonito	4	(39)	95	94	91	89	91	**92**
TT(OP)	AFP Cutubury	4	(12)	97	92	91	88	91	**92**
TT(OP)	ATR Stingray	3	(17)	88	86	86	91	88	**88**
TT(OP)	DG Murray TT	6	(5)	85	85	87	89	87	**87**
TT(OP)	ATR Bluefin	3	(11)	81	85	87	92	87	**87**
TT+CL	Hyola Enforcer CT	5	(16)	119	109	102	97	104	**106**
TT+LL	InVigor LT 4530P	4.5	(20)	110	113	109	99	107	**107**
Low-Med Rainfall — GT, GT+CL									
Herbicide tolerance	Variety	Year		2017	2018	2019	2020	2021	2017–2021
		Site mean yield (t/ha)		1.85	1.85	1.09	1.83	2.64	
		Maturity	No. trials	(6)	(5)	(7)	(8)	(11)	(37)
GT(TF)	Nuseed Hunter TF	4	(7)	120	117	112	111	113	**114**
GT(TF)	Nuseed Emu TF	3	(17)	111	112	107	114	108	**110**
GT(TF)	Nuseed Raptor TF	4	(17)	134	119	98	91	106	**108**
GT(RR)	Pioneer 44Y27 RR	4	(36)	112	110	104	103	107	**107**
GT(RR)	Pioneer 44Y30 RR	4	(11)	105	106	107	107	107	**107**
GT(RR)	Pioneer 45Y28 RR	5	(6)	111	107	102	-	106	**106**
GT(TF)	InVigor R 4520P	4.5	(26)	116	110	98	90	106	**103**
GT(TF)	InVigor R 4022P	4	(26)	107	105	100	96	104	**102**
GT(TF)	DG Lofty TF	3	(11)	99	100	97	99	99	**99**
GT(TF)	DG Bindo TF	4.5	(5)	100	98	94	93	96	**96**
GT(TF)	Hyola 410XX	4.5	(26)	88	90	98	99	93	**94**
GT+CL(TF)	Hyola Regiment XC	5	(11)	104	104	107	107	105	**106**
GT+CL(TF)	Hyola Battalion XC	3.5	(19)	106	103	98	99	99	**100**
GT+CL(TF)	Hyola Garrison XC	4	(15)	103	99	97	93	97	**97**

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

Shaded cells indicate that the variety was not present in trials; all shaded values are predicted yields from MET analysis.

OP = Open pollinated

Herbicide tolerance: TT =Triazine Tolerant, CL= Clearfield® (Imidazolinone tolerant), LL = LibertyLink (glufosinate tolerant), GT = Glyphosate Tolerant (RR = Roundup Ready type, TF = TruFlex® type)

Harvest maturity key: 3 = early, 4 = early-mid, 5 = mid, 6 = mid-late (information provided by seed companies)

Yield data source: NVT Online, **nvtonline.com.au**

TABLE 3. Yield of canola yields in the WA MED-HIGH RAINFALL NVT, expressed as a percentage of site mean yield for each trial yield (2017–2021), and the weighted average over the five-year period

Med-High Rainfall — TT, TT+CL, TT+LL									
Herbicide tolerance	Variety	Year		2017	2018	2019	2020	2021	2017–2021
		Site mean yield (t/ha)		1.99	2.19	1.98	2.76	2.93	
		Maturity	No. trials	(12)	(10)	(12)	(8)	(11)	(53)
TT	HyTTec Trifecta	5	(31)	114	116	113	114	119	**115**
TT	Hyola Blazer TT	4.5	(20)	113	112	112	113	118	**114**
TT	HyTTec Trident	3	(25)	109	118	108	111	116	**112**
TT	HyTTec Trophy	4	(47)	110	112	109	111	114	**111**
TT	SF Dynatron TT	5	(23)	109	104	110	111	113	**109**
TT	InVigor T 4511	4	(11)	105	111	105	107	109	**107**
TT	InVigor T 4510	4	(53)	106	107	107	108	108	**107**
TT	RGT Capacity TT	4	(22)	106	104	106	106	107	**106**
TT	InVigor T 6010	6	(23)	107	102	106	104	106	**105**
TT	RGT Baseline TT	6	(7)	104	102	103	103	108	**104**
TT(OP)	DG Torrens TT	4.5	(15)	101	98	100	98	100	**100**
TT(OP)	DG Bidgee TT	4.5	(11)	100	99	98	97	102	**99**
TT	SF Spark TT	3	(14)	99	100	99	99	99	**99**
TT(OP)	Renegade TT	4	(11)	97	96	98	98	94	**97**
TT(OP)	DG Murray TT	6	(16)	97	97	94	92	96	**95**
TT(OP)	Bandit TT	3	(11)	92	93	93	94	90	**92**
TT(OP)	ATR Bonito	4	(40)	93	89	94	94	90	**92**
TT(OP)	ATR Wahoo	6	(10)	94	87	94	91	91	**92**
TT(OP)	ATR Mako	4	(17)	90	89	92	92	89	**90**
TT(OP)	ATR Stingray	3	(10)	89	85	90	88	83	**87**
TT(OP)	AFP Cutubury	4	(8)	87	85	89	87	82	**86**
TT(OP)	ATR Bluefin	3	(7)	85	83	87	86	79	**84**
TT+CL	Pioneer PT520 TC	5	(5)	106	107	106	108	113	**108**
TT+CL	Hyola Enforcer CT	5	(28)	103	108	102	102	103	**104**
TT+LL	InVigor LT 4530P	4.5	(19)	103	102	104	104	100	**103**

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

Shaded cells indicate that the variety was not present in trials; all shaded values are predicted yields from MET analysis.

OP = Open pollinated

Herbicide tolerance: TT =Triazine Tolerant, CL= Clearfield® (Imidazolinone tolerant), LL = LibertyLink (glufosinate tolerant), GT = Glyphosate Tolerant (RR = Roundup Ready type, TF = TruFlex® type)

Harvest maturity key: 3 = early, 4 = early-mid, 5 = mid, 6 = mid-late (information provided by seed companies)

Yield data source: NVT Online, **nvtonline.com.au**

[Table 3. continued following page...]

TABLE 3. Yield of canola yields in the WA MED-HIGH RAINFALL NVT, expressed as a percentage of site mean yield for each trial yield (2017–2021), and the weighted average over the five-year period (cont'd)

Med-High Rainfall — GT, GT+CL									
Herbicide tolerance	Variety	Year		2017	2018	2019	2020	2021	2017–2021
		Site mean yield (t/ha)		2.02	2.20	2.13	2.62	2.88	
		Maturity	No. trials	(8)	(6)	(10)	(8)	(11)	(44)
GT(TF)	Nuseed Eagle TF	5	(5)	120	114	118	117	122	**119**
GT(TF)	InVigor R 4520P	4.5	(29)	120	112	117	116	118	**117**
GT(TF)	Nuseed Hunter TF	4	(4)	112	119	111	114	118	**115**
GT(RR)	Pioneer 44Y30 RR	4	(17)	116	110	115	114	116	**115**
GT(RR)	Pioneer 45Y28 RR	5	(25)	113	113	112	113	119	**114**
GT(TF)	Nuseed Raptor TF	4	(30)	111	116	109	112	117	**113**
GT(RR)	Pioneer 44Y27 RR	4	(60)	109	113	109	112	114	**111**
GT(TF)	InVigor R 4022P	4	(29)	113	107	111	111	110	**111**
GT(TF)	DG Bindo TF	4.5	(11)	105	104	105	105	108	**106**
GT(TF)	DG Hotham TF	5	(10)	101	102	102	102	108	**103**
GT(TF)	Hyola 410XX	4.5	(23)	102	105	101	102	102	**102**
GT(TF)	DG Lofty TF	3	(4)	97	101	99	101	102	**100**
GT+CL(TF)	Hyola Regiment XC	5	(11)	114	117	112	112	118	**115**
GT+CL(TF)	Hyola Garrison XC	4	(29)	105	109	103	104	106	**105**
GT+CL(TF)	Hyola Battalion XC	3.5	(11)	104	107	102	102	101	**103**
Med-High Rainfall — CL									
Herbicide tolerance	Variety	Year		2017	2018	2019	2020	2021	2017–2021
		Site mean yield (t/ha)		2.04	2.34	2.44	3.27	3.51	
		Maturity	No. trials	(7)	(6)	(5)	(3)	(3)	(24)
CL	Pioneer 45Y95 CL	5	(8)	117	113	116	115	120	**116**
CL	Pioneer 44Y94 CL	4	(10)	113	113	112	114	118	**114**
CL	Pioneer 45Y93 CL	5	(18)	112	107	112	109	117	**111**
CL	Hyola Solstice CL	5	(3)	112	115	103	108	110	**110**
CL	Hyola Equinox CL	5	(6)	104	110	96	103	99	**103**
CL	Pioneer 43Y92 CL	3	(6)	103	105	100	105	99	**103**

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

Shaded cells indicate that the variety was not present in trials; all shaded values are predicted yields from MET analysis.

OP = Open pollinated

Herbicide tolerance: TT =Triazine Tolerant, CL= Clearfield® (Imidazolinone tolerant), LL = LibertyLink (glufosinate tolerant), GT = Glyphosate Tolerant (RR = Roundup Ready type, TF = TruFlex® type)

Harvest maturity key: 3 = early, 4 = early-mid, 5 = mid, 6 = mid-late (information provided by seed companies)

Yield data source: NVT Online, **nvtonline.com.au**

WA canola varieties grown in 2017–2022

The proportion of GT canola increased to 45% of the total canola area in the 2022 growing season (Table 4) while the proportion of TT canola decreased to 47%. The proportion of Clearfield canola remained steady at 3%. Varieties with dual tolerance increased to 6% of the total crop; 3.5% for GT+CL varieties, 1.3% for TT+CL varieties and 0.5% each for TT+GT and TT+LL.

The proportion sown to hybrid TT canola has increased markedly since 2018. In the 2022 season, 50% of the TT area was sown with hybrid varieties, and 50% to OP varieties (Figure 2).

ATR Bonito (OP) maintained its place as the most common variety in 2022, being sown to more than 18% of the WA canola crop (although a large reduction from the 53% of area sown four years ago) (Table 5). The TT hybrid varieties sown over the largest area were HyTTec Trident, HyTTec Trophy and HyTTec Trifecta (Table 5). The GT varieties sown over the largest area were Pioneer 44Y27, InVigor R4022P and Pioneer 44Y30RR. Of the 29 most popular canola varieties in 2022, only seven were grown five years ago (2017) while eleven were grown in 2018. This illustrates the very rapid turnover in canola varieties across WA.

TABLE 4. Proportion (% area) of canola herbicide systems in WA 2017–2022

Herbicide tolerance	2017	2018	2019	2020	2021	2022
TT	80	72	63	62	56	47
GT	18	26	34	32	37	45
CL	1	1	2	3	3	3
Dual tolerance	1	1	1	3	4	6

Source: CBH Group

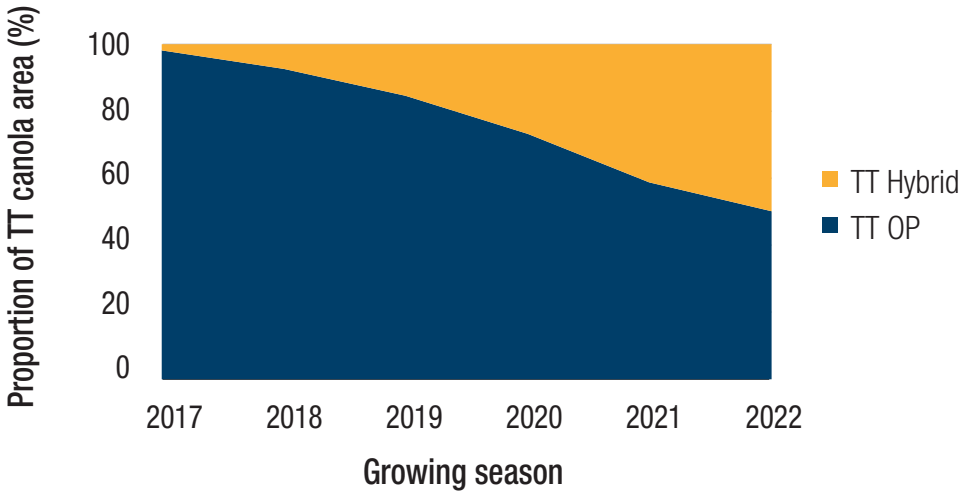

FIGURE 2. Proportion (% area) of OP and Hybrid TT canola in WA 2017–2022

Source: CBH Group

TABLE 5. Proportion (% area) of canola varieties sown in WA 2017–2022

Variety	Tolerance	2017	2018	2019	2020	2021	2022*
ATR Bonito	TT(OP)	54.5	53.0	39.1	34.6	26.4	18.4
Pioneer 44Y27 RR	GT	-	1.7	6.8	5.5	7.1	10.2
HyTTec Trident	TT	-	-	-	5.2	11.3	8.0
InVigor R 4022P	GT	-	-	-	0.8	2.7	7.3
Pioneer 44Y30 RR	GT	-	-	-	-	-	6.9
HyTTec Trophy	TT	-	0.0	2.3	5.9	5.6	6.9
HyTTec Trifecta	TT	-	-	-	0.3	1.2	4.0
Nuseed Emu TF	GT	-	-	-	-	-	3.8
Hyola 410XX	GT	-	-	1.0	2.5	2.6	3.5
Pioneer 45Y28 RR	GT	-	-	-	1.2	2.5	2.8
Nuseed Raptor TF	GT	-	-	-	1.0	3.1	2.5
Hyola Garrison XC	GT+CL	-	-	-	-	0.0	2.4
ATR Stingray	TT(OP)	12.7	6.7	6.1	5.5	3.5	1.9
Pioneer 44Y94 CL	CL	-	-	-	-	0.9	1.7
InVigor T 4510	TT	0.1	1.9	3.5	3.1	2.5	1.5
InVigor R 3520	GT	-	0.0	0.5	0.5	1.8	1.4
Hyola Enforcer CT	TT+CL	-	-	-	-	0.7	1.1
AFP Cutubury	TT(OP)	-	0.0	0.2	0.5	0.7	1.1
InVigor R 5520P	GT	0.1	0.6	1.0	0.9	0.8	1.0
Hyola Battalion XC	GT+CL	-	-	-	-	-	0.9
Pioneer 43Y23 RR	GT	5.4	7.9	7.4	4.8	3.2	0.8
Nuseed GT-53	GT	1.4	3.7	3.6	3.5	4.4	0.8
Hyola Blazer TT	TT	-	-	-	-	0.0	0.8
InVigor R 4520P	GT	-	-	-	-	-	0.8
Pioneer 43Y29 RR	GT	-	-	3.1	3.4	3.6	0.7
DG Bidgee TT	TT(OP)	-	-	-	-	-	0.6
Hyola 404RR	GT	4.8	8.4	5.4	3.6	2.8	0.5
InVigor T 6010	TT	-	-	-	-	0.3	0.5
Nuseed Condor TF	GT	-	-	-	-	-	0.5

Source: CBH Group

*Varieties sown over more than 0.5% of the total area are shown for the 2022 growing season.

Records of 0.0 indicate percentages below 0.05 (which are rounded to 0.0)

Canola seed commercialisation companies

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BASF

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Michael Allingame +61 (0)437 454 283

Nuseed

nuseed.com.au

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Andrew Royce +61 (0)427 466 916
Michael Hickey +61 (0)438 913 106

Nutrien Ag solutions/Dynagro Seed (formerly commercialised by Seednet)

seednet.com.au/products/dyna-gro-canola

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ABBREVIATIONS

CC	Conventional Canola
CL	Clearfield® (Imidazolinone tolerant)
GT	Glyphosate Tolerance
EPR	End Point Royalties
LL	LibertyLink
MET	Multi-Environment Trials
NVT	National Variety Trials
OP	Open Pollinated
RR	Roundup Ready®
TF	TruFlex®
TT	Triazine Tolerant

Photo: Megan Hele

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OATS

Introduction

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 a milling end use and for 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. Grain Industry of Western Australia (GIWA) oat delivery grades available at selected CBH receival bins 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 baling as 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 more widely sown grain oat varieties (Table 2). The variety description section summarises the strengths and weaknesses of all grain and hay varieties documented in this guide.

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 due to their agronomic and disease characteristics.
4. Likelihood of meeting oat receival specifications.
5. Location of receival segregations for OAT1 and OAT2 varieties.

GRAIN AND HAY OAT VARIETY CHOICE IN 2023 – WHAT SHOULD I GROW?

Bannister's popularity continues to increase. In 2021, it occupied nearly half the planted area of oats with Bannister sown on the same area as Bilby, Carrolup, Durack, Pallinup, Wandering and Williams combined (Figure 1). Growers reduced the area sown to Carrolup and Williams to accommodate the increased planting of Bannister. There was a tripling in the plantings of Bilby (from 0.6 to 1.8% of the oat planted area), while the Pallinup, Wandering and Yallara plantings largely remained stable. Pallinup and Williams were the two dominant varieties in the Geraldton Port Zone, while Bannister dominated the other three port zones.

Bannister is recommended if targeting the OAT1 market and the oat Septoria risk is low-moderate. Bilby and Williams are recommended in higher rainfall areas with a low risk of drought stress during grain filling. If targeting the OWAN or OAT2 market, Wandering is recommended, while Durack is a good OAT2 option with a June sowing.

If targeting export hay, the hay-only varieties Brusher and Forester are suitable for the far south-west. At the same time, Mulgara and Wintaroo are 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 and Yallara 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

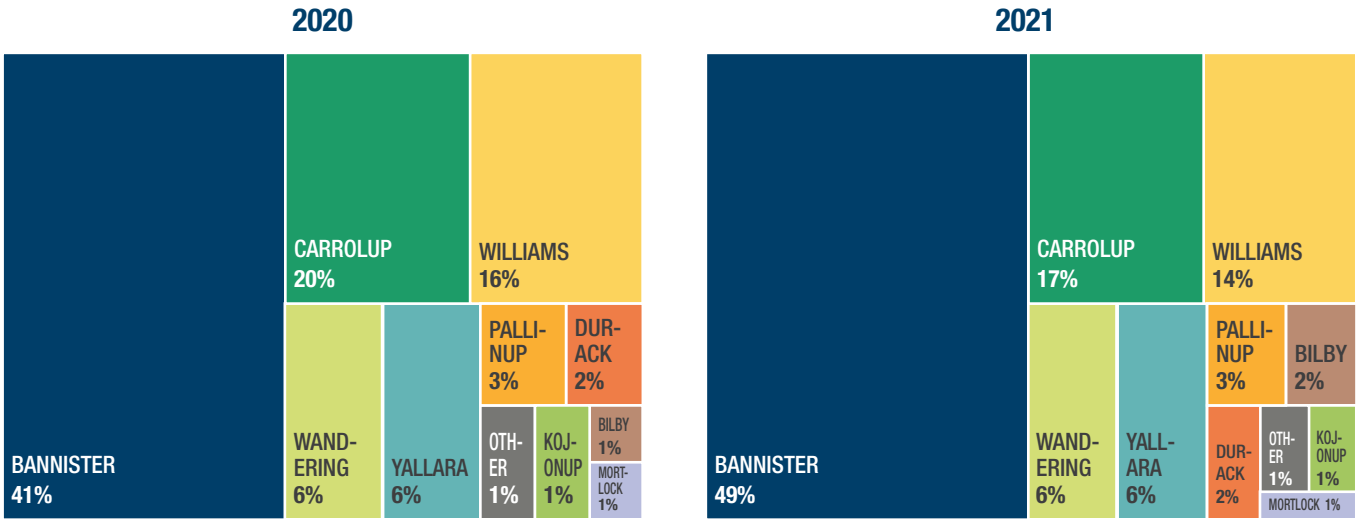

FIGURE 1. Relative popularity (percentage of oat area) of the top ten oat varieties plus the combined area sown to the other seven varieties delivered in WA in 2020 and 2021. The top ten varieties occupied 99% of the area planted to oats in both seasons, while the top five varieties occupied 92% and 91%, respectively.

Source: grower estimates as provided to CBH for 2020 and 2021

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 (domestic feed market only) crops (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 domestically consumed livestock feed. Grain of these two varieties cannot be delivered into the Bunge and CBH bulk handling systems.

WHAT IS NEW IN 2023?

No new milling oat varieties, but three hay-only varieties (Archer, Kultarr and Wallaby) were released in 2022.

InterGrain has two advanced grain lines, 13008-18 and 14309-51, with milling potential being evaluated in National Variety Trials (NVT). Seednet has acquired the license to commercialise the grain variety Koala. Koala was bred by the NOBP and was sown in WA oat NVT in 2022.

In addition to releasing Archer collaboratively with Grains Innovation Australia (GIA) and being the licensee of Kultarr and Wallaby for AEXCO, InterGrain is also evaluating a range of hay-only lines for potential release in 2024, including 14049-09 as a later sowing hay-only variety.

The following are notes on five new oat varieties: Archer, Koala, Kultarr, Kingbale and Wallaby.

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 oaten grain feed markets and/or consumed on-farm.

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]	108%	102%	88%	87%	105%	104%	88%
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[3]	MSS	SVS	MSS	S	MSS	MSS	MSS
Oat leaf rust	RMR	MRMS	VS	MR	VS	MR	MR
Oat stem rust	MS	SVS	S	SVS	SVS	MSS	MSS
Barley and cereal yellow dwarf	MS	S	S	MSS	MSS	MSS	MSS

Source: Blakely Paynter, Manisha Shanker 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 (2017–2021). 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/

[3] Resistance rating: VS = very susceptible, SVS = susceptible - very susceptible, S = susceptible, MSS = moderately susceptible - susceptible, MS = moderately susceptible, MRMS = moderately resistant - moderately susceptible, MR = moderately resistant, RMR = resistant - moderately resistant, R = resistant, - = no data available

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 hay-only variety. Preliminary data from InterGrain indicates Archer has high hay yields with suitable quality for export hay and a useful disease profile. However, cereal cyst nematode (CCN) may require rotational management (Tables 10, 12 and 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 is being evaluated by the Department of Primary Industries and Regional Development (DPIRD), with support from AgriFutures, to gather additional hay yield and quality information before the 2023 cropping season and complement that generated by InterGrain.

Archer seed will be available from InterGrain's network of Seedclub members and resellers for planting in 2023. Farmer-to-farmer trading of Archer seed is not allowed, as with IMI-tolerant wheat and barley varieties.

Koala

Key points:

- 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 2023–2024.
- 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.
- 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 to be evaluated for its milling potential. 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) (MRMS *versus* MS) (Table 12). Bannister and Koala's grain quality packages (hectolitre weight and screenings through a 2.0mm sieve) are similar (Figures 5 and 7).

DPIRD is evaluating Koala in response to varying nitrogen (N) rates to gather additional agronomic, grain yield and quality information before the 2023 cropping season to complement that generated by NVT.

Koala seed will be bulked in WA in 2023 with the intent for seed to be available for sale from Seednet partners in 2024.

Kultarr

Key points:

- Being evaluated for its potential as an export hay variety.
- Suited to low to medium rainfall environments.
- Taller plant height matched to more challenging years.
- Limited agronomic performance data exists for WA conditions.

Kultarr (tested as 07423-18), according to the commercialising agent InterGrain, 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, with support from AgriFutures, to gather additional hay yield and quality information before the 2023 cropping season and complement that 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 2023. Seed is also free to trade from farmer to farmer by complying with the InterGrain seed sales declaration agreement (**intergrain.com/source-seeds/ftf-trading/**).

Kingbale

Key points:

- Single gene, IMI-tolerant oat suitable for export hay.
- Similar agronomic characteristics to the export-hay variety Wintaroo.
- Targeted for sowing into soil with IMI residues from previous crops and for IBS use with Sentry® herbicide.
- Sentry® is now approved for IBS application in Kingbale hay, forage, seed and grain (domestic feed market only) crops.
- 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 oaten grain feed markets and/or consumed on-farm.

Kingbale (tested as GIA17010-1) was released as a hay variety by InterGrain in 2021. It was developed through mutation breeding by InterGrain's partner, GIA. Kingbale is a late maturity, tall height hay-only variety susceptible to lodging. InterGrain indicates that Kingbale has a disease and agronomic profile like Wintaroo, which includes good early vigour and hay colour retention, a tall plant type and CCN resistance. It is rated as S to OLR and OSR (Tables 10, 12 and 13).

Kingbale is being evaluated by DPIRD, with support from AgriFutures, to gather additional hay yield and quality information before the 2023 cropping season and complement that being generated by InterGrain.

Kingbale seed will be available from InterGrain's network of Seedclub members and resellers for planting in 2023. Farmer-to-farmer trading of Kingbale seed is not allowed, as with IMI-tolerant wheat and barley varieties.

Wallaby

Key points:

- Being evaluated for its 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 excellent qualities, including 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 a comparable grain yield to Carrolup, allowing for easier seed bulk-up for the following year's hay crop.

Wallaby is being evaluated by DPIRD, with support from AgriFutures, to gather additional hay yield and quality information before the 2023 cropping season and complement that 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 2023. Seed is also 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.

RLL is commonly found in areas with high rainfall, mild weather and high humidity in eastern Australia. The detailed epidemiology of the disease is not well understood, and no detailed study of the pathogen life cycle currently exists. RLL survives on crop residue, and infection will likely arise from spores produced in the infested residue and secondary spread from infected plants.

Early sowing reduces the risk of screenings

A screening limit introduced in 2019–2020 for the receival of milling oat in the OAT2 grade has increased the 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 milling oat growers 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 high rates of applied nitrogen (N). Early April sowing and variety selection are critical tools for meeting the recently introduced OAT2 delivery standards for milling oats.

Tips for nitrogen fertiliser – grain and hay

Nitrogen (N) strategies differ for grain and hay oats, but high rates of applied N can be detrimental to grain and hay quality.

If growing oats to deliver milling oat grain, the recommended N strategy is to apply one-third of the N fertiliser needed at seeding and two-thirds at six to ten weeks after seeding. While there is some flexibility around the recommended strategy regarding when the N can be applied, applying all the N upfront is a strategy that carries the most risk.

The grain quality of Carrolup and Williams is more sensitive to increasing N than Bannister. As more N is applied to grain crops, the risk of high screenings and low hectolitre weight increases. 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 drives more biomass, 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, the 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 (thick stem diameter, high acid detergent fibre (ADF), high neutral detergent fibre (NDF) or high lignin), except that it increased crude protein and decreased WSC.
- Applying more than 90kg N/ha increased the risk of not meeting the industry's lower WSC limit for premium hay of 22%.
- Varieties responded similarly to increasing N for hay quality traits. The key difference is that for customers who seek high levels of WSC, more N can be applied to varieties with higher genetic levels of WSC before they drop a 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 differences in WSC, with Yallara one of the higher WSC varieties evaluated.

- Planting date was not a significant driver of a changed response to applied N when averaged across varieties and locations. While there were differences between the planting dates in their agronomic traits, hay yield and hay quality parameters (except hay greenness, ADF and NDF), for most traits, the response to N was similar between the planting dates, albeit at a different level.
- Season and variety were more prominent factors in determining hay quality than the rate of N applied in the three years the research was conducted (2019–2021).

Target plant density

The target plant density for oats depends on end-use (grain and hay) and rainfall zone.

When considering the rate of seed to be planted, 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.

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:

$$\text{seed rate in kg/ha} = 109 \text{ kg/ha} = \frac{35 \times 240}{0.96 \times 0.80 \times 100}$$

Lodging management in hay oats?

Lodging is a perennial problem for the hay industry, especially in high rainfall environments and when high soil nutrition results in big canopies early in the season, posing a logistical issue for export fodder producers. Crop lodging costs hay yield, causes uneven crop ripening, makes it difficult to cut the crop at a consistent height and affects the 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 between Z30 to Z32 (beginning of stem elongation). Another option is to graze the paddock before stem elongation.

The spraying of a label rate application of Moddus® Evo at stem elongation (Z31–Z32) was risky for hay oats in the four-year NHA project supported by AgriFutures (project number PRJ-011029). While it improved straw strength and reduced the lodging risk, when it occurred, 400mL/ha of Moddus® Evo was likely to cause a yield decline, although some varieties showed a decreased sensitivity in some seasons. The yield decline was fortunately 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 showed that applying Moddus® Evo at 200mL/ha (below the label rate) was safer for the hay oat crop, with 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 rate of Moddus Evo® to be applied to reduce the risk (and reduce the cost) associated with its application.

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 the decline in WSC, increased fibre with 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, which produced taller plants, not just the peduncle, which is the target for managing stuck panicles. While there was no adverse effect of applying gibberellic acid as ProGibb® SG on hay yield or quality, later applications (i.e. post-flag leaf emergence) may be required so that the effect is only seen on the peduncle. However, the risk of stuck panicles is best managed by breeders releasing varieties that elongate their peduncle and allow panicle emergence under most conditions. Further work is required to understand the best timing for gibberellic acid or other growth regulator products to elongate just the peduncle and reduce the risk of stuck panicles.

Using fungicides to protect hay quality in the swath

Rainfall during the windrow curing process encourages the growth of saprophytic fungi. Saprophytic fungi usually consist of cosmopolitan fungi such as *Alternaria* spp. and *Cladosporium* spp., colonising senescing or dead tissue and causing dark discolouration or spots. Curing hay provides an ideal environment for colonisation, especially when curing coincides with or follows rainfall events. Hay discolouration due to weather-induced saprophytic fungal growth 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 for minimising saprophytic colonisation of curing hay were evaluated by DPIRD (Kylie Chambers and Geoff Thomas) and Agriculture Victoria (Hari Dadu and Mark McLean) plant pathologists in the NHA project with support from AgriFutures (project number PRJ-011029). Results of the research suggested that foliar fungicides should be applied as needed for in-crop disease control and that effective disease control will 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, the researchers could not provide any concrete recommendations to industry on strobilurin use. Fungicides should be applied to manage the diseases present with any additional saprophyte suppression, an off-target bonus rather than for the sole purpose of the application. This practice can reduce the impact of fungal staining on visual quality. Growers applying late-season fungicides to reduce fungal staining on visual quality should apply them well before the withholding period (e.g. 28 days before cutting rather than 21 days). Applying fungicide before the withholding period is just as effective at reducing saprophytic growth and provides growers with a wider cutting window while reducing hay residue levels. Further work is required to provide growers and industry with fungicide and non-fungicide options to help reduce or avoid saprophytic fungal growth while maintaining and protecting our current export markets.

Applying fungicide (strobilurin and demethylation inhibitor, DMI) can reduce saprophytic fungal colonisation of bleached (senescent) leaf material in the windrow but does not affect green leaf retention or the nutritional quality of hay post-weathering. However, strobilurin chemistries have a greater and more consistent effect on reducing saprophytic growth than DMIs.

Please note: to avoid chemical residues in hay and ensure our export hay markets are not jeopardised, 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.

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, Bannister is susceptible to oat Septoria. There is a greater risk of grain staining and subsequent receival downgrading for Bannister in higher rainfall areas than Carrolup and Williams.

In situations of high disease pressure, such as growing a susceptible variety, oat-on-oat rotations and regions of high rainfall, 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 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 to control it is unreliable.

Harvest timing for grain oats

Harvest timing is critical to maximising oat yield.

To reduce shedding, it is crucial to harvest oats as soon as the crop is ripe. Harvest non-dwarf and other varieties likely to shed or lodge 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

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 (2017–2021) 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 2017 to 2021 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 are 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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		3.63	4.33	2.86	2.82	3.95	3.48
Variety	(No. trials)	(4)	(3)	(4)	(4)	(4)	(19)
Deliverable as OAT1							
Bannister	(19)	107	111	105	102	107	**106**
Bilby	(19)	105	102	101	106	103	**103**
Carrolup	(19)	83	85	94	86	88	**87**
Kojonup	(19)	93	91	85	86	103	**92**
Mitika	(15)	94	91	98	99	-	**95**
Kowari	(19)	100	95	99	104	99	**100**
Williams	(19)	102	107	106	99	105	**104**
Yallara	(19)	84	89	98	89	80	**88**
Deliverable as OAT2							
Durack	(19)	87	84	97	96	86	**90**
Wandering	(19)	105	107	106	103	107	**106**
Not yet evaluated for milling							
Koala	(19)	107	114	98	95	107	**104**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		4.27	4.26	3.44	3.03	4.24	3.88
Variety	(No. trials)	(2)	(2)	(2)	(2)	(3)	(11)
Deliverable as OAT1							
Bannister	(11)	108	109	111	107	105	**108**
Bilby	(11)	101	100	96	104	102	**101**
Carrolup	(11)	88	91	96	85	91	**90**
Kojonup	(11)	101	101	110	89	97	**99**
Mitika	(8)	92	93	90	95	-	**93**
Kowari	(11)	95	96	91	99	99	**96**
Williams	(11)	101	109	110	101	100	**104**
Yallara	(11)	92	85	91	91	93	**91**
Deliverable as OAT2							
Durack	(11)	86	86	83	90	92	**88**
Wandering	(11)	101	109	107	103	101	**104**
Not yet evaluated for milling							
Koala	(11)	116	109	121	107	107	**112**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		3.52	2.08	1.09	1.22	3.60	2.30
Variety	(No. trials)	(1)	(1)	(1)	(1)	(1)	(5)
Deliverable as OAT1							
Bannister	(5)	114	107	108	88	108	**105**
Bilby	(5)	102	103	99	124	103	**106**
Carrolup	(5)	82	90	97	72	83	**85**
Kojonup	(5)	99	84	73	59	92	**81**
Mitika	(4)	89	97	97	118	-	**99**
Kowari	(5)	94	100	96	132	96	**104**
Williams	(5)	110	109	117	86	97	**104**
Yallara	(5)	77	90	104	63	95	**86**
Deliverable as OAT2							
Durack	(5)	77	93	98	114	87	**94**
Wandering	(5)	111	111	114	105	98	**108**
Not yet evaluated for milling							
Koala	(5)	117	97	94	41	117	**93**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		3.03	3.07	1.83	2.20	2.44	2.45
Variety	(No. trials)	(2)	(1)	(2)	(2)	(2)	(9)
Deliverable as OAT1							
Bannister	(9)	114	109	101	109	109	**108**
Bilby	(9)	104	100	105	102	99	**102**
Carrolup	(9)	75	91	91	87	92	**87**
Kojonup	(9)	101	91	79	92	99	**93**
Mitika	(7)	87	93	101	93	-	**93**
Kowari	(9)	94	95	103	97	94	**97**
Williams	(9)	100	109	101	107	107	**104**
Yallara	(9)	80	93	99	87	93	**90**
Deliverable as OAT2							
Durack	(9)	74	89	102	87	87	**88**
Wandering	(9)	102	109	103	108	106	**105**
Not yet evaluated for milling							
Koala	(9)	127	107	91	108	113	**109**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		3.64	4.90	4.55	3.67	4.84	4.32
Variety	(No. trials)	(1)	(1)	(1)	(1)	(1)	(5)
Deliverable as OAT1							
Bannister	(5)	109	116	109	115	108	**111**
Bilby	(5)	103	96	101	101	102	**101**
Carrolup	(5)	81	90	88	83	86	**86**
Kojonup	(5)	108	111	106	118	110	**111**
Mitika	(4)	89	84	92	87	-	**89**
Kowari	(5)	95	86	96	95	98	**94**
Williams	(5)	94	110	104	111	102	**104**
Yallara	(5)	87	90	83	62	77	**80**
Deliverable as OAT2							
Durack	(5)	80	75	83	70	82	**78**
Wandering	(5)	95	106	105	114	104	**105**
Not yet evaluated for milling							
Koala	(5)	126	134	114	121	114	**122**

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 (2017–2021) and the weighted average over the five-year period (where there are four or more observations)

Year		2017	2018	2019	2020	2021	2017–2021
Site mean yield (t/ha)		3.62	3.93	2.75	2.67	3.78	3.34
Variety	(No. trials)	(10)	(8)	(10)	(10)	(11)	(49)
Deliverable as OAT1							
Bannister	(49)	109	111	106	106	107	**108**
Bilby	(49)	103	100	100	105	102	**102**
Carrolup	(49)	83	88	93	85	89	**88**
Kojonup	(49)	98	96	94	91	100	**96**
Mitika	(38)	91	91	95	96	-	**94**
Kowari	(49)	97	94	97	102	98	**98**
Williams	(49)	101	108	107	102	103	**104**
Yallara	(49)	85	89	94	84	87	**88**
Deliverable as OAT2							
Durack	(49)	83	84	92	90	87	**87**
Wandering	(49)	103	108	106	105	104	**105**
Not yet evaluated for milling							
Koala	(49)	115	114	105	101	109	**109**

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 percentage) 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						
Bilby	55%	33%	12%	49	2017–2021	Bilby ≤ Bannister
Carrolup	92%	8%	0%	49	2017–2021	Carrolup < Bannister
Durack	88%	4%	8%	49	2017–2021	Durack < Bannister
Koala	31%	41%	29%	49	2017–2021	Koala = Bannister
Kojonup	71%	29%	0%	49	2017–2021	Kojonup < Bannister
Kowari	78%	10%	12%	49	2017–2021	Kowari < Bannister
Mitika	79%	11%	11%	38	2017–2020	Mitika < Bannister
Wandering	29%	65%	6%	49	2017–2021	Wandering = Bannister
Williams	35%	55%	10%	49	2017–2021	Williams ≤ Bannister
Yallara	88%	8%	4%	49	2017–2021	Yallara < Bannister
Variety B: Carrolup						
Bannister	0%	8%	92%	49	2017–2021	Bannister > Carrolup
Bilby	0%	20%	80%	49	2017–2021	Bilby > Carrolup
Durack	22%	55%	22%	49	2017–2021	Durack = Carrolup
Koala	6%	14%	80%	49	2017–2021	Koala > Carrolup
Kojonup	20%	22%	57%	49	2017–2021	Kojonup ≥ Carrolup
Kowari	8%	20%	71%	49	2017–2021	Kowari > Carrolup
Mitika	8%	34%	58%	38	2017–2020	Mitika ≥ Carrolup
Wandering	0%	6%	94%	49	2017–2021	Wandering > Carrolup
Williams	0%	12%	88%	49	2017–2021	Williams > Carrolup
Yallara	18%	53%	29%	49	2017–2021	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 (Tables 3 to 8). However, Wandering cannot be delivered into the OAT1 grade, and Koala is not yet available for seed sale 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 (Figure 2). Since 2017, Bannister has outperformed Williams in environments above 3t/ha but performed the same in environments below 3t/ha (Figure 3). Bannister outyielded Williams in nearly two out of every five WA oat NVT (Table 9). However, over the past decade (2012–2021), Bannister has performed similarly to Williams over a range of yield potentials (Figure 2).

Carrolup, Durack and Yallara are inferior to Bannister, Wandering and Williams at most levels of yield potential. However, Durack 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 2017 (Figure 3). In 49 WA oat NVT, Bilby has been lower yielding than Williams in 43% of trials, the same in 30% and higher in 27% of trials (data not shown). Kowari sits between Carrolup and Bannister for yield potential. Kowari has been higher yielding than Carrolup in 71% of WA oat NVT since 2017 and lower yielding than Bannister in 79% of trials (Table 9).

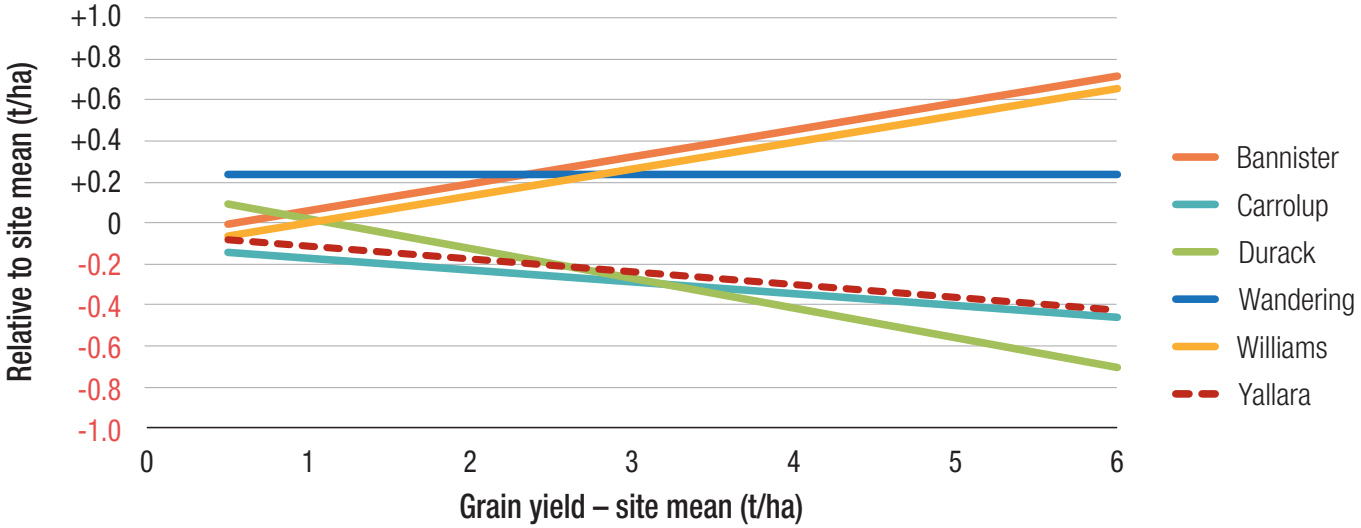

FIGURE 2. Fitted grain yield of Bannister, Carrolup, Durack, Wandering, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2012–2021). Each variety sown in all 111 trial-years of data, NVT Online, **nvtonline.com.au**.

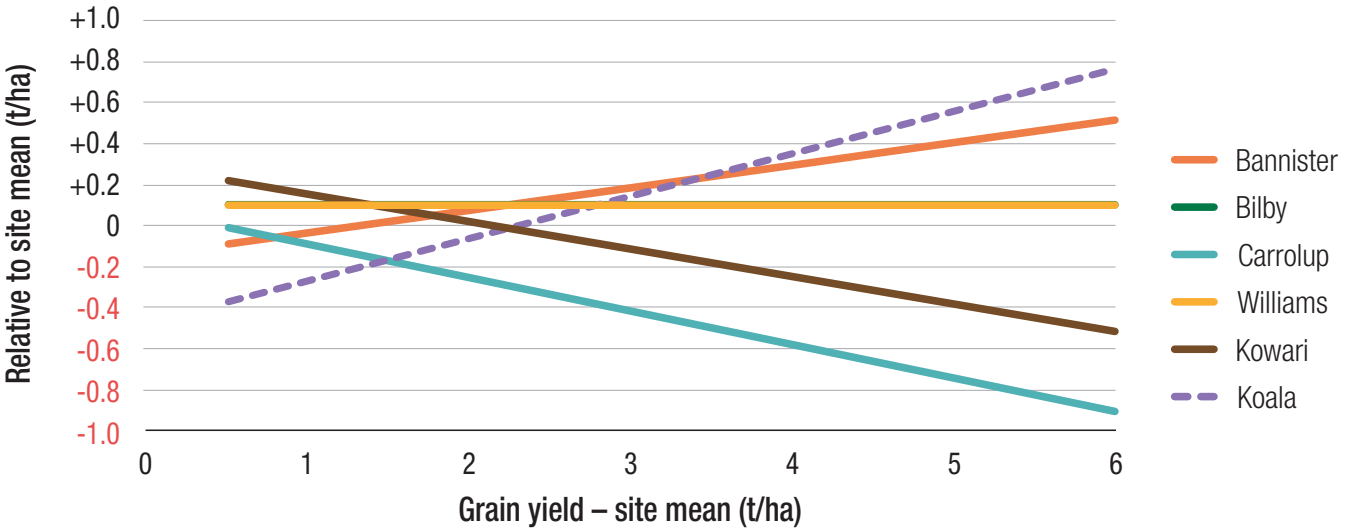

FIGURE 3. Fitted grain yield of Bannister, Bilby, Carrolup, Koala, Kowari and Williams at different site means.

Source: based on NVT statewide tables of yields and grain quality (2017–2021). Each variety sown in all 54 trial-years of data, NVT Online, **nvtonline.com.au**.

GRAIN QUALITY

Grain quality is an essential trait of milling oat varieties. 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 in Figures 4 to 7. The deviation from the site mean has then been assessed for quadratic and linear trends. If neither the quadratic nor the linear trend are 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.

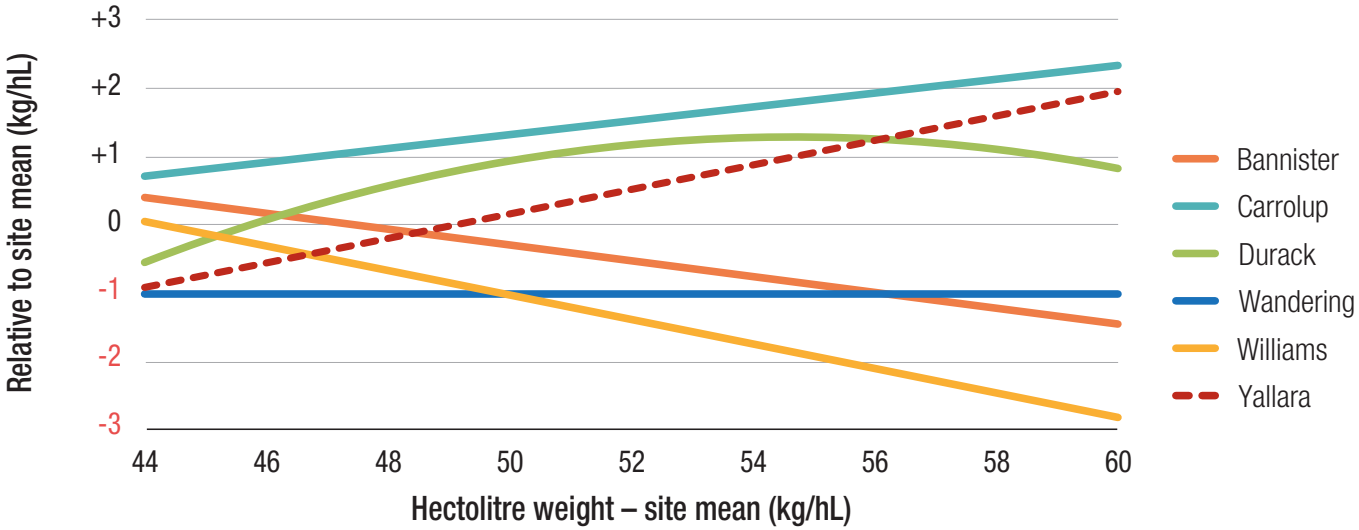

FIGURE 4. Fitted hectolitre weight of Bannister, Carrolup, Durack, Wandering, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2012–2021). Each variety sown in all 84 trial-years of data, NVT Online, nvtonline.com.au.

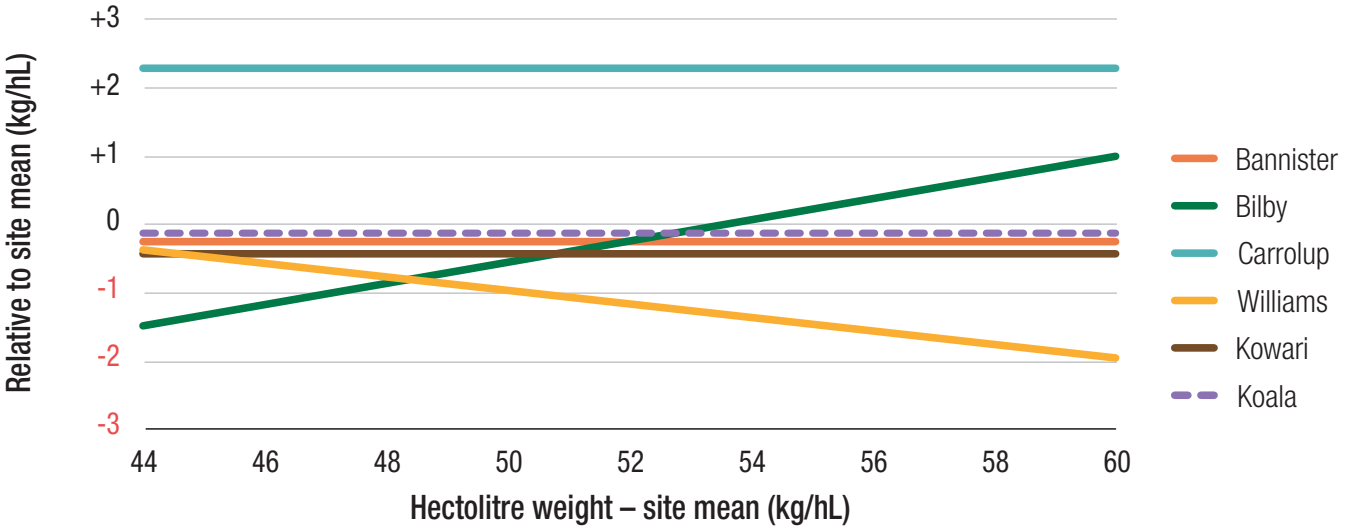

FIGURE 5. Fitted hectolitre weight of Bannister, Bilby, Carrolup, Koala, Kowari and Williams at different site means.

Source: based on NVT statewide tables of yields and grain quality (2017–2021). Each variety sown in all 51 trial-years of data, NVT Online, 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). Across 49 statewide NVT trials (2017–2021), Yallara averaged 81% of the yield of Bannister.

Carrolup is the benchmark variety for hectolitre weight among milling oat varieties, followed by Durack and Yallara (Figure 4). 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 and Kowari have inferior hectolitre weight relative to Carrolup (Figure 5). The hectolitre weight of Koala is the same as Bannister and a general improvement over Williams.

The benchmark varieties for grain plumpness are Kowari, Mitika (data not shown) and possibly Yallara (Figures 6 and 7). Genetic differences are noted at the OAT1 screenings limit of 10% through a 2.0mm slotted sieve, with greater genetic differences observed at the OAT2 screenings limit of 15%. 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, 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.

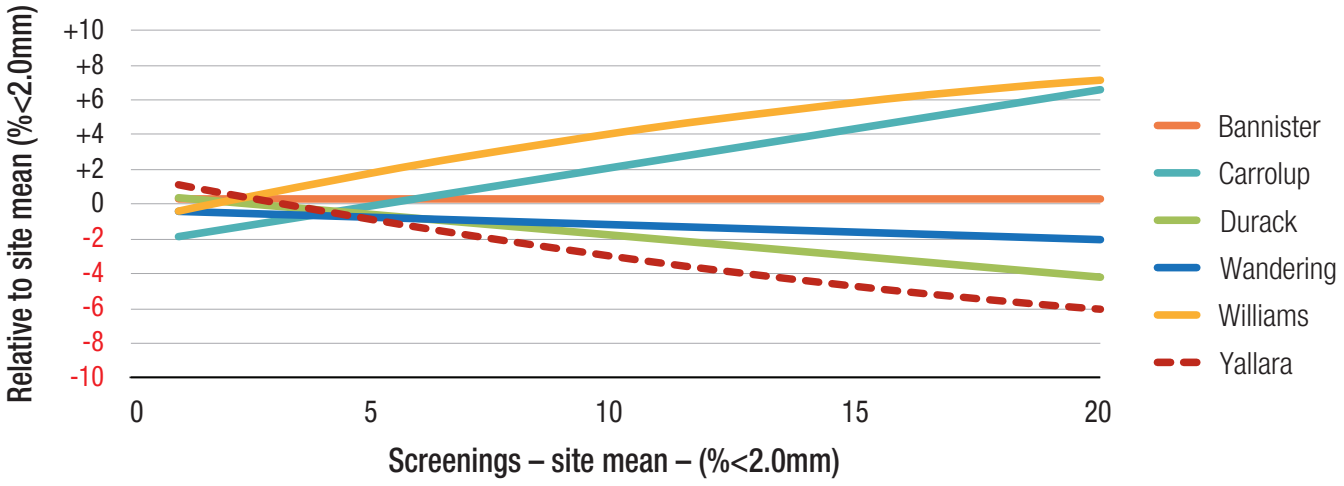

FIGURE 6. Fitted grain plumpness of Bannister, Carrolup, Durack, Wandering, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2012–2021). Each variety sown in all 81 trial-years of data, NVT Online, **nvtonline.com.au**.

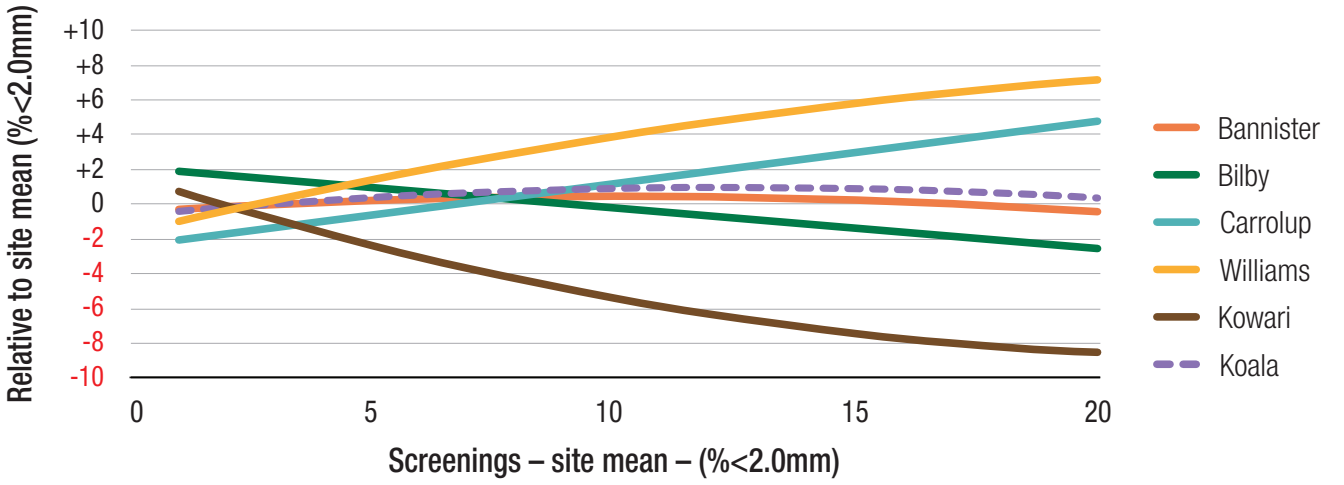

FIGURE 7. Fitted grain plumpness of Bannister, Bilby, Carrolup, Koala, Kowari and Williams at different site means.

Source: based on NVT statewide tables of yields and grain quality (2017–2021). Each variety sown in all 48 trial-years of data, NVT Online, **nvtonline.com.au**.

Hay – yield and quality

Blakely Paynter (DPIRD)

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 in Table 10, as predicted by near-infrared analysis (NIR), include digestibility, crude protein (CP), water-soluble carbohydrates (WSC), acid detergent fibre (ADF), neutral detergent fibre (NDF) and neutral detergent fibre measured after thirty hours of incubation in rumen fluid (NDFDom30).

TABLE 10. Average hay yield and quality (predicted by NIR) in NOBP and InterGrain trials in WA from 2017 to 2021

Variety	Hay yield (t/ha)	Digestibility (% dm)	CP (% dm)	WSC (% dm)	ADF (% dm)	NDF (% dm)	NDFDom30 (% dm)
(No. trials)	(15)	(14)	(14)	(14)	(10)	(10)	(10)
Deliverable as OAT1							
Bannister	8.5	67.7	6.1	24.9	33.4	51.0	52.9
Bilby	-	-	-	-	-	-	-
Carrolup	8.2	65.6	6.1	25.2	33.0	50.9	51.8
Kojonup	-	-	-	-	-	-	-
Kowari	-	-	-	-	-	-	-
Mitika	-	-	-	-	-	-	-
Williams	8.5	65.8	6.1	23.8	33.2	52.2	52.5
Yallara	8.7	65.7	6.0	25.3	33.3	51.1	53.2
Deliverable as OAT2							
Durack	8.6	65.3	5.9	24.4	33.2	51.2	51.5
Wandering	8.5	66.7	6.2	23.5	33.4	51.5	51.2
Not yet evaluated for milling							
Koala	-	-	-	-	-	-	-
Hay-only variety							
Archer	9.0	65.5	6.2	24.1	33.7	51.9	52.2
Brusher	8.7	66.8	6.4	25.2	33.2	51.6	52.6
Forester	-	-	-	-	-	-	-
Kingbale	8.4	65.2	5.8	25.0	33.9	52.1	52.7
Koorabup	8.2	65.2	5.8	24.4	33.7	52.3	52.6
Kultarr	8.8	66.1	5.9	25.0	34.0	53.1	53.8
Mulgara	8.7	66.8	5.9	26.1	33.9	50.8	53.0
Swan	8.8	-	-	-	-	-	-
Tammar	8.7	-	-	-	-	51.8	-
Tungoo	8.5	-	-	-	-	51.3	-
Wallaby	8.3	68.6	5.9	26.1	32.9	49.7	52.7
Winjardie	8.7	-	-	-	-	-	-
Wintaroo	8.6	65.9	5.9	24.7	33.8	51.6	52.4

Source: InterGrain

CP = crude protein, WSC = water soluble carbohydrates, ADF = acid detergent fibre, NDF = neutral detergent fibre, NDFDom30 = neutral detergent fibre after 30-hour in vitro incubation in rumen fluid, - = no data available.

The difference in yield between varieties was less than 1t/ha, with Archer at the higher end and Carrolup and Koorabup at the lower end of the hay yield range (2017–2021) (Table 10). In datasets tabulated by the NOBP and included in previous sowing guides, Forester achieved the best overall hay quality. Forester 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).

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, Wandering, Williams and Yallara. The susceptibility of Bannister to oat Septoria affects the visual grading of its hay more than other dual-purpose varieties. Of the dual-purpose varieties, Carrolup and Williams are the preferred varieties for export hay.

The following varietal ranking 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.
- CP – little difference was noted between varieties, with the range only 0.6%. Brusher was at the higher end, with Kingbale and Koorabup at the lower end of the range.
- WSC – Brusher, Carrolup, Mulgara, Wallaby and Yallara had higher WSC.
- ADF – Brusher, Carrolup, Durack, Wallaby and Williams had lower ADF levels.
- NDF – Wallaby had the lowest NDF.
- NDFDom30 – Bannister, Kultarr, Mulgara and Yallara hay had higher levels of rumen digestibility after 30 hours than other varieties tested.

Kingbale tested similarly to Wintaroo. The similarity between Kingbale and Wintaroo was also noted in the NHA research supported by AgriFutures (project number PRJ-011029) across two locations in SA and two in WA. Kingbale, like Wintaroo, requires close monitoring around cutting time as it tends to stay greener longer than other varieties. It is crucial to monitor the stems as they tend to turn white while the top remains green. Growers familiar with Wintaroo will find no difference in performance by switching to Kingbale, as the agronomic performance (height, hay yield, stem diameter and hay quality) of the two varieties is identical. The critical difference is that growers can spray Sentry® IBS before sowing Kingbale to control brome and barley grass, and Kingbale can be sown onto stubble containing IMI residues.

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 is 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. The varietal differences (between lowest and highest) at the first sowing date were 1.0t/ha and 0.6t/ha at the second. 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 as measured by a Soil Plant Analysis Development (SPAD) chlorophyll meter than the other seven varieties. 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 varietal ranking comments relate to hay quality traits in the NHA trials (data not shown):

- Digestibility – Brusher, Mulgara and Yallara were more digestible than Durack.
- CP – Williams had the highest CP and Wintaroo the lowest.
- WSC – Yallara had the highest WSC and Koorabup and Williams the lowest.
- ADF – Koorabup and Wintaroo had the highest average ADF, with Brusher and Yallara the lowest.
- NDF – 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 for 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 consistently maximise hay quality. 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. The number of grades and even grading systems differs 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 Grade1 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, double gees and foreign material such as dirt, stones, sticks, insects, wool, wire and carcases.

Livestock deaths caused by annual ryegrass toxicity poisoning from Australian hay or straw exports in 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 by introducing twist fungus (*Dilophospora alopecuri*) or Safeguard ryegrass.

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

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.

Disease and pest resistance

Manisha Shankar, Kylie Chambers, Geoff Thomas, Blakely Paynter, Carla Wilkinson and Daniel Huberli (DPIRD)

Foliar disease abbreviations:

- OLR = oat 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.

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 2023 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 leaf rust (OLR) 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 phone **+61 (0)8 9368 3533**.

Send OLR 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 phone **+61 (0)2 9351 8808**.

Samples suspected of infection with RLL can be sent to DPIRD Diagnostic Laboratory Services (DDLS) to be included in DPIRD surveillance projects. 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 **+61 (0)8 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). 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. Bilby, 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 excellent resistance.

OAT LEAF RUST (OLR)

Oat leaf rust (OLR, *Puccinia coronata* var. *avenae*), also known as crown 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. OLR does not infect wheat and wheat leaf rust does not infect oats.

OLR 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. OLR can also reduce grain quality, impacting grain weight and screenings.

Most milling oat varieties have good resistance to OLR except Carrolup (VS), Kojonup (SVS) and Wandering (VS). Winjardie (SVS) and Wintaroo (SVS) have the weakest resistance of the hay-only varieties, with resistance data in Table 12.

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 excellent resistance to OSR being rated as MRMS, while the hay-only variety Mulgara is rated as MR.

RED LEATHER LEAF (RLL)

RLL (Neo*spermospora 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 **+61 (0)8 9368 3262** or Kylie Chambers at **kylie.chambers@dpird.wa.gov.au** or by phone **+61 (0)8 9690 2151**.

CROWN ROT

Crown rot (*Fusarium pseudograminearum*) is a fungal, soil-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), bacterial blight (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*) was 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*) was not detected.

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.

BARLEY AND CEREAL YELLOW DWARF (BYD/CYD)

Both barley yellow dwarf (BYD) and cereal yellow dwarf (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 *P. 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 yield-limiting nematode numbers and incorporating resistant crops and varieties to reduce nematodes. Wheat, barley, canola and oats are all susceptible crops and can increase nematode levels. 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 disease and individual diseases impact the nutritional quality of hay is less well understood. 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 updating our knowledge on Oat Septoria, rusts (both OLR and OSR) and RLL published in the 2020 disease review will be available on the AgriFutures website before the end of 2022.

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	SVS	MRMS	SVS	S
Carrolup	MSS	VS	S	S
Kojonup	S	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	MR	SVS	MSS
Wandering	MSS	VS	SVS	MSS
Not yet evaluated for milling				
Koala	MSS	MR	MRMS	S
Hay-only variety				
Archer	MSS	MR	MS	MS
Brusher	MSS	MR	S	SVS*p*
Forester	S	-	-	-
Kingbale	MSS	S	S	MS*p*
Koorabup	MRMS	MRMS	MSS	MS
Kultarr	MSS*p*	MR*p*	MSS*p*	MSS*p*
Mulgara	S	RMR	MR	MSS
Swan	-	-	-	-
Tammar	-	-	-	-
Tungoo	MRMS	MR	MSS	MS
Wallaby	MSS*p*	MR*p*	MS*p*	MSS*p*
Winjardie	SVS	SVS	-	MS
Wintaroo	MSS	S	MSS	MSS

Source: Manisha Shanker, National Oat Breeding Program and NVT Online, **nvtonline.com.au**

[1] Resistance rating: VS = very susceptible, SVS = susceptible - very susceptible, S = susceptible, MSS = moderately susceptible - susceptible, MS = moderately susceptible, MRMS = moderately resistant - moderately susceptible, MR = moderately resistant, RMR = resistant - moderately resistant, R = resistant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, *p* = provisional, - = no data available.

[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				
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: Manisha Shanker, National Oat Breeding Program and NVT Online, **nvtonline.com.au**

[1] Resistance rating: VS = very susceptible, SVS = susceptible - very susceptible, S = susceptible, MSS = moderately susceptible - susceptible, MS = moderately susceptible, MRMS = moderately resistant - moderately susceptible, MR = moderately resistant, RMR = resistant - moderately resistant, R = resistant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, *p* = provisional, - = no data available.

[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

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 and suitable for export hay.
- three grain-only varieties (Bilby, Kowari and Mitika) that are deliverable into milling oat segregations in WA but not suitable for export hay.
- one grain variety that has not yet been classified (Koala).
- thirteen hay-only varieties (Archer, Brusher, Forester, Kingbale, Koorabup, Kultarr, Mulgara, Swan, Tammar, Tungoo, Wallaby, 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 2017 to 2021. 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 Ddata 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 the occurrence of 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 than Carrolup in breeder's trials with improved hay yield. While its hay yields are lower than Brusher, hay quality in breeder trials were comparable. Bannister is the most widely sown oat variety in WA, occupying half the area sown to oats in 2021.

Grain yield (% Carrolup)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	129	131	112	119	122
Agzone 3	123	120	116	126	115
Agzone 4	139	119	111	122	130
Agzone 5	152	120	111	125	118
Agzone 6	135	129	124	139	126
Statewide	131	126	114	125	120

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 assessment

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 17% of the oat-ha in 2021.

Grain yield (% Bannister)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	78	77	90	84	82
Agzone 3	81	83	86	79	87
Agzone 4	72	84	90	82	77
Agzone 5	66	83	90	80	84
Agzone 6	74	78	81	72	80
Statewide	76	79	88	80	83

Disease resistance	Rating
Septoria	MSS
Leaf rust	VS
Stem rust	S
BYD and CYD	S
RLN (*P. neglectus*)	S
RLN (*P. quasitereoides*)	S*p*
CCN (resistance)	S

'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	Non-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 assessment

KOJONUP(b)

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, its hay yields are generally lower than Carrolup. Kojonup is a minor variety and occupied about 0.5% of the planted area to oats in 2021.

Grain yield (% Bannister)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	87	82	81	84	96
Agzone 3	94	93	99	83	92
Agzone 4	87	79	68	67	85
Agzone 5	89	83	78	84	91
Agzone 6	99	96	97	103	102
Statewide	90	86	89	86	93

Disease resistance	Rating
Septoria	S
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 assessment

WILLIAMS(b)

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. Its grain has lower hectolitre weight and higher screenings than Bannister and Yallara, especially in lower rainfall regions. Williams grain has a higher level of grain ß-glucan. Williams is suitable for export hay. Its hay yields are around 0.5-1.0t/ha lower 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/m^2 is required when grown for export hay. Williams is the third most widely sown oat variety, occupying 14% of oat planted area in 2021.

Grain yield (% Bannister)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	95	96	101	97	98
Agzone 3	94	100	99	94	95
Agzone 4	96	102	108	98	90
Agzone 5	88	100	100	98	98
Agzone 6	86	95	95	97	94
Statewide	93	97	101	96	96

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 assessment

YALLARA(ᵇ)

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. Yallara's hay yields are slightly higher than Williams and comparable to the specialist hay variety Brusher. It can produce high-quality hay with moderately fine stems. Yallara 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 was the fourth most popular oat variety in WA in 2021, occupying under 6% of the area sown to oats.

Grain yield (% Bannister)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	79	80	93	87	75
Agzone 3	85	78	82	85	89
Agzone 4	68	84	96	72	88
Agzone 5	70	85	98	80	85
Agzone 6	80	78	76	54	71
Statewide	78	80	89	79	81
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				

p = provisional assessment

DURACK(ᵇ)

OAT2 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 ß-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. Whilst 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 sown in frost-prone areas. Durack is suitable for export hay, but its hay yields are generally lower than Carrolup and Williams. Durack is susceptible to oat Septoria and OSR. Durack was the eight most popular oat variety in 2021 but occupying only just over 1.5% of the area sown to oats.

Grain yield (% Bannister)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	81	76	92	94	80
Agzone 3	80	79	75	84	88
Agzone 4	68	87	91	130	81
Agzone 5	65	82	101	80	80
Agzone 6	73	65	76	61	76
Statewide	76	76	87	85	81
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	MR				
Stem rust	SVS				
BYD and CYD	MSS				
RLN (*P. neglectus*)	MS				
RLN (*P. quasitereoides*)	S*p*				
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 assessment

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 not preferred by the export industry. Hay yields are generally higher than Carrolup, with improved digestibility and water-soluble carbohydrates. Wandering is very susceptible to OLR and OSR. Wandering was the fifth most popular oat variety, occupying 5.5% of the area sown to oats in 2021.

Grain yield (% Bannister)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	98	96	101	101	100
Agzone 3	94	100	96	96	96
Agzone 4	97	104	106	119	91
Agzone 5	89	100	102	99	97
Agzone 6	87	91	96	99	96
Statewide	94	97	100	99	97

Disease resistance	Rating
Septoria	MSS
Leaf rust	VS
Stem rust	SVS
BYD and CYD	MSS
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

p = provisional assessment

BILBY(ɒ)

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. Its 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 high ß-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 2% of the area sown to oats in 2021.

Grain yield (% Bannister)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	98	92	96	104	96
Agzone 3	94	92	86	97	97
Agzone 4	89	96	92	141	95
Agzone 5	91	92	104	94	91
Agzone 6	94	83	93	88	94
Statewide	94	90	94	99	95

Disease resistance	Rating
Septoria	SVS
Leaf rust	MRMS
Stem rust	SVS
BYD and CYD	S
RLN (*P. neglectus*)	MS*p*
RLN (*P. quasitereoides*)	VS*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	-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 assessment

KOWARI(ƀ)

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 is an improvement over Mitika for grain yield at a comparable grain quality and slightly longer straw. Kowari grain is attractive to millers seeking health claims for their products as it has a higher level of grain ß-glucan. Kowari is susceptible to oat Septoria and OSR. Kowari grain has low hull lignin, which improves feed grain quality. Kowari occupied less than 0.5% of the area sown to oats in 2021.

Grain yield (% Bannister)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	93	86	94	102	93
Agzone 3	88	88	82	93	94
Agzone 4	82	93	89	150	89
Agzone 5	82	87	102	89	86
Agzone 6	87	74	88	83	91
Statewide	89	85	92	96	92
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 / -				

p = provisional assessment

MITIKA(ƀ)

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 significantly lower than Bannister and Williams. Mitika grain is comparable to Kowari for hectolitre weight and grain plumpness, but the variety is lower yielding. Mitika, like Kowari, has higher levels of ß-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 2021.

Grain yield (% Bannister)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	88	82	93	97	-
Agzone 3	85	85	81	89	-
Agzone 4	78	91	90	134	-
Agzone 5	76	85	100	85	-
Agzone 6	82	72	84	76	-
Statewide	83	82	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	0X87;072-13/0X87;080-1//0X88;045-12				
Breeder / Seed licensee	SARDI / Barenbrug				
Access to seed	Barenbrug				
EPR ($/t, excl GST) (grain / hay)	$2.00 / -				

p = provisional assessment

KOALA(Þ)

NOT YET EVALUATED FOR MILLING

Comments

Koala (tested as SV09143-35) is a late spring, tall grain oat derived from Bannister that is yet to be evaluated for its milling potential. Its suitability for export hay has not been established. Koala has similar tolerance to oat Septoria and OLR as Bannister but is improved for OSR. Grain quality packages for Bannister and Koala (hectolitre weight and screenings through a 2.0mm sieve) are similar. Koala seed will be bulked in WA in 2023. 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)	2017	2018	2019	2020	2021
Agzone 1	-	-	-	-	-
Agzone 2	100	103	93	93	100
Agzone 3	107	100	109	100	102
Agzone 4	103	91	87	47	108
Agzone 5	111	98	90	99	104
Agzone 6	116	116	105	105	106
Statewide	106	103	99	95	102

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	–
Stem diameter	–

Variety information	
Pedigree	02088-70/Bannister
Breeder / Seed licensee	SARDI / Seednet
Access to seed	Seednet Partners
EPR ($/t, excl GST) (grain / hay)	To be advised

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 next 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)	9.0	8.2
Digestibility (% dm)	65.5	65.6
CP (% dm)	6.2	6.1
WSC (% dm)	24.1	25.2
ADF (% dm)	33.7	33.0
NDF (% dm)	51.9	50.9
NDFDom30 (% dm)	52.2	51.8

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 assessment

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 over 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. Specialist hay varieties require greater detail to management than dual purpose varieties like Carrolup. Brusher grain has low hull lignin, which improves feed grain quality.

Hay yield and quality	Brusher	Carrolup
Hay yield (t/ha)	8.7	8.2
Digestibility (% dm)	66.8	65.6
CP (% dm)	6.4	6.1
WSC (% dm)	25.2	25.2
ADF (% dm)	33.2	33.0
NDF (% dm)	51.6	50.9
NDFDom30 (% dm)	52.6	51.8

Disease resistance	Rating
Septoria	MSS
Leaf rust	MR
Stem rust	S
BYD and CYD	SVS*p*
RLN (*P. neglectus*)	MS
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 assessment

FORESTER(b)

HAY VARIETY

Comments

Forester (tested as SV97200-3) is a tall, very late spring hay-only variety adapted to high rainfall areas. Forester reaches watery ripe about a month later than Brusher and Carrolup and is best suited to very early sowing opportunities in WA (i.e., early to mid-April). Forester has good early vigour, excellent straw strength and high shattering resistance. It has good hay colour, but like all late hay varieties, it may not resist hot dry winds than earlier varieties. Forester has excellent hay quality and is an improvement compared to Tammar.

Hay yield and quality	Forester	Carrolup
Hay yield (t/ha)	-	8.2
Digestibility (% dm)	-	65.6
CP (% dm)	-	6.1
WSC (% dm)	-	25.2
ADF (% dm)	-	33.0
NDF (% dm)	-	50.9
NDFDom30 (% dm)	-	51.8

Disease resistance	Rating
Septoria	S
Leaf rust	–
Stem rust	–
BYD and CYD	–
RLN (*P. neglectus*)	–
RLN (*P. quasitereoides*)	–
CCN (resistance)	MS

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+35	+31	+28	+26	+24
Katanning	+31	+30	+29	+28	+28

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+33	+29	+26	+24	+22
Katanning	+29	+28	+27	+26	+25

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	Medium
Coleoptile + mesocotyl length	Extremely long
Hull lignin	Low
Stem diameter	Moderately thick

Variety information	
Pedigree	0T285/0X92;056-4
Breeder / Seed licensee	SARDI / AEXCO
Access to seed	AEXCO seed distributor
EPR ($/t, excl GST) (grain / hay)	$2.00 / $2.00

p = provisional assessment

KINGBALE(ɬ)

HAY VARIETY

Comments

Kingbale (tested as GIA17010-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. InterGrain is commercialising Kingbale. 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 has 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)	8.4	8.2
Digestibility (% dm)	65.2	65.6
CP (% dm)	5.8	6.1
WSC (% dm)	25.0	25.2
ADF (% dm)	33.9	33.0
NDF (% dm)	52.1	50.9
NDFDom30 (% dm)	52.7	51.8

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 assessment

KOORABUP(ɬ)

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. It has a comparable grain yield to Carrolup, allowing ease of seed bulk-up for next year's hay crop. Koorabup hay yields are lower than Archer and Brusher and close to Caaolup. It has better lodging and shattering resistance than Wintaroo and Brusher and is similar to Mulgara. Koorabup hay has quality tested poorly in breeder variety trials since 2017 and in National Hay Agronomy (NHA) trials.

Hay yield and quality	Koorabup	Carrolup
Hay yield (t/ha)	8.2	8.2
Digestibility (% dm)	65.2	65.6
CP (% dm)	5.8	6.1
WSC (% dm)	24.4	25.2
ADF (% dm)	33.7	33.0
NDF (% dm)	52.3	50.9
NDFDom30 (% dm)	52.6	51.8

Disease resistance	Rating
Septoria	MRMS
Leaf rust	MRMS
Stem rust	MSS
BYD and CYD	MS
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 assessment

KULTARR(þ)

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)	8.8	8.2
Digestibility (% dm)	66.1	65.6
CP (% dm)	5.9	6.1
WSC (% dm)	25.0	25.2
ADF (% dm)	34.0	33.0
NDF (% dm)	53.1	50.9
NDFDom30 (% dm)	53.8	51.8

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)	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 Brusher				
	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 assessment

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 its larger seed size at sowing to ensure a target denbsity of 320 plants/m^2 is acheived in medium to higher rainfall areas.

Hay yield and quality	Mulgara	Carrolup
Hay yield (t/ha)	8.7	8.2
Digestibility (% dm)	66.8	65.6
CP (% dm)	5.9	6.1
WSC (% dm)	26.1	25.2
ADF (% dm)	33.9	33.0
NDF (% dm)	50.8	50.9
NDFDom30 (% dm)	53.0	51.8

Disease resistance	Rating
Septoria	S
Leaf rust	RMR
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 assessment

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, of comparable hay quality, and has a similar disease resistance profile. Older hay varieties such as Swan (first registered in 1967) are not widely accepted by export due to their thicker stems. Best suited to lower rainfall environments. Swan grain has low hull lignin, which improves feed grain quality.

Hay yield and quality	Swan	Carrolup
Hay yield (t/ha)	8.8	8.2
Digestibility (% dm)	–	65.6
CP (% dm)	–	6.1
WSC (% dm)	–	25.2
ADF (% dm)	–	33.0
NDF (% dm)	–	50.9
NDFDom30 (% dm)	–	51.8

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

p = provisional assessment

TAMMAR(p)

HAY VARIETY

Comments

Tammar (tested as SV96098-24) is a medium-tall, late hay oat variety. Recommended for medium and high rainfall zones and provides a later cutting option. Tammar reaches watery ripe about seven days later than Brusher and nine days later than Carrolup across a range of sowing dates. Hay yields in breeder's trials were comparable to Carrolup, with improved digestibility and WSC. Tammar has excellent early vigour, lodging and shattering resistance. Tammar has excellent hay colour and resists brown leaf at hay cutting.

Hay yield and quality	Swan	Carrolup
Hay yield (t/ha)	8.7	8.2
Digestibility (% dm)	–	65.6
CP (% dm)	–	6.1
WSC (% dm)	–	25.2
ADF (% dm)	–	33.0
NDF (% dm)	51.8	50.9
NDFDom30 (% dm)	–	51.8

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	+9	+9	+9	+9	+9
Katanning	+9	+9	+9	+9	+10

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+7	+7	+7	+7	+7
Katanning	+7	+7	+7	+7	+7

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	-
Coleoptile + mesocotyl length	Extremely long
Hull lignin	Segregating
Stem diameter	Moderately fine

Variety information	
Pedigree	Zlatak/Euro//OX89;153-122
Breeder / Seed licensee	SARDI / AEXCO
Access to seed	AEXCO seed distributor
EPR ($/t, excl GST) (grain / hay)	$2.00 / $2.00

p = provisional assessment

TUNGOO(Þ)

HAY VARIETY

Comments

Tungoo (tested as SV95137-6-3) is a medium-tall, late season hay-only oat variety. Recommended for medium and high rainfall zones and provides a later cutting option. Tungoo reaches watery ripe about seven days later than Brusher and nine days later than Carrolup across a range of sowing dates. Hay yields in breeder's trials were slightly above Carrolup, with improved digestibility and similar quality for WSC and fibre. Has excellent resistance to oat Septoria and OLR. Tungoo grain has low hull lignin, which improves feed grain quality.

Hay yield and quality	Tungoo	Carrolup
Hay yield (t/ha)	8.5	8.2
Digestibility (% dm)	–	65.6
CP (% dm)	–	6.1
WSC (% dm)	–	25.2
ADF (% dm)	–	33.0
NDF (% dm)	51.3	50.9
NDFDom30 (% dm)	–	51.8

Disease resistance	Rating
Septoria	MRMS
Leaf rust	MR
Stem rust	MSS
BYD and CYD	MS
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	+9	+9	+9	+9	+9
Katanning	+9	+9	+9	+9	+9
'FlowerPower' predicted days to watery ripe (Z71)	**Relative to Brusher**				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+7	+7	+7	+7	+7
Katanning	+7	+7	+7	+7	+6

Agronomic traits	
Plant type	Non-dwarf
Coleoptile length	-
Coleoptile + mesocotyl length	Extremely long
Hull lignin	Low
Stem diameter	Moderate

Variety information	
Pedigree	Glider/OX89;019-137
Breeder / Seed licensee	SARDI / AEXCO
Access to seed	AEXCO seed distributor
EPR ($/t, excl GST) (grain / hay)	$2.00 / $2.00

p = provisional assessment

WALLABY(Þ)

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 likely suited to medium and high rainfall zones and is 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 next 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)	8.3	8.2
Digestibility (% dm)	68.6	65.6
CP (% dm)	5.9	6.1
WSC (% dm)	26.1	25.2
ADF (% dm)	32.9	33.0
NDF (% dm)	49.7	50.9
NDFDom30 (% dm)	52.7	51.8

Disease resistance	Rating
Septoria	MSS*p*
Leaf rust	MR*p*
Stem rust	MS*p*
BYD and CYD	MSS*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 Brusher**				
	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 assessment

WINJARDIE

HAY VARIETY

Comments

Winjardie (tested as Oat 146) is a tall, medium spring hay oat variety. Its 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)	8.7	8.2
Digestibility (% dm)	–	65.6
CP (% dm)	–	6.1
WSC (% dm)	–	25.2
ADF (% dm)	–	33.0
NDF (% dm)	–	50.9
NDFDom30 (% dm)	–	51.8

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 assessment

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. Specialist hay varieties require more detail to management than dual purpose varieties like Carrolup. Wintaroo hay is sought after by export hay houses. Experienced hay growers with cutting, conditioning and bailing equipment or access to a contractor will be advantaged 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)	8.6	8.2
Digestibility (% dm)	65.9	65.6
CP (% dm)	5.9	6.1
WSC (% dm)	24.7	25.2
ADF (% dm)	33.8	33.0
NDF (% dm)	51.6	50.9
NDFDom30 (% dm)	52.4	51.8

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 Brusher				
	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

p = provisional assessment

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AgriFutures™ Export Fodder

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 (DEDJTR – Vic DPI), Sam Catt, 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 in 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 National Variety Trials (2013 to 2018) in WA and break-even yield, based on a five-year average price

Crop	NVT yields (t/ha)			Break even yield (t/ha)		
	Mean	Minimum	Maximum	Low rainfall	Medium rainfall	High rainfall
Barley: malt	3.4	0.3	6	0.8	1.4	1.7
Canola: TT	2.0	0.5	3.4	0.6	0.9	1.1
Chickpea	1.3	0.3	2.2	0.4	0.5	0.6
Faba Bean	2.6	0.7	4.0	0.6	1.0	1.3
Field Pea	1.6	0.4	2.9	0.7	0.9	1.2
Lentil	1.2	0.3	1.9	0.5	0.7	0.8
Lupin	2.1	0.3	4.1	0.7	0.9	1.1
Oat	3.3	0.8	6.1	0.8	1.3	1.7
Wheat	3.0	0.6	5.7	0.8	1.4	1.9

Source: NVT 2013 to 2018. PIRSA Farm Gross Margin Guide 2018

Picking a pulse

TABLE 2. Adaptation of canola, pulses and lupin to some soil factors

Crop	pH	Soil texture	Salinity tolerance rank	Boron tolerance rank	Comments
Canola	4 to 9	All			
Chickpea	5.2 to 9	Sandy loamy to clay	5	2 (Kabuli varieties) 5 (Desi varieties)	
Faba bean	5.2 to 9	Loam-clay	1	1	Lower pH ok in higher rainfall areas
Field pea	5 to 9	Loamy sand to clay	2	2 (Dun varieties) 4 (White varieties)	
Lentil	5.2 to 9	Loam-clay	4	5	Herbicide damage an issue on sandier soils
Lupin: narrow-leaf	4 to 7	Sand to sandy loam	3	-	
Lupin: albus	6 to 7.5	Loamy sand to loam	4	-	Higher pH than narrow-leaf lupins
Vetch	5 to 9	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 = pick low weed 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	• Canola being the first sown crop in the rotation has reduced the pressure on lupin. • Sclerotinia stem and pod rot is 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/ 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®
WHP 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
WHP 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

WHP = withholding period

LUPIN

Introduction

Narrow-leafed lupins are uniquely suited to the acid and sandy soils found across large tracts of the Western Australian wheatbelt 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 around $200 million.

RECENT RELEASE

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, so lupin stubbles should be grazed with care in high-risk environments.

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.

TABLE 1. Grain yield of narrow-leaf lupin varieties in AGZONE 1 expressed as percentage of site mean yield for each trial year (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	1.92	2.64	1.03	1.34	3.51
No. of trials	(1)	(3)	(2)	(1)	(1)
Coromup	96	94	100	98	95
Coyote	111	106	108	118	112
Danja	89	-	-	-	-
Jenabillup	94	101	-	-	-
Mandelup	101	-	93	96	104
PBA Barlock	98	-	87	91	102
PBA Bateman	-	102	104	110	106
PBA Gunyidi	103	-	101	107	104
PBA Jurien	107	-	97	105	-
PBA Leeman	-	98	93	89	93
Tanjil	94	-	-		-
Wonga	-	-	73	74	90

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 (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	1.81	2.06	1.67	1.90	2.98
No. of trials	(6)	(5)	(7)	(5)	(5)
Coromup	94	94	98	93	94
Coyote	117	107	106	128	116
Danja	79	-	-	-	-
Jenabillup	94	100	-	-	-
Mandelup	103	-	97	103	106
PBA Barlock	99	-	92	100	104
PBA Bateman	-	103	102	116	108
PBA Gunyidi	105	-	100	111	106
PBA Jurien	112	-	101	117	-
PBA Leeman	-	97	94	85	91
Tanjil	91	-	-	-	-
Wonga	-	-	78	78	88

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 (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	1.10	2.36	0.67	1.37	2.04
No. of trials	(2)	(3)	(3)	(3)	(5)
Coromup	99	93	93	94	92
Coyote	105	102	107	120	110
Danja	101	-	-	-	-
Jenabillup	94	96	-	-	-
Mandelup	96	-	101	101	108
PBA Barlock	92	-	94	97	106
PBA Bateman	-	99	101	110	103
PBA Gunyidi	101	-	97	107	101
PBA Jurien	99	-	107	112	-
PBA Leeman		99	92	88	94
Tanjil	91	-	-	-	-
Wonga	-	-	71	76	89

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 (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	3.05	1.83	1.21	1.52	2.60
No. of trials	(1)	(1)	(1)	(2)	(2)
Coromup	98	93	98	94	93
Coyote	100	103	105	113	110
Danja	98	-	-	-	-
Jenabillup	96	86	-	-	-
Mandelup	101	-	101	103	105
PBA Barlock	100	-	100	99	101
PBA Bateman	-	98	102	106	103
PBA Gunyidi	99	-	101	103	101
PBA Jurien	102	-	104	110	-
PBA Leeman	-	-	97	92	93
Tanjil	101	-	-	-	-
Wonga	-	-	93	81	83

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 (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	1.74	0.91	1.96	1.97	1.73
No. of trials	(1)	(1)	(1)	(1)	(1)
Coromup	97	73	89	89	90
Coyote	119	171	105	129	105
Danja	75	-	-	-	-
Jenabillup	110	119	-	-	-
Mandelup	104	-	109	109	108
PBA Barlock	105		104	106	104
PBA Bateman	-	139	98	115	98
PBA Gunyidi	111	-	94	110	96
PBA Jurien	112	-	116	124	
PBA Leeman	-	-	94	84	94
Tanjil	91	-	-	-	-
Wonga	-	-	78	78	82

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 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
Coyote	MRMS*p*	MS*p*	MRMS	MRMS	S*p*
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*p*	MR
Tanjil	RMR	MS	MR	MR	MR

Source: NVT Online, **nvtonline.com.au**, AGT and DPIRD

R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant, MRMS = moderately resistant to moderately susceptible, MS = moderately susceptible, S = susceptible, *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	MS	R
Coyote	-	R	MRMS	-
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	MR	R
PBA Leeman	MRMS	R	MS	R
Tanjil	MR	R	MS	R

Source: DPIRD

R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant, MRMS = moderately resistant to moderately susceptible, MS = moderately susceptible, S = susceptible

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	**15.9**	**100 (32%)**	**100 (0.017%)**
Coromup	15.8	-	-
Coyote^	15.1	Similar to Mandelup	Similar to Mandelup and PBA Jurien
Jenabillup	16.0	103	67
PBA Barlock	14.8	97	115
PBA Bateman	16.2	-	-
PBA Gunyidi	14.4	102	100
PBA Jurien	15.9	102	105
PBA Leeman	15.8	-	-
Tanjil	13.7	100	113

Source: *NVT data; # 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 good 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 on paddocks growing 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.
- Carbetamide 900g/kg, Group 23/E, e.g., Ultro® 900 WG at 1.1–2.3kg/ha. DO NOT apply carbetamide pre-sowing if planting with disc seeder as greater contact between the germinating seed and herbicide may reduce crop safety.
- Dimethenamid-P 720g/L®, Group 15/K, e.g., Outlook® at 1L/ha.
- 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.
- 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.
- Pendimethalin 440g/L, Group 3/D, e.g., Stomp® at 1.5–2.25L/ha.
- Propyzamide 900g/kg, Group 3/D, e.g., Edge® 900 WG at 0.56–1.11kg/ha.
- 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 (0.55–1.1kg/ha on light soils and 1.1–1.6kg/ha on heavy soils).
- Terbuthylazine 875g/kg, Group 5/C, e.g., Terbyne® Xtreme® at 0.86–1.2kg/ha.
- Terbuthylazine 600g/kg (Group 5/C) + Propyzamide 300g/kg (Group 3/D), e.g., Effigy® 900 WG at 1.25–1.75kg/ha.
- 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.
- Trifluralin 350g/L (Group 3/D) + Tri-allate 550g/L (Group 15/J), e.g., Jetti Duo® at 1.45–1.8L/ha.

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.
- Simazine 900g/kg, Group 5/C, e.g., Simagranz® at 0.55–1.6kg/ha (0.55–1.1kg/ha on light soils and 1.1–1.6kg/ha on heavy soils).
- Terbuthylazine 875g/kg, Group 5/C, e.g., Terbyne® Xtreme® at 0.6–0.86kg/ha. Apply within two days of sowing.

Important points to consider when using pre-emergent herbicides

- Soil type will influence the maximum rate of pre-emergent herbicides that can be applied; 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.
- Do not apply simazine, atrazine and diuron, Group 5/C, on deep-white or grey sands.
- 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 the 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 (before start of main stem flowers).
- Metosulam 100g/L, Group 2/B, e.g., Eclipse® at 50–70mL/ha. Application window is between 8-leaf stage of crop to the appearance of flower bud/big bud.
- 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).
- 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.
- Picolinafen 750g/kg, Group 12/F, e.g., Glocker® 750 WG at 33–50g/ha. Apply at 2–6 leaf stage.
- 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). 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). 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). 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. 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). Do not apply in mixture with diflufenican (e.g., Brodal® Options), Group 12/F, or simazine, Group 5/C, as crop yellowing may occur — separate applications are recommended. Apply from 2nd-leaf to pre- flowering crop growth stages.
- 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). 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% and a mineral spray oil at 1% (v/v). 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. It is advised not to use oils and wetters with metosulam and to apply metosulam only on healthy crops from eight leaves to the visible bud stage.
- 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.
- 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 budworm 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.

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 (page 157), 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. AVPMA permits for products containing iprodione (PER91185) or boscalid (PER82240) for control of sclerotinia in lupin are current.
- **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 tolerance to ascochyta have become available and robust fungicide packages have been developed.

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 should be available to growers in 2022. 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	100-seed weight	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 at maturity.

CBA Captain is likely to have a moderately susceptible ascochyta blight rating, which is greater than PBA Striker (rated as susceptible).

The Centre for Crop and Disease Management (CCDM) evaluated the ascochyta resistance of CBA Captain to WA ascochyta isolates in both 2019 and 2020 field trials at DPIRD, South Perth.

CBA Captain showed no significant differences in ascochyta resistance to Genesis 090, Genesis 836, Kalkee, PBA HatTrick and PBA Striker, but was significantly more resistant than Jimbour, Kyabra, Moti and PBA Howzat when inoculated with a mix of WA ascochyta isolates.

CBA Captain has superior grain quality (coat colour, texture and shape) to all current WA chickpea varieties and is considered '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 (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	**0.45**	**1.34**	**0.90**	**1.53**	**1.75**
No. of trials	**(2)**	**(2)**	**(1)**	**(1)**	**(1)**
Desi type					
Ambar	95	104	-	-	-
CBA Captain	121	106	110	114	105
Genesis 079	80	94	-	-	-
Genesis 510	102	-	-	-	-
Genesis 836	91	89	93	94	97
Neelam	95	96	102	110	105
PBA Maiden	97	95	106	94	99
PBA Slasher	99	99	105	107	104
PBA Striker	109	106	108	111	105
Kabuli type					
Genesis 090	82	79	95	83	81

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 (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	**1.03**	**0.58**	**0.40**	**0.80**	**1.57**
No. of trials	**(1)**	**(1)**	**(1)**	**(2)**	**(2)**
Desi type					
Ambar	103	95	-	-	-
CBA Captain	103	102	109	107	103
Genesis 079	98	99	-	-	-
Genesis 510	95		-	-	-
Genesis 836	92	101	117	90	92
Neelam	91	100	111	98	101
PBA Maiden	90	106	107	97	97
PBA Slasher	93	102	106	100	102
PBA Striker	101	101	97	107	105
Kabuli type					
Genesis 090	91	92	98	82	92

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**

TABLE 5. Grain yield of chickpea varieties in AGZONE 4 expressed as percentage of site mean yield for each trial year (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	**0.55**	**1.32**	**0.84**	**1.25**	**1.24**
No. of trials	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**
Desi type					
Ambar	102	97	-	-	-
CBA Captain	127	99	113	117	102
Genesis 079	69	102	-	-	-
Genesis 510	109		-	-	-
Genesis 836	103	100	96	94	93
Neelam	117	102	101	105	102
PBA Maiden	100	107	108	89	93
PBA Slasher	112	103	104	103	101
PBA Striker	112	101	107	110	105
Kabuli type					
Genesis 090	63	97	66	77	98

Source: NVT Online, **nvtonline.com.au**

TABLE 6. Grain yield of chickpea varieties in AGZONE 5 expressed as percentage of site mean yield for 2020

Year	2020	2021
Site mean yield (t/ha)	1.20	0.82
No. of trials	(1)	(1)
Desi type		
CBA Captain	110	103
Genesis 836	88	84
Neelam	94	109
PBA Striker	86	107
Kabuli type		
Genesis 090	79	82

Source: NVT Online, **nvtonline.com.au**

DISEASE RATINGS FOR SELECTED CHICKPEA VARIETIES

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*p*
Neelam	S	S	MRMS
PBA Striker	S	S	MRMS
Kabuli type			
Genesis 090	MS	S	MRMS

Source: NVT Online, **nvtonline.com.au**

R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant, MRMS = moderately resistant to moderately susceptible, MS = moderately susceptible, S = susceptible, *p* = provisional rating

* Aggressive strains of *ascochyta rabiei* have been detected in WA. Growers need to be vigilant and apply fungicides if disease levels are higher than expected for the resistance rating of the variety.

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]
	Wongan Hills NVT 2020	Mingenew NVT 2020	Merredin NVT 2020		
Desi type					
Ambar	-	-	-	Early	Very good
CBA Captain	55	70	60	Mid(*p*)	Very good(*p*)
Genesis 836	50	64	59	-	-
Neelam	47	61	55	Mid	Very good
PBA Striker	50	66	57	Early	Moderate
Kabuli type					
Genesis 090	44	62	56	Mid-Late	Good

Source: [1]Wongan Hills, Merredin and Mullewa NVT trials October 2020, [2]NSW DPI Winter crop variety sowing guide (2020)

p = provisional rating

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.
- Few 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 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.

Sowing depth

- Aim for 5cm.
- Can be sown deeper to chase moisture.

Seed dressing and rhizobia

- P-Pickel T, 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.

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/m^2
- Kabuli: 30–35 plants/m^2

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

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 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.
- Dimethenamid-P 720g/L®, Group 15/K, e.g., Outlook® at 1L/ha.
- 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.
- Pendimethalin 440g/L, Group 3/D, e.g., Stomp® at 1.5–2.25L/ha.
- Propyzamide 900g/kg, Group 3/D, e.g., Edge® 900 WG at 0.56–1.11kg/ha.
- 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.
- Terbuthylazine 875g/kg, Group 5/C, e.g., Terbyne® Xtreme® at 0.86–1.2kg/ha.
- 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.
- Terbuthylazine 600g/kg (Group 5/C) + Propyzamide 300g/kg (Group 3/D), e.g., Effigy® 900 WG at 1.25–1.75kg/ha.
- 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 DF, Group 5/C.
- Trifluralin 350g/L (Group 3/D) + Tri-allate 550g/L (Group 15/J), e.g., Jetti Duo® at 1.45-1.8L/ha.

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.
- 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.
- Isoxaflutole 750g/kg, Group 27/H, e.g., Balance® or Palmero® at 100g/ha.
- Metribuzin 750g/kg, Group 5/C, e.g., Mentor® WG or Stacato® at 180–380g/ha.
- Simazine 900g/kg, Group 5/C, e.g., Simagranz® at 0.55–1.1kg/ha.
- Terbuthylazine 875g/kg, Group 5/C, e.g., Terbyne® Xtreme® at 0.6–0.86kg/ha. Apply within two days of sowing.
- 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 1kg/ha.

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). 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). Do not apply beyond full flowering.
- Fluazifop-p 128g/L, Group 1/A, e.g., Fusilade® Forte at 500mL/ha. 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). There should be at least one-week gap between application of haloxyfop and broadleaf herbicides. Apply from 2nd-leaf to pre-flowering crop growth stages.
- 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). 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% and a mineral spray oil at 1% (v/v). Apply up until 12 weeks before crop harvest.

v/v = volume by volume of final spray solution.

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. 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 P-Pickel T seed dressing. This gives about four weeks of protection after which the requirement for foliar fungicide application should be assessed.

Post-emergence 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 (page 157).
- To manage ascochyta, apply 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.
- Veritas Opti® fungicide (370g/L tebuconazole, 222g/L azoxystrobin) is registered for control of ascochyta blight and botrytis grey mould in chickpea crops at an application rate of 400–540mL/ha.
- Miravis Star® (pydiflumetofen 100g/L + fludioxonil 150g/L) is registered for control of ascochyta at a rate of 250-500mL/ha and for botrytis grey mould and sclerotinia of chickpea at 750–1000mL/ha.
- Aviator® Xpro® foliar fungicide (bixafen 75g/L, prothioconazole 150g/L) is registered for control of ascochyta blight in chickpeas at an application rate of 400–600mL/ha.
- Amistar Xtra® (asoxystrobin 200g/L + cyproconazole 80g/L) is registered for ascochyta and botrytis grey mould at a rate of 400–800mL/ha.
- Visit Pulse Australia website to find latest fungicide product information – www.pulseaus.com.au/growing-pulses/crop-protection-products

Desiccation

- Desiccation can be used as a harvest aid.
- 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 ripening and weed problems at harvest. Do not harvest for two days after application.
- Glyphosate 690g/kg, Group 9/M, e.g., Roundup Ready® herbicide with PLANTSHIELD® at 530 to 1400g/ha. 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.
- 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 to 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.

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-to-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 EPR of $3.85 per tonne (GST inclusive), 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 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-to-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 end point royalty (EPR) of $3.90/t.

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.

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 (2020–21)

	Agzone 3		Agzone 5	
Year	2020	2021	2020	2021
Site mean yield (t/ha)	1.50	2.90	1.92	2.49
No. of trials	(1)	(2)	(1)	(2)
Farah	108	101	99	99
Fiesta VF	114	104	98	98
Nura	103	101	100	100
PBA Amberley	114	99	96	98
PBA Bendoc	85	97	102	102
PBA Marne	92	112	110	102
PBA Rana		91		86
PBA Samira	112	96	92	96
PBA Zahra	89	99	96	98

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.

R = resistant, MR = moderately resistant, MS = moderately susceptible and S = susceptible.

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	RMR	S	MRMS	MS	VS
PBA Bendoc	MR	S	S	MRMS	VS
PBA Marne	MS*p*	S	S	MS	MRMS
PBA Rana	MRMS	S	MS	MS	VS
PBA Samira	RMR	S	MS	MRMS	S
PBA Zahra	MRMS	S	MS	MRMS	S

Source: NVT Online, **nvtonline.com.au**

R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant, MRMS = moderately resistant to moderately susceptible, MS = moderately susceptible, S = susceptible.

#Nematode resistance ratings have not been tested in Western Australia and should be used as a guide only.

p = provisional classification.

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 5.4–8.0 (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. 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.
- 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.
- Pendimethalin 440g/L, Group 3/D, e.g., Stomp® at 1.5–2.25L/ha.
- Propyzamide 900g/kg, Group 3/D, e.g., Edge® 900 WG at 0.56–1.11kg/ha.
- 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.
- Terbuthylazine 600g/kg (Group 5/C) + Propyzamide 300g/kg (Group 3/D), e.g., Effigy® 900 WG at 1.25–1.75kg/ha.
- 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 + 1.1 kg/ha Simazine 900 DF, Group 5/C.

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.
- Imazethapyr 700g/kg, Group 2/B, e.g., Spinnaker® WDG at 70g/ha.
- 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.
- 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 600–860g/ha. Apply within two days of sowing.

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.
- 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 herbicides susceptible grass and broadleaf weeds.

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). 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). Do not apply beyond full flowering.
- Fluazifop-p 128g/L, Group 1/A, e.g., Fusilade® Forte at 410mL/ha. 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). There should be at least a one-week gap between application of haloxyfop and broadleaf herbicides. Apply from 2nd-leaf to pre-flowering crop growth stages.
- 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). 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% and a mineral spray oil at 1% (v/v). 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 the majority of fungicide 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.

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® (asoxystrobin + 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® (asoxystrobin + cyproconazole).

Cercospora

- Often seen 6–8 weeks after sowing.
- Suggested fungicides are Veritas® (tebuconazole + azoxystrobin), Miravis Star® (pydiflumetofen + fludioxonil), Aviator® Xpro® (prothioconazole + bixafen), or Amistar Xtra® (asoxystrobin + 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 to 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.

- 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

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 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.

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.

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 that found 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 (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	0.56	1.48	1.17	3.13	2.16
No. of trials	(1)	(2)	(1)	(1)	(1)
GIA Kastar	-	-	-	92	83
GIA Ourstar	-	-	-	85	87
Kaspa	101	95	101	101	96
Parafield	58	78	-	-	-
PBA Butler	102	103	99	105	103
PBA Gunyah	108	98	104	101	99
PBA Oura	99	98	101	96	99
PBA Pearl	86	104	93	100	-
PBA Percy	128	96	112	93	-
PBA Taylor	122	106	106	106	105
PBA Twilight	95	93	102	96	94
PBA Wharton	110	101	105	101	100

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 (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	1.63	1.33	0.87	2.00	2.33
No. of trials	(2)	(2)	(1)	(1)	(1)
GIA Kastar	-	-	-	88	83
GIA Ourstar	-	-	-	80	78
Kaspa	103	108	99	93	92
Parafield	78	87	-	-	-
PBA Butler	107	124	107	103	104
PBA Gunyah	104	97	99	97	96
PBA Oura	95	80	95	96	96
PBA Pearl	93	104	103	105	-
PBA Percy	95	29	90	80	-
PBA Taylor	112	108	108	104	103
PBA Twilight	98	96	92	99	96
PBA Wharton	105	98	99	107	104

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 (2017–2020)

Year	2017	2018	2019	2020
Site mean yield (t/ha)	1.66	1.12	2.19	2.08
No. of trials	(1)	(1)	(1)	(1)
GIA Kastar	-	-	-	85
GIA Ourstar	-	-	-	73
Kaspa	113	85	98	101
Parafield	81	78	85	
PBA Butler	128	96	104	109
PBA Gunyah	101	93	100	101
PBA Oura	83	106	99	93
PBA Pearl	103	118	102	99
PBA Percy	67	121	109	87
PBA Taylor	119	102	108	112
PBA Twilight	76	79	89	94
PBA Wharton	85	92	96	103

Source: NVT Online, **nvtonline.com.au**

TABLE 4. Grain yield of field pea varieties in AGZONE 4 expressed as percentage of site mean yield for each trial year (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	1.04	1.88	0.62	1.57	1.03
No. of trials	(1)	(1)	(1)	(1)	(1)
GIA Kastar	-	-	-	97	67
GIA Ourstar	-	-	-	76	95
Kaspa	105	99	101	95	80
Parafield	65	70	-	-	-
PBA Butler	109	104	120	106	93
PBA Gunyah	107	103	101	96	92
PBA Oura	94	96	81	93	105
PBA Pearl	88	94	97	105	-
PBA Percy	106	93	36	64	-
PBA Taylor	121	111	118	102	97
PBA Twilight	95	103	104	103	91
PBA Wharton	107	111	117	108	102

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 (2017–2021)

Year	2017	2018	2019	2020	2021
Site mean yield (t/ha)	1.36	0.91	0.68	1.22	1.58
No. of trials	(4)	(4)	(4)	(4)	(4)
GIA Kastar	-	-	-	83	76
GIA Ourstar	-	-	-	85	80
Kaspa	109	92	94	93	94
Parafield	94	70	85	-	-
PBA Butler	114	94	98	102	105
PBA Gunyah	102	102	99	97	95
PBA Oura	92	103	100	98	97
PBA Pearl	98	97	102	106	-
PBA Percy	89	118	98	93	-
PBA Taylor	110	108	102	104	103
PBA Twilight	89	100	101	95	90
PBA Wharton	92	110	106	102	96

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

R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant, MRMS = moderately resistant to moderately susceptible, MS = moderately susceptible, S = susceptible. *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	R*p*	S*p*	-
GIA Ourstar	S	MS*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	R*p*	S	R

Source: NVT Online, **nvtonline.com.au**

R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant, MRMS = moderately resistant to moderately susceptible, MS = moderately susceptible, S = susceptible. *p* = provisional rating.

TABLE 9. Nematode resistance of field pea varieties (Victorian ratings)

Variety	*Pratylenchus neglectus* resistance	*Pratylenchus thornei* resistance
GIA Kastar	RMR*p*	S*p*
GIA Ourstar	MRMS*p*	SVS*p*
Kaspa	RMR	MRMS
PBA Butler	RMR	MRMS
PBA Gunyah	RMR	MRMS
PBA Oura	MR	MRMS
PBA Pearl	RMR	MRMS
PBA Percy	RMR	RMR
PBA Taylor	RMR	MRMS
PBA Twilight	RMR	MRMS
PBA Wharton	RMR	MRMS

Source: NVT Online, **nvtonline.com.au** Nematode resistance relates to the effect of the variety on the nematode density present within the paddock.

R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant, MRMS = moderately resistant to moderately susceptible, MS = moderately susceptible, S = susceptible. *p* = provisional rating.

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 can be advisable to only grow the same type of varieties on your farm to avoid 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/m^2.
- 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 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.
- Dimethenamid-P 720g/L®, Group 15/K, e.g., Outlook® at 1L/ha.
- 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.
- 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).
- Pendimethalin 440g/L, Group 3/D, e.g., Stomp® at 1.5–2.25L/ha.
- Propyzamide 900g/kg, Group 3/D, e.g., Edge® 900 WG at 0.56–1.11kg/ha.
- 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.
- Terbuthylazine 600g/kg (Group 5/C) + Propyzamide 300g/kg (Group 3/D), e.g., Effigy® 900 WG at 1.25–1.75kg/ha.
- 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.
- Trifluralin 350g/L (Group 3/D) + Tri-allate 550g/L (Group 15/J), e.g., Jetti Duo® at 1.45–1.8L/ha.

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.
- Imazethapyr 700g/kg, Group 2/B, e.g., Spinnaker® WDG at 70g/ha.
- 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).

- Terbuthylazine 875g/kg, Group 5/C, e.g., Terbyne® Xtreme® at 600–860g/ha. Apply within two days of crop sowing.

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.
- 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.
- 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 with it.
- Imazamox 700g/kg, Group 2/B, e.g., Raptor® at 45g/ha + BS1000® at 0.2% (v/v). Do not apply after four-node stage of crop.
- 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. 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 may delay maturity 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.
- 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.

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). 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). 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). Do not spray when temperatures are higher than 25°C.
- Fluazifop-p 128g/L, Group 1/A, e.g., Fusilade® Forte at 500mL/ha. 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). 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.
- 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). 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% and a mineral spray oil at 1% (v/v). 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 to 14 days after flowering commences. Border spraying is an effective strategy in most areas. Control of pea weevil is needed when there are 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.

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 to 3 L/ha. Spray as soon as the crop has reached full maturity.
- Glyphosate 690g/kg, Group 9/M, e.g., Roundup Ready® herbicide with PLANTSHIELD® at 250 to 1400g/ha. 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.
- 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 to 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 300-600 rpm	Low 300-600 rpm
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-to-late April, which has resulted in rapid growth and good yields of 1.4 to 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 Leader was released in 2021 and is a medium seed-size red lentil with IMI tolerance. GIA Leader is a longer season variety best suited to areas with a favourable finish.

GIA Lightning was released in 2022 and is a small seeded red lentil with IMI tolerance and improved adaptation to lighter textured soils.

GIA Leader, GIA Lightning are available from PB Seeds and has an EPR of $5.40/t (GST excl.)

GIA Metro, GIA Sire and GIA Thunder were announced in 2022. GIA Metro has tolerance to metribuzin + IMI herbicides – particularly useful on light-textured soils prone to damage from the applications of 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.

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 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 and is licensed to PB Seeds.

GIA and XT lentil lines have tolerance to imidazolinone 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.

PBA Jumbo2 produces high yields in the rest of Australia and offers the best available disease ratings, but in most WA experiments PBA Jumbo2 has not produced higher yields than PBA Bolt.

PBA Hallmark XT and PBA Highland XT are XT lines better suited to WA than PBA Hurricane XT, which often lacks vigour in cooler southern regions.

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.

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.

GRAIN YIELD OF LENTIL VARIETIES

Refer to Tables 1 and 2.

TABLE 1. Grain yield of lentil varieties in AGZONE 1, AGZONE 2, AGZONE 3 and AGZONE 5 expressed as percentage of site mean yield for each trial year (2020–2021)

Agzone	Agzone 1		Agzone 2		Agzone 3	Agzone 5	
Year	2020	2021	2020	2021	2021	2020	2021
Site mean yield (t/ha)	1.68	1.55	1.40	1.70	1.92	0.47	1.71
No. of trials	(1)	(1)	(1)	(1)	(1)	(1)	(1)
GIA Leader	91	98	100	100	96	100	106
GIA Lightning	95	106	119	103	128	138	115
GIA Metro	-	71	-	73	68	-	76
GIA Sire	-	84	-	82	91	-	92
GIA Thunder	119	115	117	115	114	120	115
Nipper	37	-	54	-	-	81	-
PBA Ace	98	-	88	-	-	77	-
PBA Blitz	90	99	79	92	103	102	79
PBA Bolt	97	99	100	98	102	102	99
PBA Hallmark XT	95	95	122	94	124	124	108
PBA Highland XT	118	105	121	104	119	115	106
PBA Hurricane XT	97	99	109	98	113	114	104
PBA Jumbo2	117	109	93	113	80	80	102
PBA Kelpie XT	128	107	106	105	104	94	93

Source: NVT Online, **nvtonline.com.au**

LENTIL VARIETY CHARACTERISTICS

TABLE 2. 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

No variety is immune to disease, and fungicide application could be required under severe disease pressure.

TABLE 3. Lentil variety disease resistance ratings

Variety	Botrytis grey mould	Ascochyta blight (Hurricane Virulent)	Ascochyta Blight (Nipper Virulent)	Nematode resistance # (*Pratylenchus neglectus*)
GIA Leader	MR*p*	MRp	MR*p*	R
GIA Lightning	MS*p*	MRMS*p*	R*p*	R
GIA Metro	MRMS*p*	RMR*p*	MR*p*	MR
GIA Sire	MS*p*	MS*p*	Rp	MR
GIA Thunder	MRMS*p*	MRMS*p*	R*p*	MR
Nipper	MR*p*	MR	MRMS	RMR
PBA Ace	MS	RMR*p*	R	MR
PBA Blitz	MRMS*p*	MR	MRMS	MR
PBA Bolt	S	MRMS	MR	MR
PBA Hallmark XT	MR*p*	MRMS	RMR	MR
PBA Highland XT	MS	MR	MR	MR
PBA Hurricane XT	MS	MRMS	RMR	MRMS
PBA Jumbo2	RMR*p*	RMR*p*	R	MR
PBA Kelpie XT	MRMS*p*	MRMS	MRMS	MRMS

Source: NVT Online, **nvtonline.com.au**

R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant, MRMS = moderately resistant to moderately susceptible, MS = moderately susceptible, S = susceptible. *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 4. 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 classification

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.
- 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 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 to 6cm.

Seed dressing

- P-Pickel T (thiram + thiabendzole), let dry then apply Group FE 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/m^2. Recommended plant density provides better competition with weeds than lower densities and aids efficient harvest.

Seeding rate

- Small-seeded varieties (PBA Hurricane XT) 35 to 40kg/ha.
- Medium-sized varieties (PBA Bolt, PBA Hallmark XT) 40 to 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 spacing. Inter-row sowing between previous year's cereal rows can assist harvesting 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

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-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.
- 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 safety 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.
- Pendimethalin 440g/L, Group 3/D, e.g., Stomp® at 1.5–2.25L/ha.
- 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.
- 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.
- 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%).

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 (varieties: PBA Herald XT and PBA Hurricane XT only) and 70 to 100g/ha (PBA Hallmark XT only) as per permit PER87042 with validity up to 28 February 2024.
- 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.

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 3rd leaf and start of crop flowering.
- 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.
- 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 3–5 leaf stage of crop.

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). 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). Apply up to the seven node/ early branching of lentils.
- Haloxyfop-R 520g/L, Group 1/A, e.g., Verdict® at50–100mL/ha + Uptake® oil at 0.5% or non-ionic wetting surfactant (e.g., BS1000®) at 0.2% (v/v). Apply from 2nd-node to pre-flowering crop growth stages.
- 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). 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% and a mineral spray oil at 1% (v/v). 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.

Disease management

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 ai.i/L) e.g., SpinFlo®
- 500mL/ha procymidone (500g a.i./L) e.g., Sumisclex®, Fortress®
- 400 to 540mL/ha of Veritas Opti® (tebuconazole 370g/L + azoxystrobin 222g/L)
- 0.75 to 1.0L/ha of Miravis Star® (pydiflumetofen 100g/L + fludioxonil 150g/L)
- 400 to 600 mL/ha of Amistar Xtra® (asoxystrobin 200g/L + cyproconazole 80g/L)
- 400 to 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 to 2L/ha of chlorothalonil (720g a.i./L) e.g., Barrack®
- 400 to 540mL/ha of Veritas Opti® (tebuconazole 370g/L + azoxystrobin 222g/L)
- 250 to 500 mL/ha of Miravis Star® (pydiflumetofen 100g/L + fludioxonil 150g/L)
- 400 to 600mL/ha of Aviator® xPro® (150g/L prothioconazole + 75g/L bixafen)
- 400 to 600 mL/ha of Amistar Xtra® (asoxystrobin 200g/L + cyproconazole 80g/L)
- 1 to 2.2kg/ha of mancozeb (750g a.i./kg) e.g., Dithane®

Crop-topping

- Paraquat 250g/L, Group 22/L, e.g., Gramoxone® or Shirquat® at 400 to 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 increase 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 – more than 50% of seeds have changed colour to yellow-buff.
- Glyphosate 690g/kg, Group 9/M, e.g., Roundup Ready® herbicide with PLANTSHIELD® at 530 to 1400g/ha. 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 may reduce germination percentage to commercially unacceptable levels.
- 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 to mid-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-to-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.

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 information provided below is from South Australia through the National Vetch Breeding Program.

See Tables below 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 at Badgingarra in 2021

Genotype	Grain yield (t/ha)	Dry matter in early September (t/ha)
Morava	2.6	3.3
Studenica	2.4	4.4
Timok	2.5	3.9
Volga	2.7	3.6

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	4.81	3.22
Morava	3.69	1.71
Rasina	3.96	-
Timok	3.75	2.11
Volga	4.21	2.19

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	2.24	3.09	2.19	2.51
Rasina	-	2.86	2.21	2.54
Timok	2.13	3.15	2.08	2.45
Volga	2.26	3.06	2.45	2.59

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	S	VS	0.65
Rasina	Early-mid	High	Mod	Purple	0-2	0	R	MS	S	0.60
Timok	Mid	High	Very high	Purple	0-2	0-2	R	MS	S	0.57
Volga	Early	Very high	High	Purple	0-2	2-5	R	MS	S	0.54
Studenica	Very early	High	High	White	0-2	0	R	MS	S	0.65
Purple vetch (*Vicia villosa subsp. benghalensis*)										
Barloo*	Mid	Low	High	Purple	20-30	5-10	R	S	VS	NS
Popany	Very late	Low	High	Purple	20-30	5-10	R	S	VS	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	S	VS	NS
RM4	Mid	Moderate	Very high	Purple	2-5	2-5	R	MR	VS	NS

* Also known as Early Purple or Early Popany.

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 greater contact between the germinating seed and herbicide may reduce crop safety.
- Diuron 900g/kg, Group 5/C, e.g., Diurex® WG at 0.83–1.1kg/ha (Common vetch only).
- Fomesafen 240g/L, Group 14/G, e.g., Reflex® at 0.5–1.5L/ha.
- Trifluralin 480g/L, Group 3/D, e.g., TriflurX® at 1.7L/ha.

Post-sowing pre-emergent (PSPE) herbicides

- Cyanazine 900g/L (e.g., Bladex®), Group 5/C, at 1.1–1.7kg/ha (SA only).
- Diuron 900g/kg, Group 5/C, e.g., Diurex® WG at 550–830g/ha (Common vetch only).
- Fomesafen 240g/L, Group 14/G, e.g., Reflex® at 500–900mL/ha.
- Metribuzin 750, Group 5/C, at 180–380g/ha.

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).
- Pyraflufen-ethyl 20g/L, Group 14/G, e.g., Ecopar® at 800 mL/ha + BS1000® 0.2% (v/v) at 3–5 crop leaves.

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). Do not apply at flowering stage of crop.
- Fluazifop-p 128g/L, Group 1/A, e.g., Fusilade® Forte at 820mL/ha.
- 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). Apply from 2nd crop leaf to pre-flowering growth stages.
- 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).
- 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% and a mineral spray oil at 1% (v/v). 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 to 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 increase any yield reduction. DO NOT harvest within seven days of application.

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.

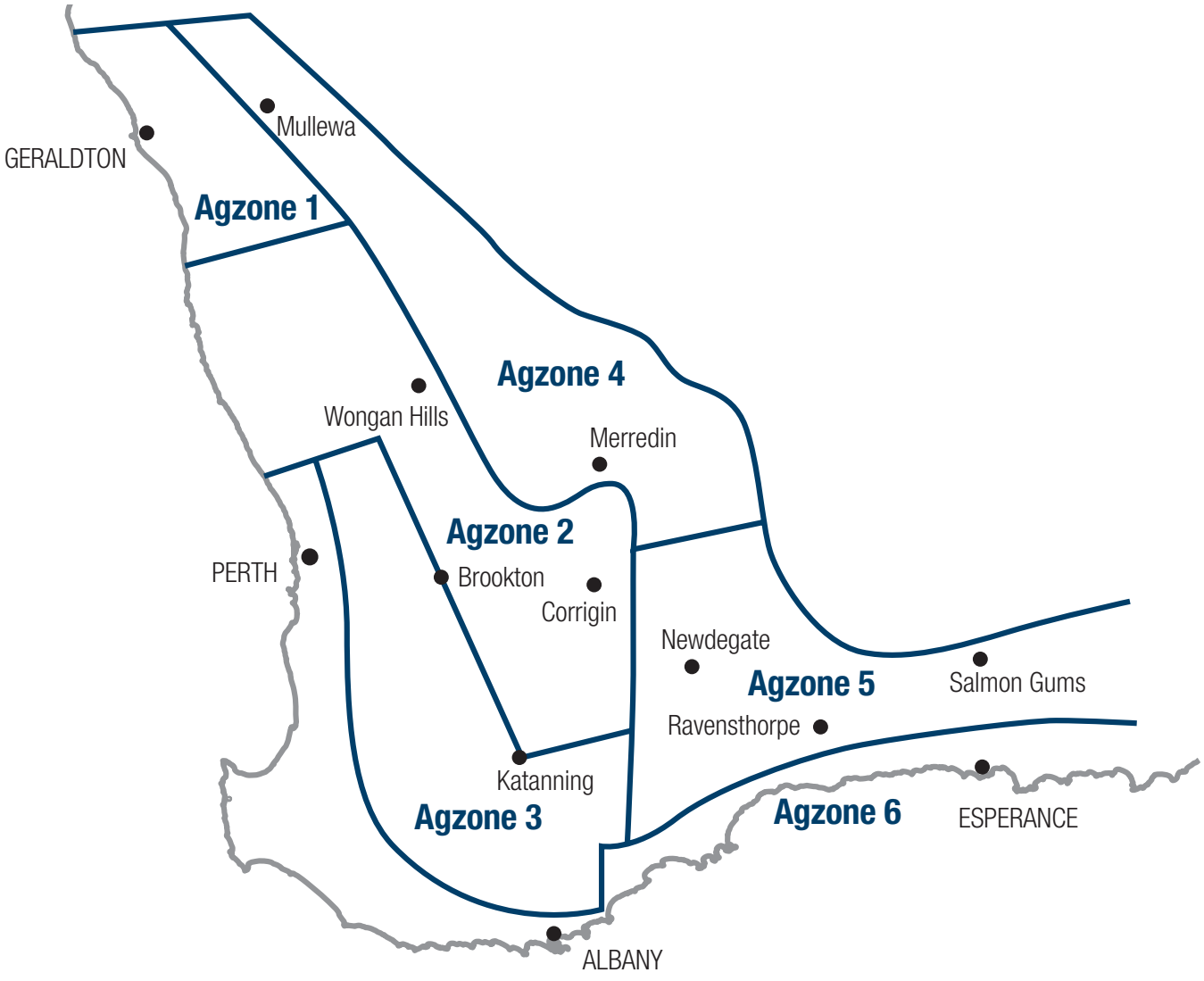
TYPE OF OATS TO SOW

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.

ABOVE: 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



Agzones in Western Australia

Refer to page 98 for the distribution of Low-Med Rainfall and Med-High Rainfall Canola NVT's across Agzones, previously known as 'Early' and 'Mid' trial series respectively.