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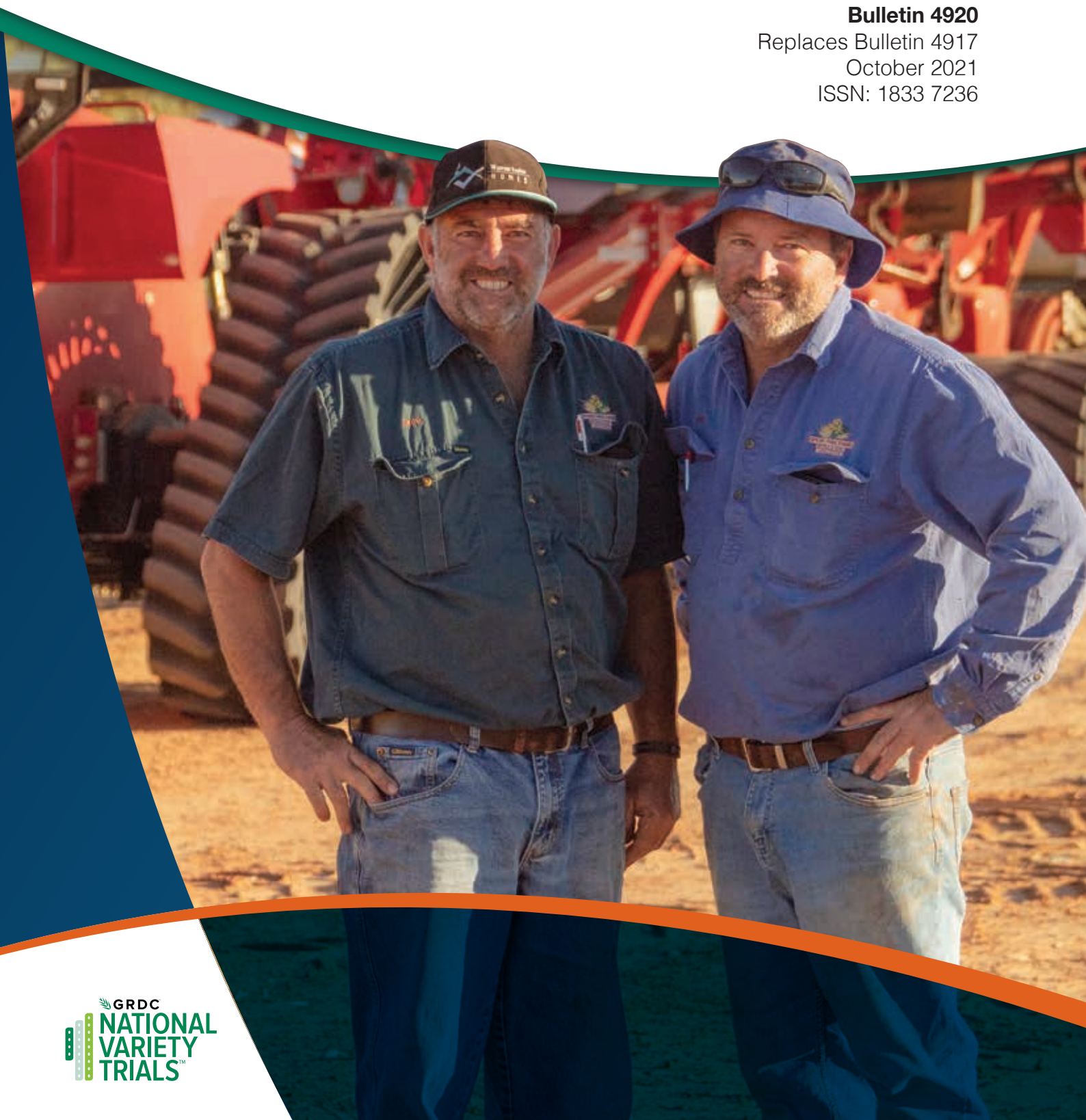

GRDC NATIONAL VARIETY TRIALS™

Department of
Primary Industries and Regional Development

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The contributions of service providers and the cooperation of growers in providing trial sites for NVT and DPIRD experiments are also gratefully acknowledged.

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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.

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 (), 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* 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 2022 edition of the Crop Sowing Guide for WA, which introduces 27 new variety releases: three wheat, nine barley (three recently accredited for malt and six currently under malt evaluation), twelve canola, two field pea and a lentil.

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, lupin agzones have been reduced from 8 agzones to 6 so that all varieties for each of the major crops grown in WA are evaluated using the same environmental regions.

Not sure whether pulses are for your system? Yields and break-even yields for pulses are outlined in the 'Picking a Pulse' section (page 156) along with first-hand experiences with a range of pulse varieties. The pulse section also includes an 'agronomy guide' to support the management of these high-value crops. Please also consult your agronomist for more specific pulse information for your local area.

With soaring canola prices in 2021 and the possibility of 2022 prices continuing to be historically high, it is important to select the most appropriate canola variety for your farming system. Points to consider are outlined on page 99.

Introduction of tariffs on barley imports into China in 2020 has changed the trade flows for barley. It is expected that the scenario of a weaker market for malt barley and more robust demand for feed barley will likely continue unless there is a change of policy in China. To help with barley decisions, market feedback from GIWA can be found on page 57 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 2022 to confirm variety resistance ratings for new varieties and any changes to existing varieties. The latest NVT data will be available early in 2022 via the NVT website and the Long Term MET Yield Reporter tool.

WHEAT

By Brenda Shackley, Dion Nicol, Jeremy Curry, Manisha Shankar and Geoff Thomas, DPIRD

Introduction

Wheat is Western Australia's largest crop, with about 4.5M hectares sown each year. WA's wheat industry is supported by significant investment in variety improvement through pre-breeding, breeding and research carried out by private and public institutions. This guide provides an independent source of information to support the wheat industry with decisions on variety selection and management. It summarises the yield performance of varieties in the GRDC National Variety Trials (NVT) along with their disease resistance ratings and agronomic information for their management. At the back of the wheat section there are variety snapshots for 20 of the most common and recently released wheat varieties.

As Scepter is represented in all five years of trials used in the NVT Long Term Multi Environment Trial (MET) analysis (Tables 6 to 11) and is the most popular variety grown in WA (50% of the area sown to wheat in WA in 2020), it is used as the comparison variety for yield (in the variety snapshots) and days to flowering data (Table 13).

When deciding whether to adopt a new variety into a farming system, it is important to determine whether the change will be advantageous. A new variety should provide:

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

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 might perform across variable seasons for your region/location.

In addition, it is important to consider how varietal differences can be used to advantage, such as matching a variety's maturity with its best time of sowing (and likely germination) to mitigate the risks of frost or terminal drought. Finally, it is important to be aware of whether a variety can access specific quality segregations. For example, Calingiri will only be received as a feed grade wheat in WA from the 2022 harvest and beyond (see Variety Classification section).

WHAT IS NEW?

Calibre is an AH wheat released by Australian Grains Technologies (AGT) in 2021, which is derived from Scepter with a slightly shorter maturity, similar to Mace. Calibre was included in the WA NVT for the first time in 2020, where it was one of the highest yielding varieties. It has a similar disease package to Scepter with provisional ratings of RMR*p* for stem and stripe rust, S*p* for leaf rust and powdery mildew but a slightly poorer yellow spot rating (MS*p*) than Scepter. Calibre has a longer coleoptile than Scepter and Mace, similar to Magenta.

LRPB Avenger is an APW and APWN wheat variety released by Longreach in 2021. LRPB Avenger offers a maturity between Corack and Vixen. LRPB Avenger has been tested in the NVT since 2019, where it outyields Scepter and Mace under tight finishes when yield potentials are <2.5t/ha. Disease ratings are MS for yellow spot and stem rust, MRMS for stripe rust and S for leaf rust, with provisional rating of S*p* for powdery mildew. LRPB Avenger has a longer coleoptile length similar to Magenta.

Valiant CL Plus is an imidazolinone herbicide tolerant AH wheat released by InterGrain in 2021. Valiant CL Plus was included in the WA NVT for the first time in 2020, in Agzones 2, 3, 5 and 6. InterGrain suggests that Valiant CL Plus has

a slower/longer maturity than Cutlass and has provisional ratings of RMR*p* for stripe rust, MR*p* for stem rust and MSS*p* for leaf rust. Valiant CL Plus yields similar to Cutlass and Denison when sown in NVT main season trials and slightly lower than other CL Plus varieties of shorter/quicker maturity in main season sowing times. Valiant CL Plus provides a longer coleoptile length and is a new option for maximising early sowing opportunities in a Clearfield system.

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 2021, the varieties Binnu, Clearfield JNZ, Clearfield STL, Endure, Tammarin Rock, Yandanooka and Zippy are to be removed from the master list, which means they will no longer be deliverable into their respective wheat classification segregations beyond 2021 and instead will only be deliverable as feed. These varieties have been surpassed in yield performance and are no longer recommended varieties.

In September 2020, it was announced that Calingiri would be removed from the master list in 2022.

Calingiri will continue to be received as ANW for the 2021 harvest but will only be received as a feed grade wheat in WA from the 2022 harvest onwards.

Australian Premium White Noodle (APWN) is a quality class created to allow varietal control of the hard wheat component of the 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, King Rock, LRPB Avenger, LRPB Envoy, LRPB Havoc, LRPB Trojan, LRPB Scout, Mace, RockStar, Sheriff CL Plus, Vixen, Westonia and Wyalkatchem.

WHAT VARIETY SHOULD I GROW?

Scepter dominates the WA planting area of wheat, accounting for half of all hectares sown to wheat and superseding Mace, which continues to decline in area (Table 1). In 2020 there was an increased area sown to Chief CL Plus and recently released varieties with fast-mid maturity including LRPB Havoc and Devil. About one million hectares of wheat is still being sown to varieties that have been superseded for yield, disease and quality attributes. These varieties include Mace, Calingiri, Magenta and several other less popular varieties that together account for a significant 17% of WA's wheat crop. 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 of 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. Percentage of planned area sown to wheat varieties for the 2016 to 2020 WA growing seasons

Variety	2016	2017	2018	2019	2020
Scepter	0.1	14.6	37.8	52.4	53.2
Mace	66.5	54.5	30.5	16.9	12.0
Chief CL Plus	-	0.0	1.0	4.9	6.3
Ninja	-	0.2	3.4	5.1	5.2
Zen	1.3	4.3	6.3	4.2	5.0
LRPB Havoc	-	-	0.1	1.5	3.2
Devil	-	-	-	0.3	2.6
Calingiri	8.2	7.3	5.7	3.1	2.5
Magenta	4.1	4.0	2.7	1.6	1.4
Yitpi	3.0	2.5	1.5	1.1	1.2
Corack	2.4	1.8	1.8	1.7	1.1
Cutlass	0.0	0.2	0.4	0.8	0.9
Cobra	1.9	1.7	1.3	0.9	0.6
Westonia	0.5	0.3	0.4	0.3	0.4
Wyalkatchem	2.9	1.2	1.3	0.7	0.4
Machete	0.3	0.1	0.1	0.5	0.4
LRPB Trojan	0.9	1.8	0.9	0.4	0.4
Kinsei	-	-	-	0.0	0.3
DS Pascal	-	0.0	0.1	0.5	0.3
Illabo	-	-	-	0.1	0.3
Emu Rock	0.6	0.4	0.6	0.2	0.3

Source: Data from CBH Group

Varieties with less than 0.2% of total crop area in 2020 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 faster maturity to optimise production 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 that may respond to different pricing signals.

In addition to diversification within the wheat program, diversification of crop types can also provide additional management options to 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: 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 may change.
- susceptibility to pre-harvest sprouting (presented as falling number index ratings) and blackpoint.

Tables 2 to 5 compare varieties with Scepter to assist in variety selection across various agronomic types. The preferred 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 may mask important variety-by-environment interactions (i.e. how a variety performance changes under different environmental conditions). Refer to Tables 6 to 11 for a more precise estimate of variety performance in specific regions.

AH and APW quick–mid season varieties

With the release of Calibre and LRPB Avenger in 2021, growers now have a wider range of wheat varieties to choose from that are suitable for May/June sowing times. Growers are encouraged to adopt varieties with a range of maturity lengths to allow flexibility in response to available sowing opportunities and/or take advantage of varietal herbicide or disease tolerance.

Scepter is still a strong overall package that achieves consistently high yields and has relatively good disease and pre-harvest sprouting resistance (see Tables 2 and 21). Within the main season NVT, LRPB Avenger, Sting and Vixen achieve higher yields than Scepter in lower-yielding environments (i.e.<2.5t/ha).

Calibre's predicted mean yield (2016-2020) is the highest overall (Table 2), however 2020 was the first time Calibre was included in the NVT where it yielded similar or slightly lower then a number of key varieties (Tables 6 to 11).

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

Calibre offers an improved provisional stem and stripe rust rating in this maturity group. Apart from Calibre and LRPB Avenger, which are provisionally rated MS*p* for yellow spot, all other varieties competing in this maturity class are MRMS for yellow spot and most are susceptible to powdery mildew and the new strain of leaf rust. LRPB Havoc has the highest powdery mildew rating in the group following an increased rating to MS in 2021 (Table 2).

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 as well in seasons with late end of season rainfall or early germination.

Vixen offers a quick maturity alternative in this group. In 2020, Vixen sown in mid to late May flowered, on average, nine days before Scepter (see Maturity). Vixen is more yield competitive over

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

	Scepter	Calibre	Vixen	Devil	Sting	LRPB Avenger	LRPB Havoc	Mace
Statewide MET yield (% site mean)[1]	110%	114%^	111%	110%	110%	108%	106%	104%
Maturity	Quick–mid	Quick–mid	Quick	Quick–mid	Quick	Quick	Quick–mid	Quick–mid
Classification	AH	AH	AH(N)	AH(N)	AH	APW(N)	AH(N)	AH(N)
Falling no. index	5	-	3	3	-	-	3	5
Stem rust	MRMS	RMR*p*	MRMS	MS	MRMS	MS	S	MRMS
Stripe rust	MR*	RMR*p*	MRMS	MR	MR	MRMS	MR	RMR*
Leaf rust	MSS	S*p*	SVS	SVS	SVS	S	S	MSS
Powdery mildew	S	S*p*	S	SVS	S*p*	S*p*	MS	MSS
Yellow spot	MRMS	MS*p*	MRMS	MRMS	MRMS	MS	MRMS	MRMS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2016–2020). 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. ^ = single year of NVT data in 2020. Falling no. index please refer to page 32.

several seasons than predecessors in the quick maturity group such as Emu Rock 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 herbicides and are registered for spraying with label rates of Intervix®.

In 2021, InterGrain released the slow maturity Valiant CL Plus that 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, Valiant CL Plus has yielded similarly to Cutlass (Table 4), but lower than Razor CL Plus, Hammer CL Plus, Chief CL Plus and Sheriff CL Plus (Table 3). InterGrain report that Valiant CL Plus has a slightly later maturity than Cutlass and a longer coleoptile than Scepter.

The yields of 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 some non-imidazolinone resistant varieties such as Scepter, Calibre, Devil, Vixen and Sting. Hammer CL Plus is an AH, while Chief CL Plus and Sheriff CL Plus are both classified as APW and APWN and Razor CL Plus is classified as ASW. NVT results to date indicate the slightly quicker maturity Razor CL Plus performs slightly better than Hammer CL Plus and Chief CL Plus. In the lower yielding NVTs, Chief CL Plus performance was lower than Razor CL Plus and Hammer CL Plus. Disease packages vary significantly within Clearfield varieties and this may 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. With early sowing opportunities they enable flowering to be maintained at an optimum date. When sown on main-season/May sowing dates, mid–slow maturity wheats exhibit delayed development which can help to avoid frost.

Denison and Valiant CL Plus are recent releases which have been nominally classified as slow maturity (later than Yitpi or Cutlass). Although Denison is typically slower developing than Cutlass when sown in May, DPIRD trials in 2020 showed that Denison sown early to mid-April has a maturity similar to or earlier than Cutlass (see section – Maturity page 21).

RockStar 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 2020 – see Maturity section). Catapult and Kinsei have achieved superior yields to other mid–slow varieties such as Yitpi, Magenta and LRPB Trojan since their entry into the NVT in 2018 and 2017. The average yields of Denison, Valiant CL Plus and Cutlass fall between the two groups mentioned above.

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

	Scepter	Razor CL Plus	Hammer CL Plus	Chief CL Plus	Sheriff CL Plus	Valiant CL Plus
Statewide MET yield (% site mean)[1]	110%	104%	103%^	102%	101%	98%^
Maturity	Quick–mid	Quick–mid	Quick–mid	Mid	Mid	Slow(*p*)
Classification	AH	ASW	AH	APW(N)	APW(N)	AH
Falling no. index	5	4*p*	-	4	4*p*	-
Stem rust	MRMS	MR	MR	MR	MS	MR*p*
Stripe rust	MR*	RMR	RMR	S	MS	RMR*p*
Leaf rust	MSS	S	S	MR*	SVS	MSS*p*
Powdery mildew	S	MSS	SVS*p*	S	SVS	–
Yellow spot	MRMS	MSS	MRMS	MRMS	MRMS	MRMS*p*

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2016–2020). 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. ^ = single year of NVT data in 2020. Falling no. index please refer to page 32.

It should be noted that the yield advantage of these mid–slow varieties over their quicker maturity counterparts can be significant in earlier sowing opportunities (late April to early May). However, this yield advantage is not always represented 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, pages 23 and 25). In addition, the newer mid–slow varieties have a much lower risk of poor yields when sowing/emergence is delayed compared to the superseded mid–slow maturity varieties such as Magenta and Yitpi (as seen in Figure 1 and their NVT performance in Tables 6 to 11).

Catapult, RockStar and Valiant CL Plus (provisional ratings) have superior stem (MR) and stripe (RMR) rust resistance ratings compared to Kinsei (MSS and MRMS, respectively) and Denison (MS and MR, respectively). Apart from Cutlass (RMR), Kinsei (MSS) and Valiant CL Plus (MSS*p*), other recent mid–slow releases are all susceptible (S) to the new pathotype of leaf rust. However Cutlass and Kinsei have inferior yellow spot ratings compared to other mid–slow varieties, which are all MRMS/MRMS*p*. RockStar has the highest powdery mildew rating (MSS) for this group of new releases.

Provisional falling number index ratings suggest RockStar is at higher risk of low falling number than Catapult. In opportunistic sampling of DPIRD trials in 2020, the falling number of RockStar was below 300 seconds when sown in April at Mullewa, Katanning and Gibson.

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

	Scepter	Rockstar	Catapult	Kinsei	Denison	Cutlass	Valiant CL Plus	Yitpi
Statewide MET yield (% site mean)[1]	110%	108%	104%	103%	100%^	98%	98%^	93%
Maturity	Quick–mid	Mid–slow	Mid–slow	Mid–slow	Slow(*p*)	Mid–slow	Slow(*p*)	Mid–slow
Classification	AH	AH(N)	AH	ANW	APW	APW(N)	AH	AH
Falling no. index	5	3*p*	6*p*	4	-	4	-	5
Stem rust	MRMS	MR	MR	MSS	MS	R	MR*p*	S
Stripe rust	MR*	RMR	RMR	MRMS	MR	RMR*	RMR*p*	MRMS
Leaf rust	MSS	S	S	MSS	S	RMR*	MSS*p*	S
Powdery mildew	S	MSS	S	S	S*p*	S	–	MS
Yellow spot	MRMS	MRMS	MRMS	MS	MRMS	MSS	MRMS*p*	SVS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat NVT MET data (2016–2020). 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. ^ = single year of NVT data in 2020. 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%	94%
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	S	S
Stripe rust	MR*	MS	MRMS	MRMS	SVS
Leaf rust	MSS	S	MSS	S	S
Powdery mildew	S	S	S	S	S
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 (2016–2020). 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. ^ = single year of NVT data in 2020. 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 has seen an increase from the relatively stable and long term 60:40 ratio of ANW to APW. For the past two years, the ratio has ranged from 80:20 to 90:10, which has increased the volume/proportion of ANW to the premium Japanese market.

Calingiri is due for removal from the Wheat Variety Master List in 2022, which means that the 2021 harvest will be the final year it will be received as ANW in WA. While Calingiri was popular for its ability to take advantage of early sowing opportunities, Kinsei supersedes it for yield in April sowings and has also proven to be a lower risk in later emerging situations (such as in the main season NVTs). Ninja and Zen are competitive varieties for May plantings and are superior to Calingiri in these scenarios.

Ninja remains the highest yielding ANW in the main season NVT, yielding just below Scepter over the past five years (Table 5). The slower maturing Kinsei has also performed well, with both varieties having improved yields over all other ANW varieties. Ninja is marginally quicker in maturity than Zen and Calingiri, while Kinsei is slightly later in maturity. Zen is consistently low for small grain screenings in the NVT data (results not shown). As Ninja and Zen are S for stem and leaf rust, disease should be actively monitored and managed. Kinsei's disease ratings are marginally better than Zen and Ninja, particularly for stem and stripe rust.

YIELD IMPROVEMENT AND GRAIN PROTEIN

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–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 last 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.

Yield increases come with an inevitable decline in grain protein concentration. WA often produces vast quantities of low protein wheat, particularly in favourable/above average seasons. The combination of higher yielding varieties and good seasons lead to many questions about the protein efficiency of new varieties.

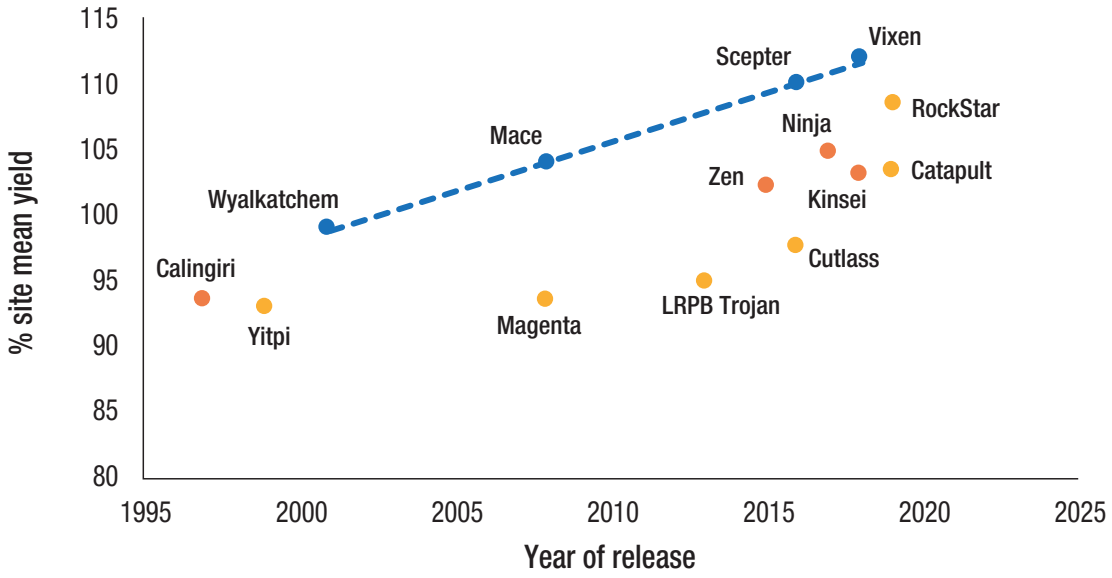

FIGURE 1. Wheat yield improvement in WA shown by relative site mean yield by variety year of release in NVT MET analysis 2017-2020 for all agzones (161 NVT sites). Blue dots are the leading quick to mid-maturity varieties, orange dots are ANW varieties and yellow dots are mid–slow maturing varieties.

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

There is an average decline in mean protein concentration of around 0.3% for each additional 10% of yield (Figure 2). This relationship is not strong and the relative differences in yield are greater than for protein. An alternative method to compare varieties is through protein yield, a measure of the total production of grain protein produced per hectare. Protein yield is calculated by multiplying yield (kg/ha) by protein concentration (%).

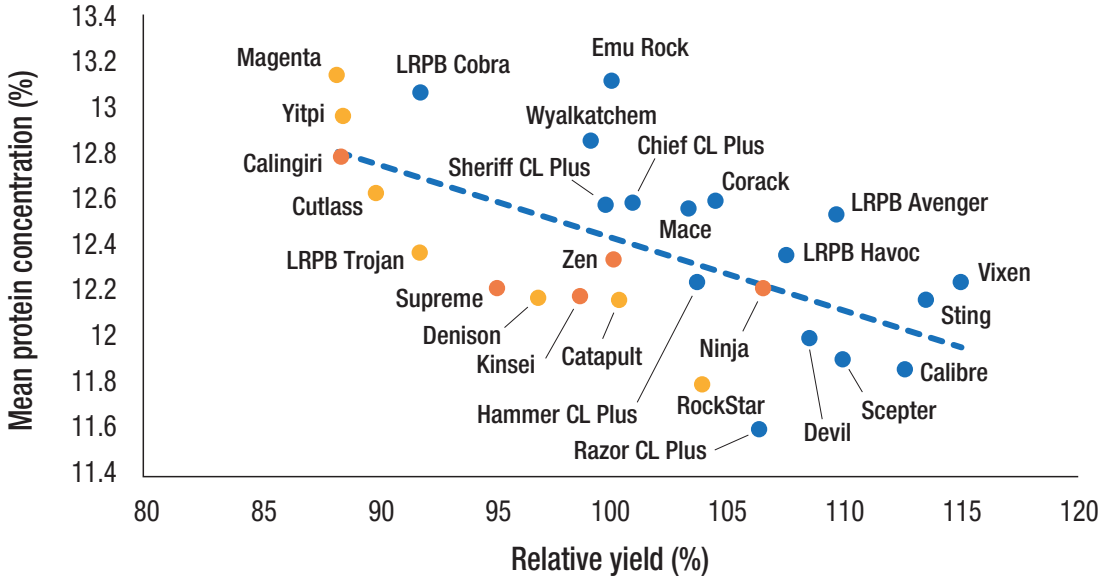

FIGURE 2. Mean protein concentration by relative yield for released varieties in WA (based on single sites in 2020, 43 NVT sites). Blue dots are quick and quick–mid maturing varieties, orange dots are ANW varieties and yellow dots are mid–slow maturing varieties. The blue dotted line represents the trend.

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

Note: this data uses single site yield data to compare with the composite quality data (i.e. single sample protein value of each site).

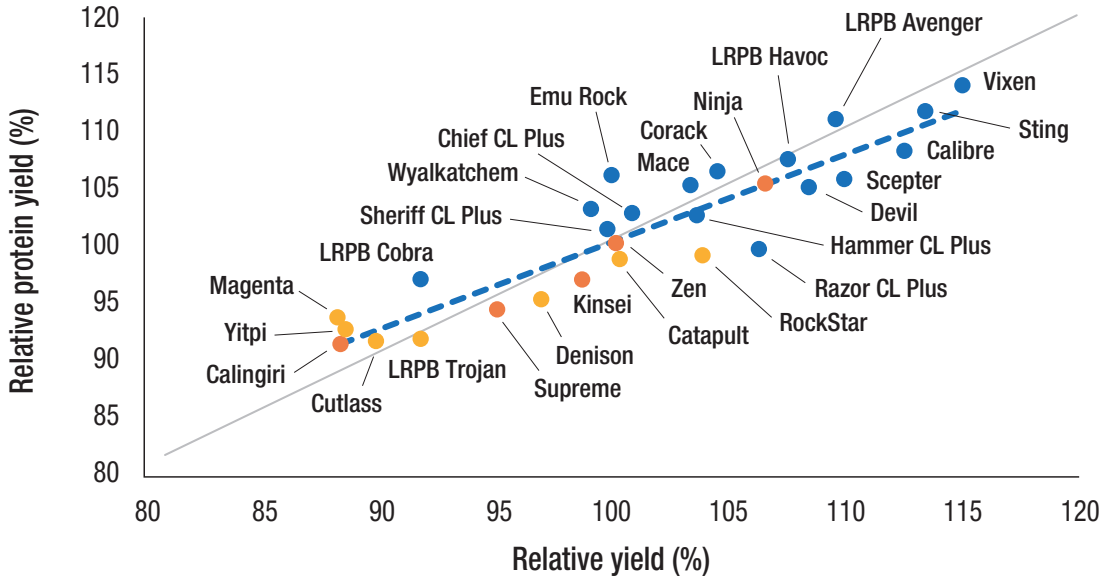

FIGURE 3. Relationship between relative protein yield and relative yield in WA (based on single sites in 2020, 43 NVT sites). Blue dots are quick and quick–mid maturing varieties, orange dots are ANW varieties and yellow dots are mid–slow maturing varieties. The blue dotted line represents the trend, and the solid line represents a 1:1 relationship between yield and protein yield.

Source: NVT Online for 2020 single site means, nvtonline.com.au

Analyses of NVT data and DPIRD time of sowing trials have demonstrated that the highest yielding varieties are typically among the best for the total quantity of protein produced per hectare. The results of the 2020 NVT single site relative grain yields and relative protein yields are presented for released varieties that were at all sites (Figure 3). This indicates that higher yielding varieties have a higher protein yield, suggesting that most of the reductions in grain protein concentration are driven by increases in yield (protein dilution).

Phenology is also a very important factor, with later flowering times tending to have lower yield and a higher protein concentration but overall, less protein per hectare (protein yield). This is supported by the fact that most of the mid–slow varieties have a lower protein yield (Figure 3). Therefore, any comparisons between varieties should consider their maturity differences and when they are likely to be sown. Early sowing of long season wheats will ensure a higher yield and therefore protein yield in general. Both methods of analyses show two varieties that are furthest from the trend line, Emu Rock which has a higher protein than expected for its yield and Razor CL Plus which has a lower protein and protein yield than expected for its yield.

Yield has a larger impact on profit than protein with price differences between grades being minor in recent seasons. Deferred nitrogen strategies in which the majority of N is applied during stem elongation can increase protein, but seasonal conditions are key for effective application and uptake of later N and economic analysis continues to support that yield rather than protein is ‘king’. Consult your agronomist for more specific advice on nitrogen, protein and economic return.

GRAIN YIELD

GRDC’s National Variety Trials (NVT) provide an independent means of assessing varietal performance in WA. NVT results can be viewed as individual site reports or as multi-environment (MET) long-term summaries that can provide insight into a variety’s 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 2016 and 2020. 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.

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. A major driver in the relative performance of a variety is its maturity, its germination timing, the amount and timing of rainfall and abiotic stresses such as drought stress, 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 (2016–2020) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)			4.05	2.59	3.65	1.24	3.62	
Variety	Maturity	(No. trials)	(5)	(5)	(6)	(5)	(4)	(25)
Australian Hard								
Emu Rock	Quick	(25)	96	87	100	96	95	**95**
Vixen (N)	Quick	(20)	-	93	115	116	105	**107**
Sting	Quick	(9)	-	-	-	114	106	**107**
LRPB Havoc (N)	Quick–mid	(25)	104	96	111	109	100	**104**
Mace (N)	Quick–mid	(25)	100	98	105	106	100	**102**
Hammer CL Plus	Quick–mid	(4)	-	-	-	-	103	**-**
Devil (N)	Quick–mid	(20)	-	104	109	113	107	**108**
Calibre	Quick–mid	(4)	-	-	-	-	108	**-**
Scepter	Quick–mid	(25)	106	103	109	113	108	**108**
RockStar (N)	Mid–slow	(15)	-	-	107	110	108	**108**
Catapult	Mid–slow	(15)	-	-	100	105	104	**103**
Yitpi	Mid–slow	(25)	91	101	90	92	93	**93**
Valiant CL Plus	Slow(p)	(0)	-	-	-	-	-	**-**
Australian Premium White								
LRPB Avenger (N)	Quick	(9)	-	-	-	113	100	**104**
Corack	Quick–mid	(25)	101	97	108	108	99	**103**
Chief CL Plus (N)	Mid	(25)	101	103	103	103	98	**102**
Sheriff CL Plus (N)	Mid	(19)	102	103	-	101	101	**102**
LRPB Trojan (N)	Mid–slow	(25)	98	100	94	93	100	**97**
Magenta	Mid–slow	(25)	96	103	91	91	99	**96**
Cutlass (N)	Mid–slow	(25)	96	107	93	97	99	**98**
Denison	Slow(p)	(4)	-	-	-	-	101	**101**
Australian Noodle Wheat								
Ninja	Mid	(25)	105	104	104	106	107	**105**
Zen	Mid–slow	(25)	102	102	103	103	100	**102**
Calingiri	Mid–slow	(25)	97	103	92	91	96	**96**
Kinsei	Mid–slow	(20)	-	108	102	104	105	**105**
Australian Standard White								
Razor CL Plus	Quick–mid	(20)	-	92	106	105	102	**101**

(N) = Denotes supplementary classification of APWN, (*p*) = provisional
Source: based on MET analysis from 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 (2016–2020) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)			3.67	3.45	4.02	2.24	2.79	
Variety	Maturity	(No. trials)	(8)	(16)	(14)	(16)	(14)	(68)
Australian Hard								
Emu Rock	Quick	(68)	95	97	93	101	99	**97**
Vixen (N)	Quick	(60)	-	111	109	118	114	**112**
Sting	Quick	(30)	-	-	-	115	112	**111**
LRPB Havoc (N)	Quick–mid	(68)	97	107	105	110	107	**106**
Mace (N)	Quick–mid	(68)	99	104	103	107	104	**104**
Hammer CL Plus	Quick–mid	(14)	-	-	-	-	104	**-**
Devil (N)	Quick–mid	(60)	-	109	110	111	110	**110**
Calibre	Quick–mid	(14)	-	-	-	-	113	**-**
Scepter	Quick–mid	(68)	108	109	110	111	110	**110**
RockStar (N)	Mid–slow	(44)	-	-	110	107	107	**108**
Catapult	Mid–slow	(44)	-	-	104	103	102	**103**
Yitpi	Mid–slow	(68)	95	92	93	94	91	**93**
Valiant CL Plus	Slow(p)	(14)	-	-	-	-	95	**-**
Australian Premium White								
LRPB Avenger (N)	Quick	(30)	-	-	-	116	109	**109**
Corack	Quick–mid	(68)	96	106	104	110	105	**105**
Chief CL Plus (N)	Mid	(68)	96	103	103	103	101	**102**
Sheriff CL Plus (N)	Mid	(54)	100	101		100	101	**101**
LRPB Trojan (N)	Mid–slow	(68)	101	95	96	92	95	**95**
Magenta	Mid–slow	(68)	102	93	95	90	93	**64**
Cutlass (N)	Mid–slow	(68)	102	96	99	96	95	**97**
Denison	Slow(p)	(30)	-	-	-	96	97	**99**
Australian Noodle Wheat								
Ninja	Mid	(68)	107	104	106	103	105	**105**
Zen	Mid–slow	(68)	99	103	103	102	102	**102**
Calingiri	Mid–slow	(68)	97	94	95	91	92	**93**
Kinsei	Mid–slow	(60)	-	103	106	100	102	**103**
Australian Standard White								
Razor CL Plus	Quick–mid	(60)	-	104	101	107	106	**104**

(N) = Denotes supplementary classification of APWN, (*p*) = provisional
Source: based on MET analysis from 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 (2016–2020) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)			3.15	4.23	2.97	3.33	3.76	
Variety	Maturity	(No. trials)	(3)	(4)	(3)	(4)	(5)	(19)
Australian Hard								
Emu Rock	Quick	(19)	93	91	95	97	92	**93**
Vixen (N)	Quick	(12)	-	-	111	114	106	**108**
Sting	Quick	(9)	-	-	-	111	106	**107**
LRPB Havoc (N)	Quick–mid	(19)	96	102	110	110	103	**104**
Mace (N)	Quick–mid	(19)	98	100	104	106	101	**102**
Hammer CL Plus	Quick–mid	(5)	-	-	-	-	101	**-**
Devil (N)	Quick–mid	(16)	-	111	110	111	110	**110**
Calibre	Quick–mid	(5)	-	-	-	-	111	**-**
Scepter	Quick–mid	(19)	108	111	109	110	109	**109**
RockStar (N)	Mid–slow	(12)	-	-	109	108	111	**110**
Catapult	Mid–slow	(12)	-	-	102	103	105	**104**
Yitpi	Mid–slow	(19)	95	91	91	94	94	**93**
Valiant CL Plus	Slow(p)	(5)	-	-	-	-	102	**-**
Australian Premium White								
LRPB Avenger (N)	Quick	(9)	-	-	-	114	104	**105**
Corack	Quick–mid	(19)	95	100	108	110	102	**103**
Chief CL Plus (N)	Mid	(19)	96	101	105	105	102	**102**
Sheriff CL Plus (N)	Mid	(16)	101	103	-	101	102	**102**
LRPB Trojan (N)	Mid–slow	(19)	102	98	93	92	97	**96**
Magenta	Mid–slow	(19)	103	97	92	91	97	**96**
Cutlass (N)	Mid–slow	(19)	103	99	96	98	100	**99**
Denison	Slow(p)	(9)	-	-	-	101	105	**103**
Australian Noodle Wheat								
Ninja	Mid	(19)	108	108	104	103	106	**106**
Zen	Mid–slow	(19)	99	102	105	104	103	**103**
Calingiri	Mid–slow	(19)	97	96	94	93	96	**95**
Kinsei	Mid–slow	(16)	-	108	105	103	107	**106**
Australian Standard White								
Razor CL Plus	Quick–mid	(16)	-	100	103	104	100	**101**

(N) = Denotes supplementary classification of APWN, (*p*) = provisional
Source: based on MET analysis from 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 (2016–2020) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)			3.05	2.15	3.24	1.19	2.36	
Variety	Maturity	(No. trials)	(4)	(9)	(9)	(9)	(11)	(42)
Australian Hard								
Emu Rock	Quick	(42)	100	95	97	104	103	**100**
Vixen (N)	Quick	(38)	-	109	112	124	118	**116**
Sting	Quick	(20)	-	-	-	121	115	**113**
LRPB Havoc (N)	Quick–mid	(42)	106	103	107	109	113	**108**
Mace (N)	Quick–mid	(42)	102	104	104	109	106	**105**
Hammer CL Plus	Quick–mid	(11)	-	-	-	-	105	**-**
Devil (N)	Quick–mid	(38)	-	110	110	114	109	**110**
Calibre	Quick–mid	(11)	-	-	-	-	111	**-**
Scepter	Quick–mid	(42)	109	109	109	115	109	**110**
RockStar (N)	Mid–slow	(29)	-	-	108	107	105	**107**
Catapult	Mid–slow	(29)	-	-	103	106	99	**103**
Yitpi	Mid–slow	(42)	88	98	92	94	88	**92**
Valiant CL Plus	Slow(*p*)	(0)	-	-	-	-	-	**-**
Australian Premium White								
LRPB Avenger (N)	Quick	(20)	-	-	-	120	113	**112**
Corack	Quick–mid	(42)	102	104	105	110	109	**107**
Chief CL Plus (N)	Mid	(42)	99	101	102	99	102	**101**
Sheriff CL Plus (N)	Mid	(24)	101	-	-	98	101	**100**
LRPB Trojan (N)	Mid–slow	(42)	97	96	95	93	93	**94**
Magenta	Mid–slow	(42)	94	97	93	91	89	**92**
Cutlass (N)	Mid–slow	(42)	93	103	97	97	90	**96**
Denison	Slow(*p*)	(11)	-	-	-	-	95	**-**
Australian Noodle Wheat								
Ninja	Mid	(42)	107	104	105	104	104	**105**
Zen	Mid–slow	(42)	101	101	102	99	103	**101**
Calingiri	Mid–slow	(42)	93	95	94	87	90	**92**
Kinsei	Mid–slow	(38)	-	103	104	97	100	**101**
Australian Standard White								
Razor CL Plus	Quick–mid	(38)	-	101	104	111	109	**106**

(N) = Denotes supplementary classification of APWN, (*p*) = provisional
Source: based on MET analysis from 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 (2016–2020) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)			3.41	3.20	2.43	2.09	2.12	
Variety	Maturity	(No. trials)	(2)	(5)	(4)	(4)	(6)	(21)
Australian Hard								
Emu Rock	Quick	(21)	95	96	97	100	102	**99**
Vixen (N)	Quick	(19)	-	112	118	120	122	**117**
Sting	Quick	(10)	-	-	-	118	118	**115**
LRPB Havoc (N)	Quick–mid	(21)	95	102	106	109	114	**107**
Mace (N)	Quick–mid	(21)	100	104	107	108	108	**106**
Hammer CL Plus	Quick–mid	(6)	-	-	-	-	106	**-**
Devil (N)	Quick–mid	(19)	-	112	115	114	113	**113**
Calibre	Quick–mid	(6)	-	-	-	-	119	**-**
Scepter	Quick–mid	(21)	108	112	115	114	113	**113**
RockStar (N)	Mid–slow	(14)	-	-	111	109	108	**109**
Catapult	Mid–slow	(14)	-	-	109	107	102	**106**
Yitpi	Mid–slow	(21)	98	96	96	95	89	**94**
Valiant CL Plus	Slow(*p*)	(6)	-	-	-	-	92	**-**
Australian Premium White								
LRPB Avenger (N)	Quick	(10)	-	-	-	118	118	**114**
Corack	Quick–mid	(21)	96	102	107	109	112	**107**
Chief CL Plus (N)	Mid	(21)	95	98	100	101	103	**100**
Sheriff CL Plus (N)	Mid	(17)	100	100	-	99	100	**100**
LRPB Trojan (N)	Mid–slow	(21)	102	97	94	93	91	**94**
Magenta	Mid–slow	(21)	103	97	94	91	87	**93**
Cutlass (N)	Mid–slow	(21)	104	102	102	99	92	**99**
Denison	Slow(*p*)	(10)	-	-	-	95	95	**97**
Australian Noodle Wheat								
Ninja	Mid	(21)	107	107	106	104	104	**105**
Zen	Mid–slow	(21)	98	99	100	100	103	**100**
Calingiri	Mid–slow	(21)	97	93	90	89	88	**91**
Kinsei	Mid–slow	(19)	-	103	101	99	100	**101**
Australian Standard White								
Razor CL Plus	Quick–mid	(19)	-	104	106	108	110	**107**

(N) = Denotes supplementary classification of APWN, (*p*) = provisional
Source: based on MET analysis from 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 (2016–2020) and the weighted average over the five-year period (where there is more than one year of data or four or more observations)

Year			2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)			4.06	3.68	3.74	4.30	3.70	
Variety	Maturity	(No. trials)	(2)	(2)	(2)	(1)	(3)	(10)
Australian Hard								
Emu Rock	Quick	(10)	94	91	92	88	89	**91**
Vixen (N)	Quick	(6)	-	-	105	105	106	**104**
Sting	Quick	(4)	-	-	-	105	106	**104**
LRPB Havoc (N)	Quick–mid	(10)	94	95	102	106	105	**100**
Mace (N)	Quick–mid	(10)	99	100	101	101	102	**101**
Hammer CL Plus	Quick–mid	(3)	-	-	-	-	100	**-**
Devil (N)	Quick–mid	(8)	-	107	109	111	111	**109**
Calibre	Quick–mid	(3)	-	-	-	-	111	**-**
Scepter	Quick–mid	(10)	107	107	108	110	110	**108**
RockStar (N)	Mid–slow	(6)	-	-	110	113	113	**110**
Catapult	Mid–slow	(6)	-	-	105	104	105	**106**
Yitpi	Mid–slow	(10)	99	101	95	91	92	**96**
Valiant CL Plus	Slow(p)	(3)	-	-	-	-	104	**-**
Australian Premium White								
LRPB Avenger (N)	Quick	(4)	-	-	-	103	104	**102**
Corack	Quick–mid	(10)	95	97	101	104	104	**100**
Chief CL Plus (N)	Mid	(10)	96	98	102	106	105	**101**
Sheriff CL Plus (N)	Mid	(8)	100	101	-	104	104	**102**
LRPB Trojan (N)	Mid–slow	(10)	103	101	98	95	95	**98**
Magenta	Mid–slow	(10)	104	103	98	95	95	**99**
Cutlass (N)	Mid–slow	(10)	105	107	101	99	100	**103**
Denison	Slow(p)	(4)	-	-	-	110	108	**105**
Australian Noodle Wheat								
Ninja	Mid	(10)	106	105	106	107	107	**106**
Zen	Mid–slow	(10)	98	99	102	106	105	**102**
Calingiri	Mid–slow	(10)	98	99	97	97	97	**98**
Kinsei	Mid–slow	(8)	-	105	106	110	109	**107**
Australian Standard White								
Razor CL Plus	Quick–mid	(8)	-	97	99	97	98	**98**

(N) = Denotes supplementary classification of APWN, (*p*) = provisional
Source: based on MET analysis from NVT Online, **nvtonline.com.au**

SUGGESTED SOWING TIMES

Suggested sowing times for varieties (Table 12) have been developed to support variety decisions in relation to sowing time preferences or 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. Understanding varietal maturity length can assist with decisions on planting order of wheat varieties and help optimise variety development 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, spring wheat varieties are broadly classified according to their flowering time 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).

This predominant maturity type has been developed because of its suitability to traditional sowing times 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 may result in an advanced rate of development (due to warmer temperatures and longer daylengths) and a reduced duration 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: Calingiri, 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 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 2020

Variety	Maturity	Northern NVTs*	Mullewa	Merredin	Katanning	Gibson	Average
Sowing date		**25-May**	**21-May**	**14-May**	**12-May**	**15-May**	
Emu Rock	Quick	-14	-15	-15	-11	-14	**-14**
Vixen	Quick	-12	-8	-9	-8	-12	**-10**
LRPB Avenger	Quick	-8	-7	-9	-9	-9	**-9**
Sting	Quick	-7	-9	-6	-7	-6	**-7**
Mace	Quick–mid	-4	-1	-4	-3	-6	**-4**
Devil	Quick–mid	-2	-2	-3	-2	-2	**-2**
Hammer CL Plus	Quick–mid	0	0	-1	-2	0	**-1**
Scepter	Quick–mid	0	0	0	0	0	**0**
Chief CL Plus	Mid	0	2	-1	-2	1	**0**
Ninja	Mid	3	5	-1	-1	-2	**1**
Magenta	Mid–slow	6	3	3	7	3	**4**
Calingiri	Mid–slow	6	3	2	2	2	**3**
RockStar	Mid–slow	8	6	3	4	2	**5**
Kinsei	Mid–slow	8	6	4	7	5	**6**
Catapult	Mid–slow	9	9	8	7	8	**8**
Cutlass	Mid–slow	11	9	7	10	13	**10**
Denison	Slow(*p*)	15	14	14	10	14	**13**
Scepter's flowering date		**27-Aug**	**19-Aug**	**27-Aug**	**17-Sep**	**10-Sep**	

*NVT sites include Oglivie, Yuna, Nabawa, Eradu and Mullewa. (*p*) = provisional

Scepter is classified as quick–mid maturity and Table 13 illustrates how other varieties compared in northern NVT sites and DPIRD experiments in 2020 when sown mid to late May. A more detailed flowering comparison between Scepter and other varieties can be found in the variety snapshots (pages 35 to 44).

Flowering dates change with sowing date, location and from season to season due to differences in temperatures. Figure 4 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 time). 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.

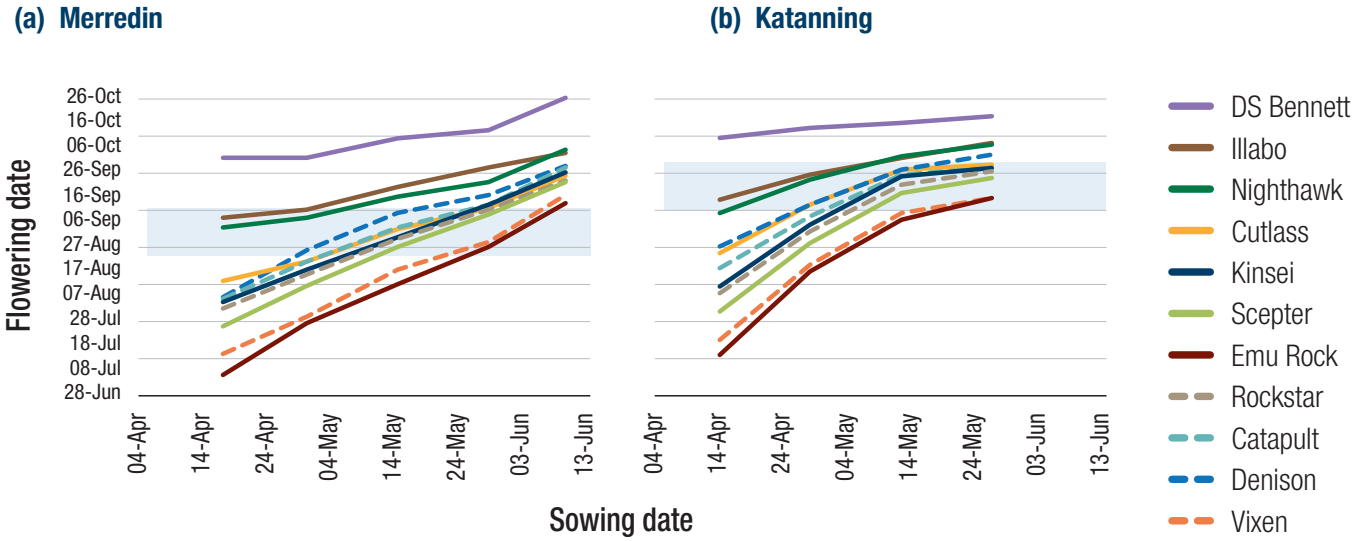

FIGURE 4. Flowering date response of varieties sown on a range of sowing dates (mid-April to early June) at a) Merredin and b) Katanning in 2020.

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 early, dry finishes and cool, late finishes over the last few years, which changes the developmental timings of wheat crops and results 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 shorter maturity varieties that currently dominate WA's wheat area. From 2015 to 2020, DPIRD and GRDC funded agronomy 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, Merredin and Gibson peak yields generally occurred from an early May sowing (Figure 5).

However, the variety combinations to maximise yield from each sowing date at each site varied significantly.

At the northern Mullewa site, the maximum yields across sowing times were maintained by sowing Kinsei or Cutlass, Scepter and Vixen in their recommended sowing window. Even at early April sowing dates, the slower maturity varieties, LRPB Nighthawk and EGA Wedgetail, were not competitive due to their later development causing grain fill to occur during dry and warmer conditions in September and October.

At Merredin, in the eastern wheatbelt, it was the quick–mid and mid–slow spring wheats that once again maximised yield potential across the sowing window. By sowing a mid–slow variety (like Cutlass or Kinsei) in April before switching to quick–mid varieties (like Scepter) in the mainstream May sowing period, high yield potential can be maintained across sowing dates.

At the cool and wet Gibson environment on the south coast, maximum yields were also produced from May sowings, typically with quick–mid and mid–slow maturing varieties. However, even at this south coastal site, these spring types were penalised when sown too early into April, because they were unable to produce the adequate biomass required for high yields. In this environment, slower maturing varieties like Longsword generated higher yields when sown in early April.

At Katanning, a frost prone site in the south-west, quick–mid and mid–slow maturity varieties achieved the highest grain yields but were severely penalised when sown too early and exposed to frost during critical development times (near flowering). In this environment, delayed sowing of these types until at least May resulted in the best yields, while earlier sowing opportunities were best captured by using slower maturing varieties such as winter wheats.

Results of the trials across the WA wheatbelt show that the optimum combination of variety (and particularly maturity type) for any given sowing date will change with site and season. However, even at these vastly different sites with a range of environmental constraints, there are opportunities to maintain high yields across the sowing window by matching varieties to a given sowing date.

In addition, growers should consider the whole farming system and acknowledge that sowing wheat may not be the most appropriate decision, particularly with early sowing times. Sowing a different crop type or taking the opportunity for improved weed control before sowing may result in greater returns overall.

It should be noted that while it is common to group varieties of the same maturity together when considering their response to sowing time, varietal differences do occur even within the same maturity group. For example, Scepter, despite its quick–mid maturity, appears to be more adaptable across a range of sowing times than some other quick–mid varieties, however it is still at risk of frost or increased disease when sown too early. Similarly, not all mid–slow varieties will perform the same in any given environment, with Catapult, Cutlass and RockStar generally having higher yields than DS Pascal, Magenta and Yitpi.

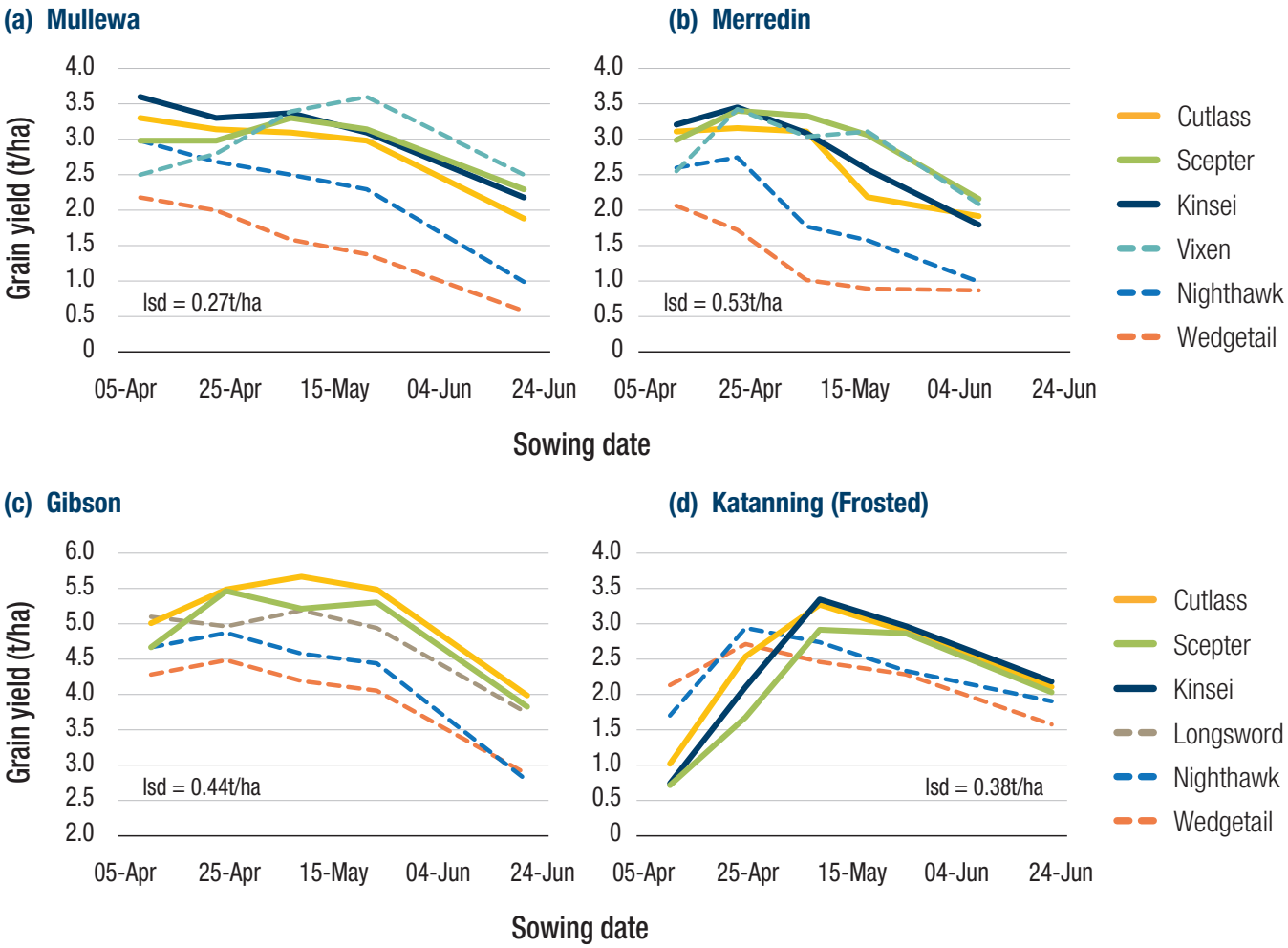

FIGURE 5. Grain yield (t/ha) response of varieties sown on five sowing dates (early April to mid-June) at a) Mullewa (2018 and 2020), b) Merredin (2018–2020), c) Gibson (2017–2018) and d) Katanning (frosted 2017–2018).

Irrigation was used at the early sowing dates to ensure timely germination. Source: DPIRD/GRDC Tactical Wheat Agronomy for the West Project (2015–2018) and DPIRD Wheat agronomy research (2020).

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.

Between 2017 and 2020 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.

Cutlass and Kinsei have consistently been amongst the highest yielding varieties across all the early-season sites in the past three years. Catapult has been included since 2018, yielding similarly to Kinsei and Cutlass (Table 14), however Catapult tends to yield higher than Cutlass in Agzones 2,3,5 and 6 compared to Agzones 1 and 4 (Tables 15 and 16). RockStar was one of the highest yielding varieties in this trial series in 2019 and competitive with Denison in 2020 (single year of data only available). Denison has a longer maturity than RockStar and more data is required to confirm their comparative performances in this late-April sowing window. 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 'early-season' trial series demonstrated that Yitpi, Magenta, LRPB Trojan and DS Pascal yields are inferior to more recent mid–slow maturing varieties such as Catapult, Cutlass, Denison, Kinsei and RockStar (Tables 15 and 16). While Yitpi, Magenta, LRPB Trojan and DS Pascal offer unique agronomic characteristics such as improved pre-harvest sprouting resistance and/or improved powdery mildew resistance, these benefits should be weighed against the greater yield potential of some of the newer mid–slow varieties.

The suitability of winter wheats and slower spring varieties is still being assessed, however, they appear to be more competitive when sown at more southern and/or frost-prone locations (Figure 6).

TABLE 14. Relative performance of slower maturity wheat varieties compared with Scepter in EARLY SEASON NVT

	Scepter	RockStar	Denison	Kinsei	Catapult	Cutlass	LRPB Nighthawk	Illabo
Statewide MET yield (% site mean)[1]	107%	118%	119% ^	113%	112%	110%	96%	94%
Maturity	Quick-mid	Mid–slow	Slow(p)	Mid–slow	Mid–slow	Mid–slow	Very slow	Fast winter
Classification	AH	AH(N)	APW	ANW	AH	APW(N)	APW	AH
Falling no. index	5	3*p*	-	4	6*p*	4	-	6*p*
Stem rust	MRMS	MR	MS	MSS	MR	R	RMR	MRMS
Stripe rust	MR*	RMR	MR	MRMS	RMR	RMR*	RMR	RMR
Leaf rust	MSS	S	S	MSS	S	RMR*	MSS	S
Powdery mildew	S	MSS	S*p*	S	S	S	MSS	R
Yellow spot	MRMS	MRMS	MRMS	MS	MRMS	MSS	MRMS	MS

[1]Regional differences in yield are masked when using a statewide average of the WA wheat EARLY SEASON NVT MET data (2017–2020). Readers are directed to Tables 15 to 16 for a more precise estimate of variety performance in their region.

(N) = Denotes supplementary classification of APWN, (*p*) = provisional

^ = single year of NVT data in 2020.

* = 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 (2017–2020), expressed as a percentage of site mean yield

Agzone			1				4				
Year			2017	2018	2019	2020	2017	2018	2019	2020	2020
Site			Ogilvie	Ogilvie	Ogilvie	Ogilvie	Bencubbin	Bencubbin	Moorine Rock	Bencubbin	Kalannie
Sowing date			20-Apr	20-Apr	17-Apr	4-May	24-Apr	30-Apr	11-Apr	21-Apr	21-Apr
Site mean yield (t/ha)			3.50	4.00	1.90	4.00	1.20	2.90	2.10	2.20	2.46
Variety (order of maturity)	Classification	Maturity									
Scepter	AH	Quick–mid	-	92	105	-	-	111	95	-	-
RockStar	AH (N)	Mid–slow	-	-	116	117	-	-	118	114	114
LRPB Trojan	APW (N)	Mid–slow	94	101	104	107	103	109	103	104	100
Magenta	APW	Mid–slow	100	99	102	108	106	105	100	104	100
Catapult	AH	Mid–slow	-	104	111	109	-	115	106	109	103
Kinsei	ANW	Mid–slow	111	103	115	114	120	113	105	114	106
DS Pascal	APW	Mid–slow	107	107	100	-	98	100	106	-	-
Yitpi	AH	Mid–slow	94	99	96	105	99	104	100	99	99
Cutlass	APW (N)	Mid–slow	108	110	110	111	111	114	112	110	112
Denison	APW	Slow(*p*)	-	-	-	113	-	-	-	117	117
LRPB Nighthawk	APW	Very slow	-	103	98	90	-	89	100	97	106
Longsword	Feed	Fast winter	115	97	105	85	101	85	92	99	98
Illabo	AH	Fast winter	97	100	95	69	77	81	95	86	96
Forrest	ASW	Very slow	-	103	99	-	-	96	103	-	-
EGA Wedgetail	APW	Mid winter	83	91	79	60	61	68	86	72	84
DS Bennett	Feed	Mid–long winter	-	-	79	-	-	-	82	-	-

(*p*) = provisional

TABLE 16. Relative performance of varieties in the Early season NVT for AGZONES 2, 3, 5 and 6 (2017–2020), expressed as a percentage of site mean yield

Agzone			2			3		5		6	
Year			2017	2019	2020	2017	2019	2019	2020	2018	2020
Site			Eneabba	Wickepin	Eneabba	York	Narrogin	Hyden	Hyden	Gibson	Gibson
Sowing date			20-Apr	18-Apr	22-Apr	24-Apr	18-Apr	16-Apr	30-Apr	2-May	23-Apr
Site mean yield (t/ha)			2.80	3.20	4.30	4.10	3.50	2.40	2.10	3.10	4.00
Variety (order of maturity)	Classification	Maturity									
Scepter	AH	Quick–mid	-	120	-	-	97	127	-	104	-
RockStar	AH (N)	Mid–slow	-	118	115	-	109	134	130	-	134
LRPB Trojan	APW (N)	Mid–slow	105	107	109	111	100	114	115	102	104
Magenta	APW	Mid–slow	104	105	103	106	99	104	109	97	98
Catapult	AH	Mid–slow	-	117	111	-	105	122	122	115	119
Kinsei	ANW	Mid–slow	120	117	114	114	106	112	116	115	119
DS Pascal	APW	Mid–slow	101	94	-	93	103	97	92	103	107
Yitpi	AH	Mid–slow	97	97	98	102	96	103	106	89	90
Cutlass	APW (N)	Mid–slow	115	107	109	107	106	113	111	110	120
Denison	APW	Slow(*p*)	-	-	116	-	-	-	111	-	136
LRPB Nighthawk	APW	Very slow	-	90	96	-	103	81	76	-	104
Longsword	Feed	Fast winter	103	105	101	91	106	85	81	120	113
Illabo	AH	Fast winter	89	95	91	86	105	91	76	120	111
Forrest	ASW	Very slow	-	86	-	-	100	74	-	86	-
EGA Wedgetail	APW	Mid winter	67	79	77	75	94	78	84	95	80
DS Bennett	Feed	Mid–long winter	-	82	-	-	103	76	45	-	102

(*p*) = provisional

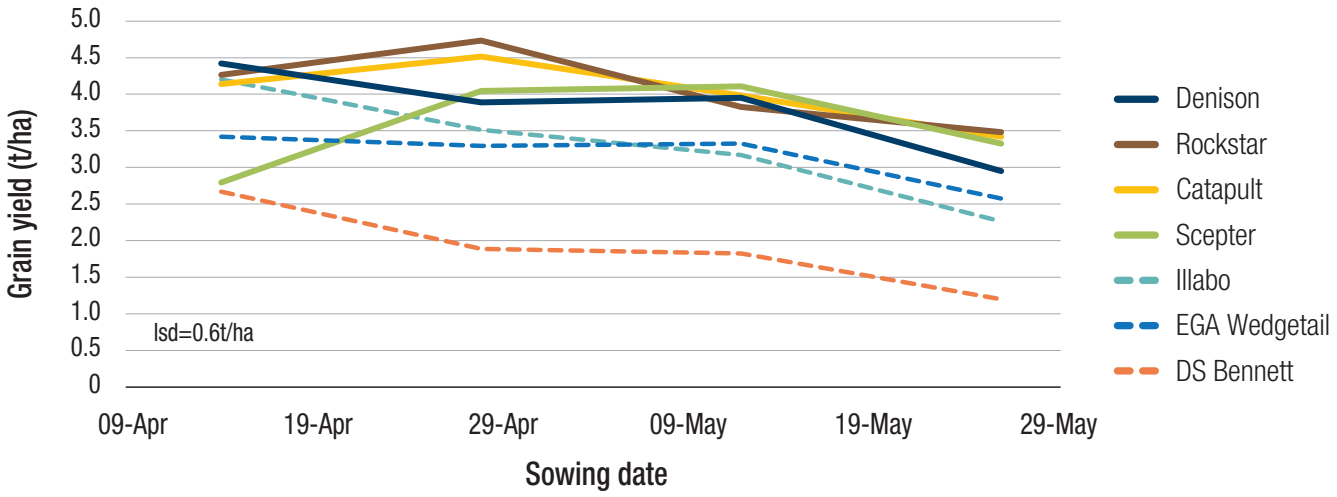

FIGURE 6. Grain yield (t/ha) response of mid–slow spring and winter wheat varieties sown on four sowing dates at Katanning in 2020.

Source: DPIRD Wheat Agronomy research

DISEASE RESISTANCE

Key points:

- It is important to 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.
- Diversify wheat varieties and crop type.

When selecting a wheat variety, it is important to consider the yield and potential quality grade along with the disease resistance of each variety (Table 19). Higher resistance ratings reduce disease severity and potential yield loss. Avoiding susceptible or very susceptible varieties significantly reduces chances 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 last 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	Rusts, powdery mildew and viruses.
Seed	Loose smut.
Soil borne	Root lesion nematode, CCN, rhizoctonia root rot, take-all, flag smut and common bunt.

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

Table 18 provides the suggested minimum resistance to five of the common leaf diseases for wheat varieties in different disease risk profiles. This table is a useful guide when selecting a suitable variety in problem paddocks.

Planning for and 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 could be prudent to use seed dressing or in-furrow fungicide and proactively monitor for the presence of disease to enable a rapid and appropriate response if disease is detected.

Using a diverse range of varieties with different disease resistance traits reduces the risk that the whole farm will require disease management at the same time. Diversification also reduces the risk associated with the emergence of a new pathotype that could render a significant proportion of a farm or region susceptible, requiring 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 Western Australia. 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 19 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 may differ on rare occasions when a more virulent isolate occurs.

TABLE 18. Suggested minimum resistance of wheat varieties to common leaf diseases in different disease risk areas

Disease risk*	Stem rust	Stripe rust	Leaf rust	Yellow spot	Nodorum blotch
Low risk	MSS	MS	MS	MSS	S
Medium risk	MS	MRMS	MRMS	MS	MS
High risk	MR	MR	MR	MRMS	MRMS

*Determined by considering factors such as disease history in previous years, presence and amount of primary inoculum and prevailing weather conditions (temperature, rainfall and relative humidity).

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 plant parts (Table 19). Susceptible varieties are more likely to suffer glume blotch in seasons where disease is present in the foliage and weather favourable to disease occurs after head emergence.

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 good Integrated Disease Management (IDM) approaches, 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
- 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 19. 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	
Arrino	ANW	MS	MS	MS	SVS	S	VS	MRMS
Calibre	AH	MS*p*	–	–	RMR*p*	RMR*p*	S*p*	S*p*
Calingiri	ANW	MS	MSS	MS	S	SVS	S	S
Catapult	AH	MRMS	MS	MRMS	MR	RMR	S	S
Chief CL Plus	APW (N)	MRMS	MS	MR	MR	S	MR*	S
Corack	APW	MRMS	MSS	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*p*	MRMS*p*	MS	MR	S	S*p*
DS Bennett	Feed	MRMS	MRMS	MR*p*	MRMS	R	SVS	R
DS Pascal	APW	MS	MRMS	MRMS	MSS	RMR	MS	RMR
EGA Bonnie Rock	AH (N)	MRMS	MS	MS	MSS	VS	SVS	S
EGA Wedgetail	APW	MSS	MRMS	MRMS*p*	MRMS	MS	MSS	MS*p*
Emu Rock	AH	MRMS	SVS	MR	MS	MRMS	SVS	S
Hammer CL Plus	AH	MRMS	MS*p*	MR*p*	MR	RMR	S	SVS*p*
Illabo	AH	MS	MRMS	MR	MRMS	RMR	S	R
Kinsei	ANW	MS	MRMS	MR	MSS	MRMS	MSS	S
Longsword	Feed	MRMS	MRMS	MRMS	MR	RMR	MS*	MS
LRPB Avenger	APW (N)	MS	MSS*p*	MRMS*p*	MS	MRMS	S	S*p*
LRPB Cobra	AH	MRMS	MRMS	MS	MR	MSS	MRMS*	MSS
LRPB Havoc	AH (N)	MRMS	MS	MRMS	S	MR	S	MS
LRPB Nighthawk	APW	MRMS	MRMS	MRMS	RMR	RMR	MSS	MSS
LRPB Trojan	APW (N)	MSS	MS	MS	MRMS	MR	MRMS*	S
Mace	AH (N)	MRMS	MS	MRMS	MRMS	RMR*	MSS	MSS
Magenta	APW	MR	MRMS	MRMS	RMR	MSS	RMR*	MRMS
Ninja	ANW	MRMS	MS	MRMS	S	MS	S	S
Razor CL Plus	ASW	MSS	MS	MRMS	MR	RMR	S	MSS
RockStar	AH (N)	MRMS	MRMS	MR	MR	RMR	S	MSS
Scepter	AH	MRMS	MS	MS	MRMS	MR*	MSS	S
Sheriff CL Plus	APW (N)	MRMS	MS	MRMS	MS	MS	SVS	SVS
Sting	AH	MRMS	MSS*p*	MRMS*p*	MRMS	MR	SVS	S*p*
Valiant CL Plus	AH	MRMS*p*	–	–	MR*p*	RMR*p*	MSS*p*	–
Vixen	AH (N)	MRMS	MSS	MS	MRMS	MRMS	SVS	S
Westonia	APW (N)	MSS	MS	MS	SVS	VS	S	S
Wyalkatchem	APW (N)	MR	MSS	MRMS	MSS	S	S	SVS
Yitpi	AH	SVS	MS	MRMS	S	MRMS	S	MS
Zen	ANW	MRMS	MRMS	MR	S	MRMS	S	S

[Table 19. continued following page...]

TABLE 19. 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*		
Arrino	ANW	MSS	MSS	MS	S	S	–	–
Calibre	AH	–	–	–	–	–	–	–
Calingiri	ANW	MSS	RMR	MRMS	SVS	S	–	S
Catapult	AH	MSS	RMR	MRMS	S	MS*p*	R	MS*p*
Chief CL Plus	APW (N)	S	SVS	MR	MRMS	MS	MS	MSS
Corack	APW	S	S	MSS	MSS	MSS	RMR	S
Cutlass	APW (N)	MSS	MSS	S	MSS	MS*p*	MR	S
Devil	AH (N)	S	SVS	MR	S	MS*p*	MSS	MSS
Denison	APW	MS*p*	R*p*	MR*p*	S	–	MSS	MSS
DS Bennett	Feed	MR	SVS	RMR	S	–	S	VS
DS Pascal	APW	MS	S	SVS	S	–	S	S
EGA Bonnie Rock	AH (N)	SVS	S	MS	VS	S	S	–
EGA Wedgetail	APW	MSS	–	–	S	–	S	S
Emu Rock	AH	S	MR	SVS	MSS	MS	S	MSS
Hammer CL Plus	AH	MS	RMR	RMR	MS	–	MRMS	MS*p*
Illabo	AH	MR	R	MS	S	MS	MRMS	S
Kinsei	ANW	MSS	RMR	MR	S	S	MSS	MSS
Longsword	Feed	MRMS	MRMS	RMR	MRMS	–	MRMS	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	MS*p*	MS	MSS
LRPB Trojan	APW (N)	S	SVS	SVS	MSS	MS*p*	MS	MS
Mace	AH (N)	S	S	MRMS	MS	MRMS	MRMS	S
Magenta	APW	MS	MSS	SVS	MSS	MSS	S	MSS
Ninja	ANW	MS	MR	RMR	S	S*p*	MS	S
Razor CL Plus	ASW	SVS	RMR	RMR	S	–	MR	S
RockStar	AH (N)	S	VS	MR	MRMS	MS*p*	MSS	S
Scepter	AH	S	MSS	MSS	S	MS	MRMS	MSS
Sheriff CL Plus	APW (N)	S	S	RMR	MRMS	MS	MS	S
Sting	AH	S	SVS	S	MRMS*p*	–	MS	S*p*
Valiant CL Plus	AH	–	–	–	–	–	–	–
Vixen	AH (N)	MSS	SVS	RMR	MRMS	MSS*p*	MSS	S
Westonia	APW (N)	SVS	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	MS	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.

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

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.

Longer coleoptiles can increase establishment rate if seeding depth increases. 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. Varieties have inherently different coleoptile lengths. Table 21 provides a guide to the coleoptile group and replaces previous reporting of coleoptile index. Coleoptile length is known to be influenced by several factors other than variety, including seed size, seed source, temperature, soil water, soil strength, certain seed dressings and the type of coleoptile length assessment (Table 20). 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 and Valiant CL Plus are provisional 'Longs' with limited testing.
- The impact of deep sowing on grain yield depends on growing season conditions and whether lower plant density and vigour can be compensated through increases in other yield components such as tiller number, grains per ear and grain weight.
- Increasing seeding rates may help to 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.

TABLE 20. Coleoptile length (cm) and plant establishment of a range of varieties germinated on filter paper 'cigars' or sown at 10cm at Katanning in 2021

Variety (Coleoptile group)	Coleoptile length (cm)		Establishment % at 10cm deep
	Filter paper	Sown at ~10cm	
DS Pascal (S)	6.3	4.9	27
Scepter (S)	7.5	5.5	31
Calibre (Lp)	8.5	6.7	48
Yitpi (L)	9.4	6.8	58
Halberd (VL)	12.3	7.8	100
lsd			30

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. Variable seed sources and grain weights.

Grain quality

Hectolitre weights and small grain screenings for individual varieties can vary from site to site and year to year. As the measurements are environmentally driven, there is a limited ability to conclude the risks of new varieties and are therefore not presented in this guide.

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

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 21). 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 wheat variety grown, stage of maturity, and the timing and intensity of seasonal rainfall and growing conditions (temperature/humidity) will all influence the falling number of a variety upon receival.

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-grain 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 now Scepter has enabled their widespread adoption across WA, even into areas of high PHS risk; this is reflected in their FNI of 5. DS Pascal is considered the variety of lowest risk, reflected in its FNI of 7. New varieties that have received a provisional rating include Catapult (rated 6p), Illabo (6p), Razor CL Plus (4p), RockStar (3p) and Sheriff CL Plus (4p).

Research carried out by DPIRD has 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 incidence of black point.

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

TABLE 21. Black point ratings, falling number index and coleoptile group of wheat varieties in 2021

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

Black point ratings are provided through the NVT project and based on the research of Dr Tara Garrard 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 2021.

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

Variety snapshots

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 2016 and 2020 for each agzone are presented as extracted from **nvtonline.com.au**. Disease ratings are as per Table 19.

Flowering information is sourced from DPIRD experiments in 2018, 2019 and 2020 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.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	100
Agzone 2	-	-	-	-	103
Agzone 3	-	-	-	-	102
Agzone 4	-	-	-	-	102
Agzone 5	-	-	-	-	105
Agzone 6	-	-	-	-	101
Disease resistance	**Adult rating**				
Yellow spot	MS*p*				
Nodorum blotch (leaf)	–				
Nodorum blotch (glume)	–				
Stem rust	RMR*p*				
Stripe rust	RMR*p*				
Leaf rust	S*p*				
Powdery mildew	S*p*				
Septoria tritici blotch	–				
Flag smut	–				
Common bunt	–				
RLN (*P. quasitereoides*)	–				
RLN (*P. neglectus*)	–				
CCN	–				
Crown rot	–				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
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)	2016	2017	2018	2019	2020
Agzone 1	-	-	92	93	96
Agzone 2	-	-	95	93	93
Agzone 3	-	-	94	94	96
Agzone 4	-	-	94	92	91
Agzone 5	-	-	95	94	90
Agzone 6	-	-	97	95	95
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*p*				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
Northern	+11	+9	+9	+10	+4
Eastern	+14	+13	+10	+3	+4
Katanning	+13	+8	+5	+4	-
Gibson	+15	+12	+6	+7	+4
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	MSS				
Falling number index	6*p*				
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.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	-	101	100	100	99
Agzone 2	-	100	100	100	100
Agzone 3	-	100	101	101	101
Agzone 4	-	101	101	99	100
Agzone 5	-	100	100	100	100
Agzone 6	-	100	101	101	101
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	S				
Flag smut	SVS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	S				
CCN	MSS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
Northern	-6	-4	-4	-3	-4
Eastern	+1	+0	+1	-1	-3
Katanning	-4	-1	-2	-2	–
Gibson	-6	-6	-2	-1	-2
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				

EMU ROCK(b)

AH

Comments

Quick maturity AH wheat best suited mid to late sowings in low rainfall environments. Useful tolerance to crown rot. Large grain size. Amongst most susceptible varieties to nodorum blotch. Susceptible to low falling numbers after pre-harvest rain, hence not suited to areas that experience pre-harvest rainfall. Consistently lower yielding than Mace and many other varieties with similar characteristics. Now superceded by the recently released quick maturing varieties such as Vixen, Sting and LRPB Avenger.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	91	84	92	85	88
Agzone 2	88	89	85	91	90
Agzone 3	86	82	87	88	84
Agzone 4	92	87	89	90	94
Agzone 5	88	86	84	88	90
Agzone 6	88	85	85	80	81
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	SVS				
Nodorum blotch (glume)	MR				
Stem rust	MS				
Stripe rust	MRMS				
Leaf rust	SVS				
Powdery mildew	S				
Septoria tritici blotch	S				
Flag smut	MR				
Common bunt	SVS				
RLN (*P. quasitereoides*)	MS				
RLN (*P. neglectus*)	MSS				
CCN	S				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
Northern	-19	-15	-17	-12	-12
Eastern	-17	-13	-7	-9	-4
Katanning	-	-10	-7	-8	-
Gibson	-	-	-	-	-
Agronomic traits					
Coleoptile group	Short				
Black point	MSS				
Falling number index	2				
Maturity	Quick				
Variety information					
Pedigree	96W657-37/Kukri				
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®

AH

Comments

Hammer CL Plus is an AH imidazolinone tolerant variety recently released in 2020 by AGT. Hammer CL Plus has been included in the WA NVT for the first time in 2020 where it yielded 4 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 SVS for powdery mildew. Registered for label rate applications of Intervix® herbicide. Note: There are no grower to grower sales permitted for any CL Plus varieties.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	95
Agzone 2	-	-	-	-	95
Agzone 3	-	-	-	-	93
Agzone 4	-	-	-	-	96
Agzone 5	-	-	-	-	94
Agzone 6	-	-	-	-	91
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS*p*				
Nodorum blotch (glume)	MR*p*				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	SVS*p*				
Septoria tritici blotch	MS				
Flag smut	RMR				
Common bunt	RMR				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	MS				
CCN	MRMS				
Crown rot	MSS*p*				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**14-Apr**	**27-Apr**	**12-May**	**27-May**	**11-Jun**
Northern	-	-	-	+0	-1
Eastern	-	-2	-1	-3	-1
Katanning	-	-2	-2	+1	-
Gibson	-	+2	+0	+0	+1
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				
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 well in comparison to Mace and slightly below Scepter in agzones 1-4. Havoc is slightly quicker in maturity than Mace. Havoc has a low falling number index rating. It's important for growers of Havoc to take note of this variety's stem and leaf rust ratings, 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)	2016	2017	2018	2019	2020
Agzone 1	98	93	102	96	93
Agzone 2	90	98	95	99	97
Agzone 3	89	92	101	100	94
Agzone 4	97	94	98	95	104
Agzone 5	88	91	92	96	101
Agzone 6	88	89	94	96	95
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	S				
Stripe rust	MR				
Leaf rust	S				
Powdery mildew	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**				
2019 & 2020 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	-9	-7	-9	-4	-5
Eastern	-5	-6	-3	-4	-4
Katanning	-	-4	-3	-4	-3
Gibson	-	-12	-6	-6	-6
Agronomic traits					
Coleoptile group	-				
Black point	MS				
Falling number index	3				
Maturity	Quick–mid				
Variety information					
Pedigree	Mace/LPB07-0980				
Breeder/Seed licensee	LongReach Plant Breeders				
Access to seed	Seed associate and farmer to farmer (WA)				
EPR ($/t, excl GST)	$4.00				

(N) denotes the supplementary classification of APWN

MACE

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 it's Falling Number Index of 5.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	94	95	96	94	93
Agzone 2	92	95	94	96	95
Agzone 3	91	90	95	96	93
Agzone 4	94	95	95	95	97
Agzone 5	93	93	93	95	96
Agzone 6	93	93	94	92	93
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	MRMS				
Stripe rust	RMR*				
Leaf rust	MSS				
Powdery mildew	MSS				
Septoria tritici blotch	S				
Flag smut	S				
Common bunt	MRMS				
RLN (*P. quasitereoides*)	MRMS				
RLN (*P. neglectus*)	MS				
CCN	MRMS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
Northern	-3	-1	-4	-1	-6
Eastern	-2	-2	-2	-4	-3
Katanning	-3	-2	-2	-3	-
Gibson	-4	-2	-3	-3	-3
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 estern Australia can attack these varieties
(N) denotes the supplementary classification of APWN

ROCKSTAR

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 yellow spot and S to leaf rust. RockStar was amongst the highest yielding varieties in the early season NVTs. RockStar has different maturity triggers than other mid–slow varieties such as Cutlass, hence, caution is recommended if sown in April. A provisional falling number rating of 3 so appears to be a higher risk to pre-harvest sprouting.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	-	-	98	97	100
Agzone 2	-	-	100	96	97
Agzone 3	-	-	100	98	102
Agzone 4	-	-	99	93	96
Agzone 5	-	-	97	96	96
Agzone 6	-	-	102	103	103
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*)	MS*p*				
RLN (*P. neglectus*)	MRMS				
CCN	MSS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
Northern	+4	+4	+4	+7	+1
Eastern	+9	+6	+6	+3	+1
Katanning	+6	+5	+2	+2	-
Gibson	+9	+7	+1	+2	+2
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	MSS				
Falling number index	3p				
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 Calibre, Devil, Vixen, LRPB Havoc, and Corack which are more susceptible. Scepter appears to have a similar pre-harvest sprouting resistance to Mace, but its powdery mildew and black point ratings are poorer than Mace (which is one of its parents). Due to a consistent increase in yield, grain protein is on average lower for this variety, and additional nitrogen may benefit the yield and protein performance of this variety.

Yield (% of Mace)	2016	2017	2018	2019	2020
Agzone 1	106	105	104	107	108
Agzone 2	109	105	107	104	106
Agzone 3	110	111	105	104	108
Agzone 4	107	105	105	106	103
Agzone 5	108	108	107	106	105
Agzone 6	108	107	107	109	108
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
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**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
Northern	+3	+1	+4	+1	+6
Eastern	+2	+2	+2	+4	+3
Katanning	+3	+2	+2	+3	-
Gibson	+1	+2	+2	+4	+2
Agronomic traits					
Coleoptile group	Short				
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 estern 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)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	101	98
Agzone 2	-	-	-	104	102
Agzone 3	-	-	-	101	97
Agzone 4	-	-	-	105	106
Agzone 5	-	-	-	104	104
Agzone 6	-	-	-	95	96
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS*p*				
Nodorum blotch (glume)	MRMS*p*				
Stem rust	MRMS				
Stripe rust	MR				
Leaf rust	SVS				
Powdery mildew	S*p*				
Septoria tritici blotch	S				
Flag smut	SVS				
Common bunt	S				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	MRMS*p*				
CCN	MS				
Crown rot	S*p*				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**14-Apr**	**27-Apr**	**12-May**	**27-May**	**11-Jun**
Northern	-	-	-10	-9	-6
Eastern	-	-8	-6	-7	-5
Katanning	-	-9	-7	-6	-
Gibson	-	-10	-6	-5	-7
Agronomic traits					
Coleoptile group	Medium(*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(b)

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% lower than Scepter depending on the agzone. InterGrain suggest Valiant CL Plus to be a slow maturity, offering unique traits of IMI tolerance and a long coleoptile (similiar to Magenta) for an April sowing. Valiant CL Plus is MRMSp for yellow spot, RMRp for stripe rust, MRp for stem rust and MSSp for leaf rust. 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)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	-	-	-	-	86
Agzone 3	-	-	-	-	94
Agzone 4	-	-	-	-	-
Agzone 5	-	-	-	-	81
Agzone 6	-	-	-	-	95
Disease resistance	**Adult rating**				
Yellow spot	MRMS*p*				
Nodorum blotch (leaf)	-				
Nodorum blotch (glume)	-				
Stem rust	MR*p*				
Stripe rust	RMR*p*				
Leaf rust	MSS*p*				
Powdery mildew	-				
Septoria tritici blotch	-				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	-				
CCN	-				
Crown rot	-				
Flowering	**Days after/before Scepter**				
Agronomic traits					
Coleoptile group	Long(*p*)				
Black point	-				
Falling number index	-				
Maturity	Long(*p*)				
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
(N) denotes the supplementary classification of APWN

VIXEN(b)

AH (N)

Comments

Vixen is a quick maturity, AH (N) released in 2018 by InterGrain. It has been in the NVT for four years where its yields are comparable to Scepter or higher in agzones 4 and 5. However, its yields have been more variable as a result of Vixen's different maturity that is favourable with later sowing and tighter finishes to the season (refer to Agzone 1 data below). MRMS to stem and stripe rust but SVS to the latest strain of leaf rust. A falling number rating of 3 so not recommended for areas prone to pre-harvest sprouting.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	-	90	106	103	97
Agzone 2	-	102	99	106	104
Agzone 3	-	-	102	104	97
Agzone 4	-	100	103	108	108
Agzone 5	-	100	103	105	108
Agzone 6	-	-	97	95	96
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MSS				
Nodorum blotch (glume)	MS				
Stem rust	MRMS				
Stripe rust	MRMS				
Leaf rust	SVS				
Powdery mildew	S				
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**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
Northern	-16	-9	-13	-6	-8
Eastern	-8	-6	-3	-6	-4
Katanning	-16	-9	-5	-8	-
Gibson	-9	-15	-10	-9	-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

CHIEF CL PLUS(Þ)

APW (N)

Comments

Chief CL Plus is an APW imidazolinone tolerant variety which was released in 2016. At release this variety was the highest yielding APW imidazolinone tolerant variety but 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)	2016	2017	2018	2019	2020
Agzone 1	95	100	94	91	91
Agzone 2	89	94	94	93	92
Agzone 3	89	91	96	95	94
Agzone 4	91	93	94	86	94
Agzone 5	88	88	87	89	91
Agzone 6	90	92	94	96	95
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MR				
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				
RLN (*P. neglectus*)	MRMS				
CCN	MS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
Northern	+2	+1	-1	+2	+0
Eastern	+8	+2	+4	-1	-1
Katanning	+2	+0	-2	-1	-
Gibson	+4	+0	+1	+0	+2
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 estern Australia can attack these varieties

(N) denotes the supplementary classification of APWN

CUTLASS(Þ)

APW (N)

Comments

Cutlass is a variety which 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, is MSS to yellow spot and S to powdery mildew. Appears to be a higher risk of pre-harvest sprouting than Yitpi.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	91	104	85	86	92
Agzone 2	94	88	90	86	86
Agzone 3	95	89	88	89	92
Agzone 4	85	94	89	84	83
Agzone 5	96	91	89	87	81
Agzone 6	98	100	94	90	91
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**				
2019 & 2020 DPIRD trials	**11-Apr**	**26-Apr**	**10-May**	**24-May**	**17-Jun**
Northern	+24	+23	+18	+12	+8
Eastern	+17	+17	+11	+6	+7
Katanning	+13	+12	+7	+4	-
Gibson	+26	+17	+10	+11	+9
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				

* = Some races in estern Australia can attack these varieties

(N) denotes the supplementary classification of APWN

DENISON(b)

APW

Comments

Denison is a slower maturing APW variety released by AGT in 2020. Denison was tested in a limited number of NVT sites in 2019 and all sites in 2020, yielding similiar to Cutlass in agzones 1, 2, 5 and 6 and slightly higher than Cutlass in agzone 3. Denison was one of the highest yielding varieties in the early season NVT in 2020. 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.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	94
Agzone 2	-	-	-	86	88
Agzone 3	-	-	-	92	96
Agzone 4	-	-	-	-	87
Agzone 5	-	-	-	83	84
Agzone 6	-	-	-	100	98
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS*p*				
Nodorum blotch (glume)	MRMS*p*				
Stem rust	MS				
Stripe rust	MR				
Leaf rust	S				
Powdery mildew	S*p*				
Septoria tritici blotch	MS*p*				
Flag smut	R*p*				
Common bunt	MR*p*				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	S				
CCN	MSS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**14-Apr**	**27-Apr**	**12-May**	**27-May**	**11-Jun**
Northern	-	17	18	14	11
Eastern	12	15	14	8	7
Katanning	27	15	10	9	-
Gibson	-	23	14	15	6
Agronomic traits					
Coleoptile group	Medium(*p*)				
Black point	MS*p*				
Falling number index	-				
Maturity	Slow(*p*)				
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(b)

APW (N)

Comments

LRPB Avenger is 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 to be 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)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	100	93
Agzone 2	-	-	-	105	99
Agzone 3	-	-	-	104	95
Agzone 4	-	-	-	104	104
Agzone 5	-	-	-	104	104
Agzone 6	-	-	-	94	95
Disease resistance	**Adult rating**				
Yellow spot	MS				
Nodorum blotch (leaf)	MSS*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**				
2019 & 2020 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	-	-8	-11	-7	-6
Eastern	-	-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

CALINGIRI

FEED (2022 HARVEST)

Comments

Calingiri has remained a popular mid–slow maturing ANW. It's yields are superseded by the more recently released ANW varieties, Zen, Ninja and Kinsei. Calingiri is SVS to stripe rust and S to stem rust, leaf rust and powdery mildew. The 2022 harvest will see Calingiri received as a FEED variety due to Wheat Quality Australia's rationalisation of the Wheat Variety Master List.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	92	100	84	81	89
Agzone 2	90	86	86	82	84
Agzone 3	90	86	86	85	88
Agzone 4	85	87	86	76	83
Agzone 5	90	83	78	78	78
Agzone 6	92	93	90	88	88
Disease resistance	**Adult rating**				
Yellow spot	MS				
Nodorum blotch (leaf)	MSS				
Nodorum blotch (glume)	MS				
Stem rust	S				
Stripe rust	SVS				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	MSS				
Flag smut	RMR				
Common bunt	MRMS				
RLN (*P. quasitereoides*)	S				
RLN (*P. neglectus*)	SVS				
CCN	–				
Crown rot	S				
Flowering	**Days after/before Scepter**				
selected NVT trials					
2016 (av sowing date May 8)	+4				
2017 (av sowing date May 24)	+4				
2018 (av sowing date May 28)	+4				
Average	+4				
Agronomic traits					
Coleoptile group	Short				
Black point	MS				
Falling number index	4				
Maturity	Mid-slow				
Variety information					
Pedigree	Chino/Kulin//Reeves				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	nil				

KINSEI(ᵖ)

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 has been in the NVTs for four years where it yields slightly less than Ninja, similiar to Zen but out yields Calingiri. Kinsei is among the highest yielding varieties in the early season NVT, only outyielded by RockStar and Denison in 2020. Kinsei is S for blackpoint which may be an issue if sowing the variety in April in susceptible environments. Kinsei's disease ratings are marginally better than Ninja and Zen.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	-	105	94	92	97
Agzone 2	-	94	96	90	93
Agzone 3	-	97	96	94	98
Agzone 4	-	94	95	84	92
Agzone 5	-	92	88	87	88
Agzone 6	-	98	98	100	99
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	S				
Septoria tritici blotch	MSS				
Flag smut	RMR				
Common bunt	MR				
RLN (*P. quasitereoides*)	S				
RLN (*P. neglectus*)	S				
CCN	MSS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2019 & 2020 DPIRD trials	**14-Apr**	**27-Apr**	**12-May**	**27-May**	**11-Jun**
Northern	+5	+7	+6	+7	+2
Eastern	+13	+11	+8	+4	+2
Katanning	+9	+8	+5	+4	-
Gibson	+8	+7	+3	+8	+3
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 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. Although the stem rust rating for Ninja has been upgraded from VSV to S, it has the lowest rust ratings of the newer ANW varieties. Rusts should be actively monitored and managed. Rated MRMS to black point.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	99	101	95	94	99
Agzone 2	99	95	96	93	95
Agzone 3	100	97	95	94	97
Agzone 4	98	95	96	90	95
Agzone 5	99	96	92	91	92
Agzone 6	99	98	98	97	97
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS				
Stem rust	S				
Stripe rust	MS				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	MS				
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**				
2019 & 2020 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	+9	+4	+2	+6	+0
Eastern	+9	+6	+4	+0	+1
Katanning	+4	+3	+0	+0	-
Gibson	+1	+3	-1	+2	-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 powdery mildew, stem and leaf rust, so diseases should be actively monitored and managed. It has a useful black point and RLN (*P.neglectus*) rating but has a weaker falling number index rating than Ninja and Kinsei. Zen is consistently low for small grain screenings in the NVT data.

Yield (% of Scepter)	2016	2017	2018	2019	2020
Agzone 1	96	99	94	91	93
Agzone 2	92	94	94	92	93
Agzone 3	92	92	96	95	94
Agzone 4	93	93	94	86	94
Agzone 5	91	88	87	88	91
Agzone 6	92	93	94	96	95
Disease resistance	**Adult rating**				
Yellow spot	MRMS				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MR				
Stem rust	S				
Stripe rust	MRMS				
Leaf rust	S				
Powdery mildew	S				
Septoria tritici blotch	S				
Flag smut	MS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MS				
RLN (*P. neglectus*)	MRMS				
CCN	S				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2019 & 2020 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				

Notes

BARLEY

By Blakely Paynter (DPIRD)

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 Barley Australia and varieties only deliverable as feed (Tables 1–15; Figures 1–11).

Trade flows for barley have changed since tariffs imposed by China on the imports of Australian barley came into effect in May 2020. Australia's loss of access to the Chinese market has been France's gain. Overall, Australian malt barley sales are down, with the volume of malt barley available to exporters in oversupply. Feed barley sales, on the other hand, are up. The substitution of export sales for malt end-use to sales for stock feed has dampened premiums offered for malt barley and favoured the switch in grower focus from quality to yield. While new brewing customers are enjoying the value and quality of Australian malt barley, the volumes of barley for malting and brewing sold to new customers have not replaced the previous Chinese demand. It is expected that the scenario of a weaker market for malt barley and more robust demand for feed barley will likely continue for another couple of years unless there is a change of policy in China. Australian barley is discounted relative to domestic wheat prices and international barley prices.

As with previous years, deciding whether to grow barley with a malt or feed classification still depends on five main factors:

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

The decision to sow wheat instead of barley depends on:

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

WA growers are fortunate that BFED1 (feed barley) receival standards only focus on hectolitre weight (minimum of 56kg/hL) as the critical quality trait. Growers in eastern Australia who deliver against Grain Trade Australia (GTA) Barley1 (feed barley) receival standards are required to meet both hectolitre weight (minimum of 62.5kg/hL) and screenings targets (maximum of 15% through a 2.2mm slotted sieve). Targeting yield and not quality supports the sowing of the highest yielding variety (regardless of its malt accreditation or segregation opportunity). The production system that maximises grain yield potential includes 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 yield potential, deficiencies and risks of the site and the variety sown.

Where a malt variety is being sown with a malt focus in mind, discussions with domestic processors and the trade before planting the variety will be necessary, as is knowledge of CBH, Bunge, and private storage options. 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. Additionally, market demand for malt barley varieties varies by port zone due to the various domestic and international markets each port zone services. Therefore, choosing a variety or varieties that suit your farming business and which meet the needs of different customers can be complicated.

BARLEY VARIETY CHOICE IN 2022 – WHAT SHOULD I GROW?

The change in variety popularity from 2019 to 2020 saw an increase in the area sown to RGT Planet and Spartacus CL (Figure 1). In 2021, Spartacus CL increased to just over 50% of the area planted to barley. Growers reduced the area sown to Bass, Flinders, La Trobe, RGT Planet while planting more Buff, Maximus CL, and Rosalind.

With the change in market demand for WA malt barley, yield potential has become the primary driver of variety choice, with recently released varieties a more attractive option because of the reduced importance of malt accreditation and malt premiums. However, consistent varietal performance over multiple seasons remains essential.

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, Cyclops, Leabrook, Laperouse, Maximus CL, and Minotaur 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.

Spartacus CL remains the most popular variety grown in WA and remains a suitable option as a malt variety. Growers who are targeting barley for sowing in an imidazolinone (IMI) herbicide management system should consider evaluating the performance of Commodus CL and Maximus CL. Commodus CL offers greater early vigour at a similar yield potential but with increased lodging risk. Maximus CL has a higher yield potential in WA barley National Variety Trials (NVT) (2018–2020) with improved tolerance to spot-form of net blotch

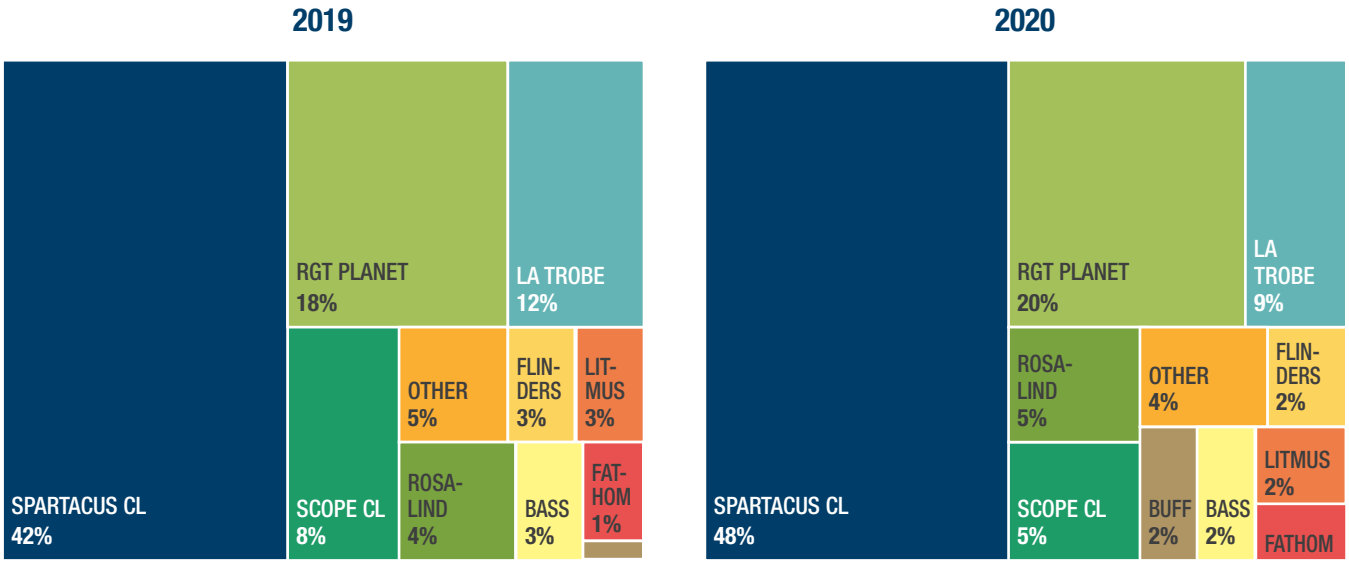

FIGURE 1. Popularity (percentage of barley area) of the top ten barley varieties plus the combined area sown to the other 20 varieties delivered in WA in 2019 and 2020. The top ten varieties occupied 95 and 96% of the area planted to barley.

Source: grower estimates as provided to CBH for 2019 and 2020

(SFNB). Additionally, it has better grain quality characters and can be delivered into malt barley segregations when offered.

End-user preference for the malt quality of Bass and Flinders means these varieties remain an option for growers where malt grade barley is achievable, and the market premium (primarily in the Kwinana and Albany port zones) can cover their lower yield outlook. There is strong demand from malting and brewing customers in south-east Asia and Japan for Bass and Flinders. They can be malted without the use of additives and are well-known by the market. However, they have been superseded for yield. If the domestic preference for Bass and Flinders is not reflected in a reasonable premium offered, they will be lost to WA end-users within a couple of seasons, if not earlier.

Barley options for specific agronomic situations include Buff on soils with a sub-soil pH_{Ca} below 4.8; Scope CL for early sowing and grazing systems where an IMI herbicide might be needed; Beast, Fathom, Laperouse, and Leabrook where weed competition might be helpful; and Fathom where SFNB is a high risk. The recently released varieties Cyclops and Minotaur are also worth considering.

This bulletin compares established barley varieties with the newest malting variety received in WA, Maximus CL. It also outlines the characteristics of newer barley varieties. More comments about each suggested barley variety for WA appear in the variety snapshot section, with additional commentary on the newer barley varieties found in the following section, "What is new?". The "Market feedback" section provides more specific market information published by the Grain Industry Association of Western Australia (GIWA) for varieties received as malt.

WHAT IS NEW?

A suite of new barley varieties is available to growers for sowing in 2022. AGT has released Beast (tested as AGB0113), Cyclops (tested as AGTB0200) and Minotaur (tested as AGTB0213). InterGrain has released Buff (tested as IGB1506), Commodus CL (tested as IGB1908T), and Maximus CL (tested as IGB1705T). SECOBRA Recherches, through Seednet partners, are making the seed of Leabrook (tested as WI4896) and Laperouse (tested as WI4592) available, while Elders has limited volumes of LG Alestar (tested as SMBA11-2341)

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	Flinders	La Trobe	Maximus CL	RGT Planet	Rosalind	Spartacus CL
First year in variety trials in WA	2004	2007	2011	2018	2016	2014	2014
Statewide MET yield (% site mean)[1]	92%	96%	104%	107%	104%	110%	102%
Maturity (sown in late May)	Medium spring	Medium spring	Early spring	Early spring	Medium spring	Early spring	Early spring
Deliverable as / accreditation stage[2]	Malt	Malt	Malt	Malt	Malt	Feed	Malt
Brewing demand (barley and malt)[3]	Acceptable	Acceptable	Acceptable	Being assessed	Preferred	-	Acceptable
Straw strength (excl. head loss)	Very good	Very good	Moderately good	Good	Good	Good	Good
Scald	MRMS	MSS	MR	MR	MR	MSS	MR
NFNB – Beecher virulent[4]	MRMS	MRMS	MS	MSS	S	MS	MS
NFNB – Beecher avirulent	MSS	MS	MS	MRMS	MRMS	MR	MS
NFNB – Oxford virulent	S	S	S	S	SVS	S	S
SFNB	S	S	S	MSS	S	S	SVS
Powdery mildew	MSS	R	MS	RMR	R	MRMS	MRMS
Leaf rust	SVS	MRMS (late APR)	S	MSS	MRMS (late APR)	MR	MSS

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

[1]Regional differences in grain yield are masked when using a statewide average of the WA barley NVT MET data (2016–2020). Growers are directed to Tables 4 to 10 for a more precise estimate of variety performance in their region and Figures 2 to 6 for an indication of relative variety performance at different site yields.

[2]Varieties classed as malt have been accredited by Barley Australia. Varieties classed as Stage 0, 1 or 2 are under evaluation by Barley Australia for their malting and brewing end-use. For more information, visit **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 and Spartacus CL may show a susceptible reaction in the presence of some strains of powdery mildew present in WA

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

Trait	Beast	Commodus CL	Cyclops	Laperouse	Maximus CL	Minotaur	Spartacus CL
First year in variety trials in WA	2019	2020	2020	2016	2018	2020	2014
Statewide MET yield (% site mean)[1]	109%	102%	110%	107%	107%	110%	102%
Maturity (sown in late May)	Early spring	Early spring	Early spring	Medium spring	Early spring	Medium spring	Early spring
Deliverable as / accreditation stage[2]	Stage 1	Stage 1	Stage 1	Stage 2	Malt	Stage 1	Malt
Brewing demand (barley and malt)[3]	-	-	-	-	Being assessed	-	Acceptable
Straw strength (excl. head loss)	Fair	Fair	Good	Good	Good	-	Good
Scald	S	S*p*	MR	S	MR	VS	MR
NFNB – Beecher virulent[4]	MRMS	MRMS*p*	MS	MS	MSS	MRMS	MS
NFNB – Beecher avirulent	S	MRMS*p*	MRMS	MS	MRMS	MRMS	MS
NFNB – Oxford virulent	MSS	S*p*	S	S	S	MS	S
SFNB	MSS	MSSp	MSS	MSS	MSS	S	SVS
Powdery mildew	MR	MR*p*	R	MR	RMR	MRMS	MRMS
Leaf rust	MSS	S*p*	S	MSS	MSS	S	MSS

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

[1]Regional differences in grain yield are masked when using a statewide average of the WA barley NVT MET data (2016–2020). Growers are directed to Tables 4 to 10 for a more precise estimate of variety performance in their region and Figures 2 to 6 for an indication of relative variety performance at different site yields.

[2]Varieties classed as malt have been accredited by Barley Australia. Varieties classed as Stage 0, 1 or 2 are under evaluation by Barley Australia for their malting and brewing end-use. For more information, visit **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. Spartacus CL may show a susceptible reaction in the presence of some strains of powdery mildew present in WA.

for purchase. Of those nine varieties, six (Beast, Buff, Commodus CL, Cyclops, Laperouse, and Minotaur) are under evaluation by Barley Australia (barleyaustralia.com.au/varieties/varieties-under-malting-evaluation/) for their malting and brewing potential. Barley Australia accredited the other three (Leabrook, LG Alestar and Maximus CL) in March 2021. Of those three recently accredited varieties, only Maximus CL so far has been picked up by the industry for segregation in WA.

Entry into the Barley Australia accreditation system does not guarantee varietal accreditation for malting and brewing, nor does it guarantee acceptance by international customers of our grain and malt. Caution is advised in adopting a variety or sowing large areas to a variety under accreditation with the expectation of future segregations unless there is a clear agronomic or grain yield advantage of planting the variety as a feed-only barley. Banks is an example of a variety failing in Stage Two of Barley Australia accreditation, and Compass is an example of an accredited variety not segregated in WA.

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 variety in some seasons but not in other seasons. Therefore, it is vital to look across seasons and sites when assessing which variety best suits each farming business.

Why consider purchasing seed of Beast, Buff, Commodus CL, Cyclops, Laperouse, Maximus CL, and Minotaur?

Beast

Key points:

- In Stage One assessment for malt accreditation in 2021, with the earliest accreditation date being March 2023.
- Targeted for sowing in low to medium rainfall zones.
- Beast has been tested in WA barley NVT for two seasons (2019 and 2020).
- Statewide performance was comparable to Rosalind in 2019 and 2020, achieving the same yield in two of every three WA barley NVT.
- Scald and NFNB (Beecher avirulent) need management as an adult plant.

Beast (tested as AGTB0113) is a tall height, early spring, two-row variety bred by AGT and registered in August 2020. Compass and Hindmarsh are in the pedigree of Beast.

Beast is undergoing agronomic evaluation by DPIRD in small plot trials for the first time in 2021. As DPIRD has limited independent information to help guide growers and industry of its weaknesses and strengths, NVT data is the primary source of independent information at this stage. Across 48 WA barley NVT (2019–2020), Beast yielded less than RGT Planet in 19% trials, the same in 6% and higher in 75% (Table 11). Relative to Rosalind, it yielded lower in 22%, the same in 65% and higher in 13% (Table 12).

According to the breeder, Beast is suited to low-to-medium rainfall environments, has good early canopy size and ground coverage, a sound grain quality package and is of a similar plant height to Compass. Straw strength may be an issue in longer growing environments and at sites with high yield potential. Head loss risk is expected to be similar to Compass.

Beast has valuable resistance to NFNB (Beecher virulent) and powdery mildew (PM) but may need management for scald and NFNB (Beecher avirulent) (Tables 13 and 14). Leaf rust risk is lower than experienced with Compass. It is rated as MS as a seedling and MSS as an adult plant to SFNB, limiting disease expression. As there have been reports of smut in Beast crops, growers are encouraged to monitor their paddocks and treat their seeds.

Seed is available for planting in 2021 from AGT Affiliates and resellers. Seed is also free to trade farmer to farmer by complying with the AGT Seed Sharing licence (agtbreeding.com.au/sourcing-seed/seed-sharing).

Buff

Key points:

- In Stage Two assessment for malt accreditation in 2021, with the earliest accreditation date being March 2022.
- Targeted for sowing on soils with an acidic profile in low to medium rainfall zones.
- Unlike Litmus, it does not have a blue aleurone that is often associated with varieties with Al tolerance.
- Due to a more consistent yield across a range of soils, Buff supersedes Litmus as it has yielded higher in two out of every three WA barley NVT since 2016.
- Between Rosalind and Spartacus CL in its statewide yield potential.
- SFNB, PM and BLR need management.

Buff (tested as IGB1506) is a medium height, medium spring, two-row barley bred by Agriculture Victoria Service, licenced to InterGrain, and registered in September 2018. Buff has some visual characteristics similar to Mundah (as Mundah is in its pedigree) but has different phenology, grain yield, grain characteristics and malt quality.

Buff has been in WA barley NVT since 2016 and is a direct competitor to Litmus on acidic soils and all other barley varieties on non-acidic soils, except where IMI residues are present. Buff has similar genetics for Al tolerance to Litmus. The Al tolerance genetics increase the production of citrate from the roots of barley, allowing increased root growth and higher yields in soil with a low soil pH and increased levels of soluble Al. Aluminium is toxic to barley roots, making barley less productive on acidic soils.

Buff has displayed a consistent yield advantage over Litmus, primarily on non-acidic soils. Across 46 WA barley NVT trials (2016–2017, 2019–2020), Buff yielded less than Litmus in 11%, the same in 22% and higher in 67%. The overall yield advantage was 9% over Litmus across the trials (relative yield is subject to regional and seasonal variation) (Table 10). As the Al tolerance in Buff is not as strong as

Litmus, Litmus may yield higher than Buff on very acidic soils with high soil Al.

The NVT multi-environment trial (MET) analysis indicates that Buff has a yield potential at least equivalent to Spartacus CL on non-acidic soils and higher than Spartacus CL on soils with an acidic profile. Across 84 WA barley NVT trials (2016–2020), Buff achieved the same yield as Spartacus CL in 29% of trials, was higher in 42% and lower in 30% (Table 11). Overall, the yield of Buff was about 4% higher than Spartacus CL in WA barley NVT (2016–2020) (Table 10), or about 0.2t/ha. Across 84 WA barley NVT (2016–2020), Buff yielded less than RGT Planet in 31% of trials, the same in 20% and higher in 49% (Table 10). Buff has a grain yield advantage over RGT Planet when the site yield is below 3t/ha and on acidic soils (Figure 2).

When grown under the same management in NVT trials, Buff grain tends to have a lower hectolitre weight (Figure 7), with slightly higher screenings (Figure 9), improved grain brightness (Figure 11) and a lower grain protein concentration (at the same grain yield) than Spartacus CL.

Relative to Litmus, Buff has improved scald and NFNB resistance but is less tolerant to PM (Tables 13 and 14). Relative to Spartacus CL, Buff has improved resistance to NFNB (Beecher avirulent and Oxford virulent) as an adult plant but weaker resistance to PM. Fungicides may be required to manage SFNB, PM and barley leaf rust (BLR). The weak PM and BLR resistance of Buff will limit its practical use in higher rainfall areas.

Buff is an improvement over Litmus for straw strength but still at risk of lodging. Data from DPIRD trials at Gibson in 2018 and 2019 suggest that Buff may have a medium or higher risk of head loss.

Seed is available for planting in 2022 from Seedclub members and resellers. Seed is also free to trade farmer to farmer by complying with the InterGrain seed sales declaration agreement (**intergrain.com/source-seeds/ftf-trading/**).

Commodus CL

Key points:

- In Stage One assessment for malt accreditation in 2021, with the earliest accreditation date being March 2023.
- Targeted for sowing in low to medium rainfall zones and lighter soil types.
- Commodus CL has only been tested in WA barley NVT for one season (2020).
- Statewide performance was marginally below Compass in 2020, with Compass having a slight yield advantage in environments that yielded less than 4t/ha.
- Commodus CL, like Spartacus CL, possesses the gene conferring tolerance to label application rates of registered IMI products.
- 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 in October 2020. Commodus CL has a similar genetic background to Compass.

Commodus CL is undergoing agronomic evaluation by DPIRD in small plot trials for the first time in 2021. As DPIRD has limited independent information to help guide growers and industry of its weaknesses and strengths, NVT data is the primary source of independent information at this stage. Across 28 WA barley NVT in 2020, Commodus CL yielded less than Compass in 29% of trials, the same in 71% and higher in 0%. Commodus CL also yielded similarly to Spartacus CL (Table 11).

According to the breeder, Commodus CL is suited to low to medium rainfall environments, has good early canopy size and ground coverage, 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.

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*p* as a seedling and MSS*p* as an adult plant to SFNB, limiting disease expression.

Seed is available for planting in 2022 from Seedclub members and resellers. It is not legal to acquire Commodus CL via farmer to farmer trading.

Cyclops

Key points:

- In Stage One assessment for malt accreditation in 2021, with the earliest accreditation date being March 2023.
- Targeted for sowing in all rainfall zones.
- Cyclops has only been tested in WA barley NVT for one season (2020).
- Statewide performance was comparable to Rosalind in 2020, with a potential advantage in environments that yield more than 3t/ha.
- NFNB (Oxford avirulent) and BLR need management.

Cyclops (tested as AGTB0200) is a medium height, early spring, two-row variety bred by AGT and registered 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 lending it to be low itch barley variety.

Cyclops is undergoing agronomic evaluation by DPIRD in small plot trials for the first time in 2021. As DPIRD has limited independent information to help guide growers and industry of its weaknesses and strengths, NVT data is the primary source of independent information at this stage. Across 28 WA barley NVT (2020), 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, it yielded the same as Rosalind in two of out every three WA barley NVT (2020) (Table 12) and showed an advantage in environments that produced 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 as MSS to SFNB (seedling and adult plant), limiting disease expression.

Seed is available for planting in 2022 from AGT Affiliates and resellers. Seed is also free to trade farmer to farmer by complying with the AGT Seed Sharing licence (**agtbreeding.com.au/sourcing-seed/seed-sharing**).

Laperouse

Key points:

- In Stage Two assessment for malt accreditation in 2021, but accreditation has been delayed. The earliest accreditation date is March 2023.
- Targeted for sowing in medium to higher rainfall areas.
- Laperouse has been tested in WA barley NVT since 2016.
- Between Rosalind and Spartacus CL in its statewide yield potential and competitive with Rosalind at sites with a potential above 4t/ha.
- NFNB (Oxford virulent) needs management.

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, registered in September 2019, and 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. In some areas, it could be an alternative to Fathom barley. Laperouse has potential for early sowing opportunities, with good straw strength and head retention.

Across 85 WA barley NVT trials (2016–2020), Laperouse has yielded more than Spartacus CL in half of the trials (Table 11). Across these trials, the overall yield advantage of Laperouse was 5% over Spartacus CL (relative yield is subject to regional and seasonal variation) (Table 10), and superior at sites where the yield is above 3t/ha. Across 84 WA barley

NVT (2016–2020), Laperouse has likewise yielded more than RGT Planet in just over half the trials (Table 11). Laperouse has a yield advantage over RGT Planet at sites where the site yield is below 4t/ha. Across 85 WA barley NVT (2016–2020), Laperouse yielded less than Rosalind in 41% of trials, the same in 46% and higher in 13% (Table 12), with Rosalind having the advantage below 3t/ha.

When grown under the same management in NVT trials, Laperouse grain tends to have a slightly lower hectolitre weight (Figure 7), with fewer screenings (Figure 9), equivalent grain brightness (Figure 11) and a lower grain protein concentration (at the same grain yield) than Spartacus CL.

Laperouse has excellent resistance to PM and useful resistance to NFNB (except Oxford virulent) and SFNB. It is rated as MRMS as a seedling and MSS to SFNB, which will limit disease expression. Laperouse is less suited to areas where scald is a regular constraint to production (Tables 13 and 14).

Seed is available for planting in 2022 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.
- Between Rosalind and Spartacus CL in its statewide yield potential.
- Maximus CL, like Spartacus 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.
- NFNB (Oxford virulent) needs management.

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

Maximus CL is a competitor to all varieties except Buff and Litmus on acidic soils. Maximus CL will replace Spartacus CL within a couple of seasons. Across 68 WA barley NVT (2018–2020), Maximus CL yielded the same as Spartacus CL in 57% of trials and higher in 43%. It has yet to yield less than Spartacus CL in WA barley NVT trials (Table 11). Maximus CL appears to have a yield advantage at all levels of yield potential (Figures 4 and 5). Across 67 WA barley NVT (2018–2020), Maximus CL has yielded higher than RGT Planet in three out of every five WA barley NVT (Table 11), with this advantage apparent when the site yield is below 3.5t/ha (Figures 4 and 5). Maximus CL was lower yielding than Rosalind in three out of every five WA barley NVT and similar in the rest (Table 12).

The grain quality of Maximus CL is an improvement over Spartacus CL for grain plumpness (Figures 8 and 9), similar for grain protein concentration (at the same grain yield) but weaker for grain brightness (Figures 10 and 11) with slightly lower hectolitre weight (Figures 6 and 7).

The main advantage of Maximus CL over Spartacus CL for disease resistance is with SFNB, where Maximus CL is rated as MSS as both a seedling and an adult plant. 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 different 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 with 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 2022 from Seedclub members and resellers. It is not legal to acquire Maximus CL via farmer to farmer trading.

Minotaur

Key points:

- In Stage One assessment for malt accreditation in 2021, with the earliest accreditation date being March 2023.
- Targeted for sowing in medium to high rainfall zones.
- Minotaur has only been tested in WA barley NVT for one season (2020).
- Statewide performance is an improvement over RGT Planet in environments that yield less than 4t/ha, but it has not matched Rosalind in those environments.
- Scald, SFNB and BLR need management.

Minotaur (tested as AGTB0213) is a medium height, medium spring, two-row variety bred by AGT and registered in August 2021. Minotaur has the prostrate growing habit of RGT Planet with a medium coleoptile. Minotaur was produced by crossing European and Australian genetics.

Minotaur is undergoing agronomic evaluation by DPIRD in small plot trials for the first time in 2021. As DPIRD has limited independent information to help guide growers and industry of its weaknesses and strengths, NVT data is the primary source of independent information at this stage. Across 28 WA barley NVT (2020), Minotaur yielded more than RGT Planet in three out of every five WA barley NVT (Table 11), with an advantage below 4t/ha (Figure 3). Relative to Rosalind, it yielded the same as Rosalind in two out of every five WA barley NVT (2020) (Table 12) but showed an advantage in environments that produced more than 5t/ha (Figure 3).

According to the breeder, Minotaur is adapted to a broader range of environments than RGT Planet and offers some improvements in physical grain quality, delivering a higher hectolitre weight.

Minotaur has useful resistance to NFNB (Beecher virulent and avirulent) and PM but may need management for scald, NFNB (Oxford avirulent) and BLR (Tables 13 and 14). It is rated as MS to SFNB (seedling and adult plant), limiting disease expression.

Seed is available for planting in 2022 from AGT Affiliates and resellers. Seed is also free to trade farmer to farmer by complying with the AGT Seed Sharing licence (agtbreeding.com.au/sourcing-seed/seed-sharing).

OTHER CONSIDERATIONS FOR BARLEY GROWERS

Changes in disease pathogens

New pathotypes and new diseases detected in WA have ramifications for variety choice and fungicide strategies in recent years. Growers, particularly those on the south coast, should be watchful for the new and aggressive Oxford virulent NFNB pathotype, the newly identified leaf disease Ramularia leaf spot (RLS) and potential changes in the virulence of PM with the detection of virulence to the *MlLa* gene.

Tips for managing grain protein in malt barley

When growing barley for malting, a higher protein can be achieved by altering the timing of nitrogen (N) supply, applying more N, sowing into legume stubble, or by 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 that can boost grain protein include applying higher levels of N fertiliser and incorporating legumes in 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 or Maximus CL (where suitable) can achieve a grain protein concentration of 1% greater 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. In some seasons, additional N application around flag leaf emergence can also boost grain protein. 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 barley is higher than when growing barley for delivery into malt segregations.

When considering the rate of seed 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 reduction in hectolitre weight expected of less than 0.5kg/hL.

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

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

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

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

TABLE 3. Western Australian malt barley variety segregation recommendations by Port zone for the 2022–2023 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	Strong demand for domestic processing and exporting as malt.
Flinders	NO	NO	NO	NO	NO	Limited	Limited	Works well as a variety for post-malt blending and sugar-adjunct brewing
La Trobe	NO	Niche	Niche	Niche	Niche	Niche	Niche	Declining market demand with a recognised quality profile.
Maximus CL	NO	Limited	Limited	Limited	Limited	Limited	Limited	International markets have had limited opportunities to evaluate.
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.

Source: GIWA Barley Council

Market feedback

Grain Industry Association of Western Australia (GIWA)

For the 2022–2023 harvest, the following observations are relevant:

- Barley is still popular among growers. The area sown to barley in WA in 2021 is on par with that in 2018 and 2020, 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 2022.
- Trade flows for barley have changed since tariffs imposed by China on the imports of Australian barley came into effect in May 2020. Australian malt barley sales are down, and feed barley sales are up. There is an over-supply of malt barley available to exporters, both in WA and nationally. The substitution of export sales for malting to sales for stock feed has dampened premiums offered for malt barley.
- The scenario of a weak market for malt barley and strong demand for feed barley, notwithstanding any changes to China's current stance, will likely continue for another couple of years. However, the supply of high-quality malt barley is still required to meet the demand from remaining and new export customers of our malt barley and the strong domestic market demand for malt barley.
- The Boortmalt and Barret Burston malthouses in Perth are the largest customers of WA malt barley grain. They procure 360,000 tonnes of malt barley grain annually from growers in the Kwinana and parts of the Albany port zones.
- Grower production of Bass, Flinders and La Trobe is declining.
- Bass and Flinders are both, however, considered as significant varieties for malting and brewing end-use in south-east Asia and Japan as they can be malted without the use of additives and are well-known by the market. However, should market demand not result in an attractive malt premium over the subsequent two harvests, the decline in production of Bass and Flinders will increase in pace.
- La Trobe has been the preferred variety for the manufacture of shochu in Japan for the last five years. Spartacus CL is now an approved variety for shochu manufacture following the lifting of Japan's maximum residue limit (MRL) for imazapyr from 0.01 to 0.7ppm in early 2021. As previously indicated in the 2021–2022 recommendations, La Trobe will no longer be a segregated variety after the 2022–2023 harvest.
- Spartacus CL and RGT Planet dominate the production area sown to barley in WA. There is a continued demand for RGT Planet from global malting and brewing customers who accredited the variety from European sourced production. Spartacus CL, while popular with the Australian brewing industry, does not have the same level of international market recognition. International sales of Spartacus CL for malting and brewing include regional Asian beer brands and brewing opportunities in central and southern America (i.e. Mexico, Ecuador, and Peru).
- Three new varieties, Leabrook, LG Alestar and Maximus CL, were accredited in March 2021 by Barley Australia as being suitable for malting and brewing. Only Maximus CL will be segregated in WA at the 2022–2023 harvest of those three varieties. The area sown to Maximus CL starts increasing in 2022 at the expense of Spartacus CL. During this transition, market development will be critical to securing Maximus CL as a preferred variety.
- Segregation opportunities for Bass, Flinders, La Trobe, Maximus CL, RGT Planet, and Spartacus CL vary by port zone across WA and within a port zone for the Kwinana and Albany Ports (Table 3).

WHY RATIONALISE MALT VARIETIES?

In line with previous advice, the WA barley industry supports the long-term aim of segregating up to two major malt varieties per port zone, with limited segregations 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 the trade who are unwilling to risk buying small, unsaleable parcels.

The Grain Industry Association of Western Australia (GIWA) Inc (through the GIWA Barley Council) developed the recommendations in consultation with the WA barley supply chain. Their purpose is to guide growers and consultants when planning the 2022 barley cropping program. A plan review will occur in autumn 2022, and any changes in demand presented to growers. This document's malt variety recommendations may differ from eastern Australia due to our focus on international markets.

While GIWA facilitates publishing industry recommendations on what malt variety to grow, it has no control over the actual segregations provided by Bunge or CBH. Some sites can only offer a single malt barley segregation, whereas others may offer two or more malt barley segregations. Growers can support segregation planning through submission of their area planted information and attending pre-harvest meetings.

The Australian barley industry works hard to uphold Australian malt variety quality to the end customer. It does not support the co-binning of segregated malt varieties, even if the varieties concerned have similar agronomic traits. Growers should not intentionally contaminate a malt barley stack with another variety. Correct variety declaration is a legal requirement under the Plant Breeders Rights Act, and misdeclaration breaches the Bulk Handling Act 1967. Growers should be careful not to contaminate their seed stocks by mixing varieties that look similar such as La Trobe, Maximus CL or Spartacus CL, or mix them with any variety.

MALT VARIETY-SPECIFIC RECOMMENDATIONS

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

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

Growers should use the market signals in this document to help them decide on which malt variety or varieties to sow in 2022. In determining malt variety choice, market demand, pricing signals, and segregation locations should be considered alongside the agronomic management required and the risk associated with delivering malt grade barley. Varieties listed as PREFERRED are more likely to attract higher premiums than ACCEPTABLE varieties. As these industry recommendations are a guide, the actual segregations implemented at the 2022–2023 harvest may differ from those proposed in this document. Growers should regularly liaise with their bulk handlers to confirm segregations.

The malt barley recommendations for the 2022 season are as follows:

Bass

- Bass is the 'market leader' for malt quality, with strong demand for domestic processing and exporting as malt. It is acceptable for export as grain.
- 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 our ability to supply premium malt to key customers.

- Suitable for additive-free malting, a growing sector of the international malt market.
- Frequently used when blending malt to customer specifications.
- Bass malt has excellent extract, and filterability and its quality profile matches market needs from 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.
- Bass, like Flinders, has a higher selection rate for malt than La Trobe, RGT Planet and Spartacus CL but is now outclassed for grain yield.
- The value that Bass brings to maltsters and brewers should be reflected in market pricing. Otherwise, future volumes will not match demand.
- Target production zones in 2022 are Kwinana-North (Midlands) and Kwinana-South. Limited segregation opportunities will be offered due to declining production.

Flinders

- Flinders is acceptable for export as grain and preferred for export as malt.
- Not suitable for the manufacture of shochu in Japan.
- Suitable for additive-free malting, a growing sector of the international malt market.
- 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 practised and when blended post-malting for starch-adjunct brewing markets.
- Flinders, like Bass, has a higher selection rate for malt than La Trobe, RGT Planet and Spartacus CL but is now out-classed for grain yield.
- The value Flinders brings to maltsters and brewers should be reflected in market pricing. Otherwise, future volumes will not match demand.
- Target production zones in 2022 are Albany-South and Esperance. Limited segregation opportunities will be offered due to declining production.

La Trobe

- La Trobe is acceptable for export as grain and as malt and is suitable for the manufacture of shochu in Japan.
- There is declining customer demand for La Trobe.
- La Trobe malt has a high extract with a high enzyme potential and is suitable for starch-adjunct brewing.
- Due to reducing production volumes, niche segregations will be offered in Kwinana, Albany, and Esperance port zones. The 2022–2023 harvest marks the last harvest that La Trobe will be segregated.

Maximus CL

- Maximus CL is being assessed for export as grain and as malt and for the manufacture of shochu in Japan.
- Maximus CL malt has a high extract with a high enzyme potential and is suitable for starch-adjunct brewing.
- Grower production will exceed market demand at the 2022–2023 harvest. Due to limited market development opportunities to date, growers should expect restricted malt-premiums offered.
- The industry is expecting Maximus CL will replace Spartacus CL on-farm.
- Use recommended imidazolinone herbicides, and be aware of market advice regarding delivering grain from paddocks sprayed with an IMI herbicide.
- Target production zones in 2022 are Kwinana, Albany and Esperance port zones. Limited segregation opportunities will be offered as the variety is new, and there is currently minimal customer demand.

RGT Planet

- RGT Planet is preferred for export as grain and as malt.
- Not suitable for the manufacture of shochu in Japan.
- 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.
- RGT Planet malt has excellent extract with a moderate enzyme potential and is suitable for sugar- and starch-adjunct brewing.
- Target production zones in 2022 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 but not preferred by all our brewing customers.
- Use recommended imidazolinone herbicides, and be aware of market advice regarding the delivery of grain from paddocks sprayed with an imidazolinone herbicide.
- Target production zones in 2022 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 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 as 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 (2016–2020) 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.

Agzones were developed using statistical analysis by the Department of Primary Industries and Regional Development (DPIRD) to group environmental regions with similar crop performance in WA.

Tables 11 and 12 use 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 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 for the period 2016 to 2020 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 your 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 5 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. A quadratic polynomial was fitted to the data if the quadratic trend was significant ($p<0.05$). If the linear trend (but not the quadratic trend) was significant ($p<0.05$), a linear polynomial was fitted to the data. If neither the quadratic nor the linear trend was significant, the grain yield response of a variety was deemed to run parallel to the site mean yield at the average deviation for that variety. It is worth noting that depending on which years and locations are analysed, the relative performance of varieties may differ. This highlights the importance of looking at 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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		4.13	2.07	4.29	1.18	5.01	3.40
Variety	(No. trials)	(2)	(2)	(2)	(1)	(1)	(8)
Deliverable as a malt variety							
Bass	(8)	94	92	92	86	95	**92**
Flinders	(6)	-	93	90	80	97	**92**
La Trobe	(8)	100	103	104	112	102	**104**
Maximus CL	(4)	-	-	105	116	103	**-**
RGT Planet	(8)	107	97	102	94	108	**102**
Spartacus CL	(8)	98	102	101	109	101	**102**
Stage Two malt accreditation							
Buff	(7)	108	118	115	132	102	**115**
Laperouse	(6)	105	-	109	119	105	**108**
Deliverable as a feed variety							
Beast	(2)	-	-	-	125	104	**-**
Commodus CL	(1)	-	-	-	-	101	**-**
Compass	(8)	102	108	110	127	101	**109**
Cyclops	(1)	-	-	-	-	108	**-**
Fathom	(8)	103	111	112	128	100	**110**
Leabrook	(8)	106	107	112	125	104	**110**
LG Alestar	(3)	97	-	-	79	97	**-**
Litmus	(6)	102	112	-	118	99	**108**
Minotaur	(1)	-	-	-	-	108	**-**
Mundah	(6)	-	97	100	102	97	**98**
Rosalind	(8)	105	112	112	128	107	**112**
Scope CL	(8)	97	103	101	106	95	**100**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		3.97	4.11	4.30	2.21	3.19	3.47
Variety	(No. trials)	(3)	(5)	(7)	(7)	(6)	(28)
Deliverable as a malt variety							
Bass	(27)	90	94	94	94	93	**93**
Flinders	(28)	95	97	93	92	96	**94**
La Trobe	(28)	99	100	104	107	106	**104**
Maximus CL	(20)	-	-	105	109	110	**107**
RGT Planet	(27)	102	101	103	99	100	**101**
Spartacus CL	(28)	97	99	102	107	106	**103**
Stage Two malt accreditation							
Buff	(27)	118	108	108	110	106	**109**
Laperouse	(25)	-	104	108	108	108	**107**
Deliverable as a feed variety							
Beast	(13)	-	-	-	113	112	**109**
Commodus CL	(6)	-	-	-	-	104	**104**
Compass	(28)	102	101	108	112	107	**107**
Cyclops	(6)	-	-	-	-	111	**110**
Fathom	(28)	106	103	107	110	104	**106**
Leabrook	(28)	105	104	110	110	107	**108**
LG Alestar	(16)	96	-	-	91	93	**94**
Litmus	(21)	108	98	-	108	95	**102**
Minotaur	(6)	-	-	-	-	108	**108**
Mundah	(23)	-	92	99	103	93	**97**
Rosalind	(28)	108	104	110	115	112	**110**
Scope CL	(27)	99	97	98	101	96	**98**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		3.59	4.37	3.67	4.25	4.59	4.21
Variety	(No. trials)	(1)	(2)	(4)	(4)	(6)	(17)
Deliverable as a malt variety							
Bass	(17)	89	91	94	93	94	**93**
Flinders	(17)	96	96	97	96	97	**97**
La Trobe	(17)	99	100	101	105	104	**103**
Maximus CL	(14)	-	-	102	107	106	**104**
RGT Planet	(17)	109	113	107	107	107	**108**
Spartacus CL	(17)	96	97	100	104	103	**101**
Stage Two malt accreditation							
Buff	(14)	-	-	102	102	99	**102**
Laperouse	(17)	106	106	105	107	108	**107**
Deliverable as a feed variety							
Beast	(10)	-	-	-	109	109	**107**
Commodus CL	(6)	-	-	-	-	102	**101**
Compass	(17)	98	99	101	104	104	**102**
Cyclops	(6)	-	-	-	-	112	**111**
Fathom	(17)	101	99	100	100	100	**100**
Leabrook	(17)	104	105	105	106	107	**106**
LG Alestar	(11)	97	-	-	95	95	**96**
Litmus	(9)	101	99	-	-	90	**94**
Minotaur	(6)	-	-	-	-	109	**110**
Mundah	(14)	-	93	95	94	93	**93**
Rosalind	(17)	107	107	105	111	108	**108**
Scope CL	(17)	93	92	94	93	92	**93**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		0.00	1.45	3.57	0.80	2.61	2.49
Variety	(No. trials)	(0)	(1)	(2)	(1)	(5)	(9)
Deliverable as a malt variety							
Bass	(9)	-	93	92	88	97	**94**
Flinders	(9)	-	94	95	85	94	**93**
La Trobe	(9)	-	123	97	102	109	**107**
Maximus CL	(8)	-	-	101	109	111	**111**
RGT Planet	(9)	-	90	100	88	98	**96**
Spartacus CL	(9)	-	130	96	101	111	**109**
Stage Two malt accreditation							
Buff	(9)	-	102	123	148	105	**113**
Laperouse	(8)	-	-	100	103	106	**105**
Deliverable as a feed variety							
Beast	(6)	-	-	-	109	113	**112**
Commodus CL	(5)	-	-	-	-	106	**105**
Compass	(9)	-	122	100	113	112	**111**
Cyclops	(5)	-	-	-	-	106	**104**
Fathom	(8)	-	108	108	126	108	**110**
Leabrook	(9)	-	112	101	109	108	**107**
LG Alestar	(6)	-	-	-	90	92	**92**
Litmus	(7)	-	104	-	159	111	**119**
Minotaur	(5)	-	-	-	-	105	**108**
Mundah	(9)	-	103	101	110	107	**106**
Rosalind	(9)	-	139	109	124	117	**118**
Scope CL	(9)	-	98	105	117	102	**104**

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

TABLE 8. Grain yield of barley varieties in AGZONE 5 expressed as a percentage of the site mean yield for each trial year (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		2.61	3.68	2.97	1.98	2.70	2.80
Variety	(No. trials)	(1)	(4)	(3)	(4)	(6)	(18)
Deliverable as a malt variety							
Bass	(18)	89	92	91	90	92	**91**
Flinders	(17)	-	97	97	95	94	**96**
La Trobe	(18)	95	102	104	116	114	**109**
Maximus CL	(13)	-	-	108	127	121	**115**
RGT Planet	(18)	118	108	106	94	91	**99**
Spartacus CL	(18)	93	100	103	121	115	**110**
Stage Two malt accreditation							
Buff	(18)	102	101	105	107	104	**104**
Laperouse	(18)	102	108	107	109	115	**110**
Deliverable as a feed variety							
Beast	(10)	-	-	-	125	125	**117**
Commodus CL	(6)	-	-	-	-	112	**105**
Compass	(18)	88	101	103	115	118	**109**
Cyclops	(6)	-	-	-	-	120	**113**
Fathom	(18)	89	99	100	106	109	**104**
Leabrook	(18)	96	106	105	107	115	**109**
LG Alestar	(11)	104	-	-	87	85	**91**
Litmus	(5)	96	85	-	-	-	**91**
Minotaur	(6)	-	-	-	-	105	**111**
Mundah	(17)	-	89	91	98	88	**91**
Rosalind	(18)	103	104	111	132	118	**116**
Scope CL	(5)	86	91	-	-	-	**94**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		4.14	2.96	4.90	4.19	4.25	4.21
Variety	(No. trials)	(2)	(1)	(2)	(3)	(3)	(11)
Deliverable as a malt variety							
Bass	(11)	83	90	92	89	90	**89**
Flinders	(11)	98	109	98	98	99	**99**
La Trobe	(11)	93	86	97	101	102	**98**
Maximus CL	(8)	-	-	100	106	108	**102**
RGT Planet	(11)	124	130	112	108	107	**113**
Spartacus CL	(11)	88	84	96	100	101	**96**
Stage Two malt accreditation							
Buff	(8)	-	-	106	105	100	**104**
Laperouse	(10)	107	94	103	107	109	**106**
Deliverable as a feed variety							
Beast	(6)	-	-	-	107	109	**102**
Commodus CL	(3)	-	-	-	-	100	**-**
Compass	(11)	88	71	95	98	100	**94**
Cyclops	(3)	-	-	-	-	114	**110**
Fathom	(11)	92	75	97	97	97	**94**
Leabrook	(11)	101	85	101	103	105	**101**
LG Alestar	(8)	102	-	-	97	96	**100**
Litmus	(3)	93	95	-	-	-	**-**
Minotaur	(3)	-	-	-	-	112	**-**
Mundah	(9)	-	82	92	84	81	**83**
Rosalind	(11)	103	93	104	108	106	**104**
Scope CL	(3)	83	80	-	-	-	**-**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		3.86	3.49	3.99	2.72	3.45	3.46
Variety	(No. trials)	(9)	(15)	(20)	(20)	(27)	(91)
Deliverable as a malt variety							
Bass	(90)	89	93	93	92	93	**92**
Flinders	(88)	96	97	94	95	96	**96**
La Trobe	(91)	97	101	102	106	107	**104**
Maximus CL	(67)	-	-	104	111	110	**107**
RGT Planet	(90)	110	106	105	103	102	**104**
Spartacus CL	(91)	95	99	100	106	106	**102**
Stage Two malt accreditation							
Buff	(83)	112	106	108	107	102	**106**
Laperouse	(84)	105	105	106	108	109	**107**
Deliverable as a feed variety							
Beast	(47)	-	-	-	112	113	**109**
Commodus CL	(27)	-	-	-	-	104	**102**
Compass	(91)	97	100	104	107	107	**104**
Cyclops	(27)	-	-	-	-	112	**110**
Fathom	(90)	100	100	104	104	103	**103**
Leabrook	(91)	103	104	107	107	108	**106**
LG Alestar	(55)	98	-	-	93	92	**94**
Litmus	(51)	101	96	-	100	91	**97**
Minotaur	(27)	-	-	-	-	108	**110**
Mundah	(78)	-	92	97	95	93	**94**
Rosalind	(91)	106	106	108	115	112	**110**
Scope CL	(69)	93	94	97	96	95	**95**

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	70%	26%	4%	90	2016–2020	Bass < RGT Planet
Beast	19%	6%	75%	48	2019–2020	Beast > RGT Planet
Buff	31%	20%	49%	84	2016–2020	Buff = RGT Planet
Commodus CL	21%	29%	50%	28	2020	Commodus CL ≥ RGT Planet
Compass	33%	16%	51%	91	2016–2020	Compass = RGT Planet
Cyclops	7%	18%	75%	28	2020	Cyclops > RGT Planet
Fathom	34%	21%	44%	90	2016–2020	Fathom = RGT Planet
Flinders	70%	22%	8%	88	2016–2020	Flinders < RGT Planet
La Trobe	35%	19%	46%	91	2016–2020	La Trobe = RGT Planet
Laperouse	27%	17%	56%	84	2016–2020	Laperouse = RGT Planet
Leabrook	29%	15%	56%	91	2016–2020	Leabrook = RGT Planet
LG Alestar	73%	25%	2%	56	2016, 2019–2020	LG Alestar < RGT Planet
Litmus	52%	10%	38%	52	2016–2017, 2019–2020	Litmus = RGT Planet
Maximus CL	22%	18%	60%	67	2018–2020	Maximus CL ≥ RGT Planet
Minotaur	0%	43%	57%	28	2020	Minotaur ≥ RGT Planet
Mundah	59%	16%	24%	79	2017–2020	Mundah ≤ RGT Planet
Rosalind	22%	14%	64%	91	2016–2020	Rosalind ≥ RGT Planet
Scope CL	52%	25%	23%	69	2016–2020	Scope CL ≤ RGT Planet
Spartacus CL	37%	16%	46%	91	2016–2020	Spartacus CL = RGT Planet
Variety B: Spartacus CL						
Bass	89%	11%	0%	91	2016–2020	Bass < Spartacus CL
Beast	0%	27%	73%	48	2019–2020	Beast > Spartacus CL
Buff	30%	29%	42%	84	2016–2020	Buff = Spartacus CL
Commodus CL	21%	79%	0%	28	2020	Commodus CL = Spartacus CL
Compass	10%	53%	37%	92	2016–2020	Compass ≥ Spartacus CL
Cyclops	18%	29%	54%	28	2020	Cyclops ≥ Spartacus CL
Fathom	31%	35%	34%	91	2016–2020	Fathom = Spartacus CL
Flinders	70%	24%	7%	89	2016–2020	Flinders < Spartacus CL
La Trobe	1%	88%	11%	92	2016–2020	La Trobe = Spartacus CL
Laperouse	12%	34%	54%	85	2016–2020	Laperouse ≥ Spartacus CL
Leabrook	12%	32%	57%	92	2016–2020	Leabrook ≥ Spartacus CL
LG Alestar	77%	14%	9%	56	2016, 2019–2020	LG Alestar < Spartacus CL
Litmus	37%	35%	29%	52	2016–2017, 2019–2020	Litmus = Spartacus CL
Maximus CL	0%	57%	43%	68	2018–2020	Maximus CL ≥ Spartacus CL
Minotaur	36%	29%	36%	28	2020	Minotaur = Spartacus CL
Mundah	75%	22%	4%	79	2017–2020	Mundah < Spartacus CL
RGT Planet	46%	16%	37%	91	2016–2020	RGT Planet = Spartacus CL
Rosalind	0%	15%	85%	92	2016–2020	Rosalind > Spartacus CL
Scope CL	66%	24%	10%	70	2016–2020	Scope 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%	91	2016–2020	Bass < Rosalind
Beast	23%	65%	13%	48	2019–2020	Beast = Rosalind
Buff	54%	24%	23%	84	2016–2020	Buff ≤ Rosalind
Commodus CL	71%	29%	0%	28	2020	Commodus CL < Rosalind
Compass	65%	30%	4%	92	2016–2020	Compass ≤ Rosalind
Cyclops	36%	36%	29%	28	2020	Cyclops = Rosalind
Fathom	69%	27%	3%	91	2016–2020	Fathom < Rosalind
Flinders	93%	6%	1%	89	2016–2020	Flinders < Rosalind
La Trobe	82%	18%	0%	92	2016–2020	La Trobe < Rosalind
Laperouse	41%	46%	13%	85	2016–2020	Laperouse ≤ Rosalind
Leabrook	55%	36%	9%	92	2016–2020	Leabrook ≤ Rosalind
LG Alestar	93%	7%	0%	56	2016, 2019–2020	LG Alestar < Rosalind
Litmus	77%	15%	8%	52	2016–2017, 2019–2020	Litmus < Rosalind
Maximus CL	57%	38%	4%	68	2018–2020	Maximus CL ≤ Rosalind
Minotaur	46%	43%	11%	28	2020	Minotaur ≤ Rosalind
Mundah	97%	3%	0%	79	2017–2020	Mundah < Rosalind
Rosalind	64%	14%	22%	91	2016–2020	RGT Planet ≤ Rosalind
Scope CL	93%	7%	0%	70	2016–2020	Scope CL < Rosalind
Spartacus CL	85%	15%	0%	92	2016–2020	Spartacus 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 generally the benchmark above 5t/ha, while Rosalind is below 4t/ha on non-acidic soils (Figures 2 to 5, 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, Cyclops, Laperouse, Maximus CL, and Minotaur. Where early vigour and weed competitiveness are primary factors in variety choice in sub-3t/ha environments, Commodus CL, Compass and Leabrook are considerations. 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. While Fathom is outclassed for yield against the newer varieties, it still has the best tolerance to SFNB (Tables 13 and 14) and is a practical option where that disease is a severe threat.

Since 2016, RGT Planet has been the highest yielding variety segregated for malt, higher-yielding in seven of every ten comparisons with Bass and Flinders and one of every two comparisons with La Trobe and Spartacus CL (Tables 4–11). With the run of drier finishes since 2018, the advantage of RGT Planet is not appearing until site yields are at least 4t/ha but becomes noticeable above 5t/ha (Figure 4). Still, for most growers with a harvested yield, most likely between 3–4t/ha, there is unlikely any significant difference between La Trobe, RGT Planet and Spartacus CL. Below 3t/ha, La Trobe and Spartacus CL have shown a clear advantage over RGT Planet since 2018.

The recent malt accreditation of Maximus CL has changed the malt barley variety story. Maximus CL has a higher yield potential than La Trobe and Spartacus CL and appears to compete with RGT Planet above 4t/ha (Figure 4). Over the last three years, Maximus CL has yielded more than RGT Planet in three out of every five WA barley NVT and two in every five WA barley NVT relative to Spartacus CL (Table 11). With the trade to stop

segregating La Trobe at the 2022–2023 harvest and the clear yield advantage of Maximus CL over Spartacus CL across a range of environments, Maximus CL will quickly replace the area sown to the malt varieties La Trobe and Spartacus CL. However, the release of Cyclops may limit the growth of Maximus CL where an IMI herbicide is not sprayed or not needed. While more years of data are required, Cyclops demonstrated a clear yield advantage over Maximus CL in the environments which yielded more than 3t/ha in 2020 (Figure 3). Cyclops is likely to be a popular variety if this trend continues, with or without Barley Australia accreditation.

Beast, Buff, Commodus CL, Cyclops, Laperouse, and Minotaur are in various stages of malting and brewing accreditation with Barley Australia (Table 2). Buff is the most advanced of these six varieties in accreditation trials, with a decision likely in March 2022. Accreditation of the other five varieties is due for announcement in March 2023. Whether or not they receive malt and brewing accreditation, each variety fits somewhere in the system:

- Buff – has a higher genetic level of tolerance to low soil pH and high soil Al. While it may not yield as high as the other new options on non-acidic soils (Figure 2, Tables 4–12), it does have a unique role on acidic soils – mainly in the eastern and northern wheatbelt due to its limited disease resistance (Tables 13 and 14).
- Beast – has matched Rosalind at two-thirds of WA barley NVT, so it is an alternative to Rosalind (Table 3).
- Commodus CL – is not yield competitive with Rosalind, but similar yielding to Compass. It offers growers a more vigorous plant type than Spartacus CL and Maximus CL in an IMI tolerant background (Figure 3).
- Cyclops – had a yield advantage over Rosalind and all other varieties in 2020 at sites that yielded more than 3t/ha (Figure 3).
- Laperouse – competes well with Rosalind as the site potential rises above 4t/ha (comparison not shown) and with Maximus CL above 2t/ha (Figure 5).
- Minotaur – a semi-dwarf alternative to Bass, Flinders and RGT Planet. In 2020, it showed a clear advantage over RGT Planet at sites that yielded less than 5t/ha. Minotaur, however, was outclassed by Cyclops across most environments in which they have been compared (Figure 3).

More years of data are needed to confirm the yield relativity of Beast, Commodus CL, Cyclops, and Minotaur in WA barley NVT. At the same time, there are sufficient years of data for Buff, Maximus CL, and Laperouse to be confident in their relative yield performance in WA.

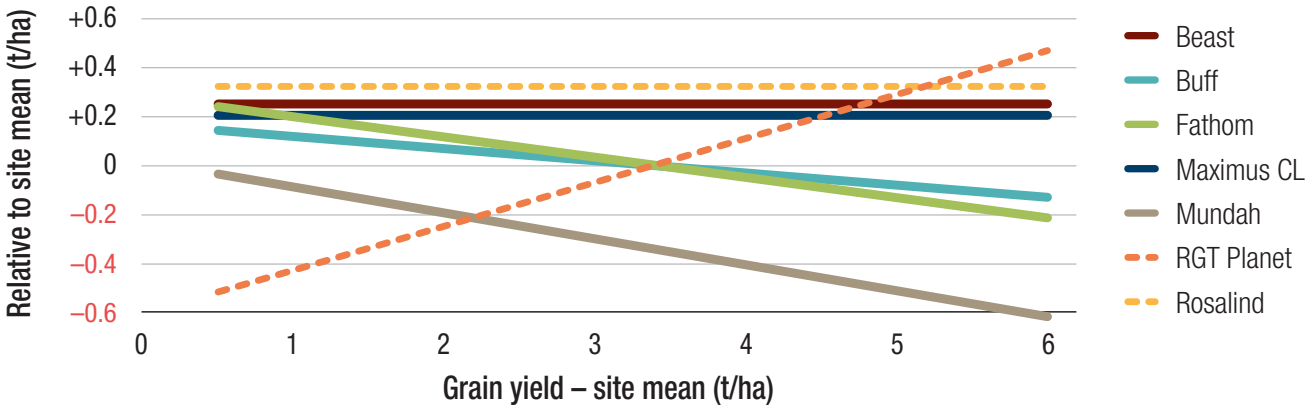

FIGURE 2. Fitted grain yield of Beast, Buff, Fathom, Maximus CL, Mundah, RGT Planet, and Rosalind at different site means.

Source: based on NVT statewide tables of yields and grain quality (2019–2020). Each variety sown in all 47 trial-years of data, NVT Online **nvtonline.com.au**

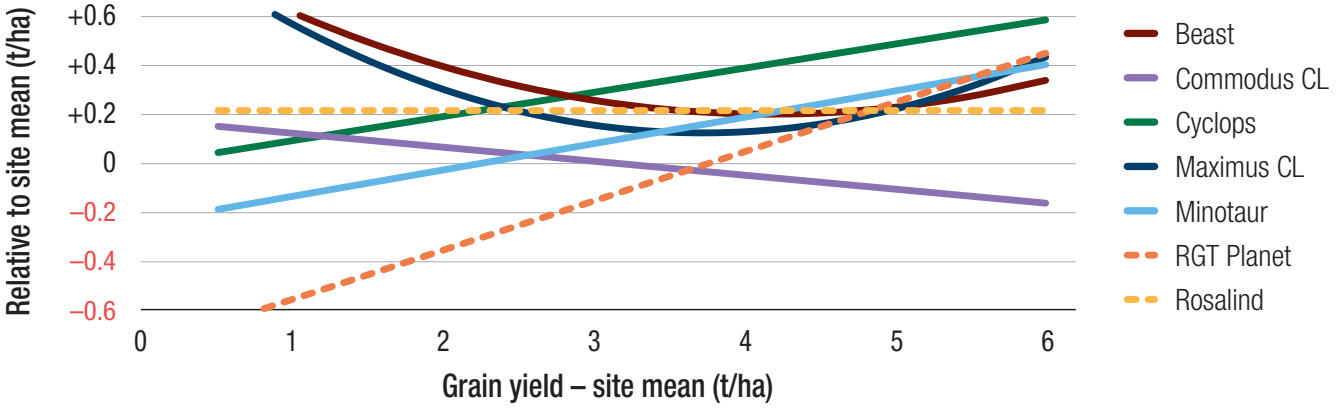

FIGURE 3. Fitted grain yield of Beast, Commodus CL, Cyclops, Maximus CL, Minotaur, RGT Planet, and Rosalind at different site means.

Source: based on NVT statewide tables of yields and grain quality (2020-only). Each variety sown in all 27 trial-years of data, NVT Online **nvtonline.com.au**

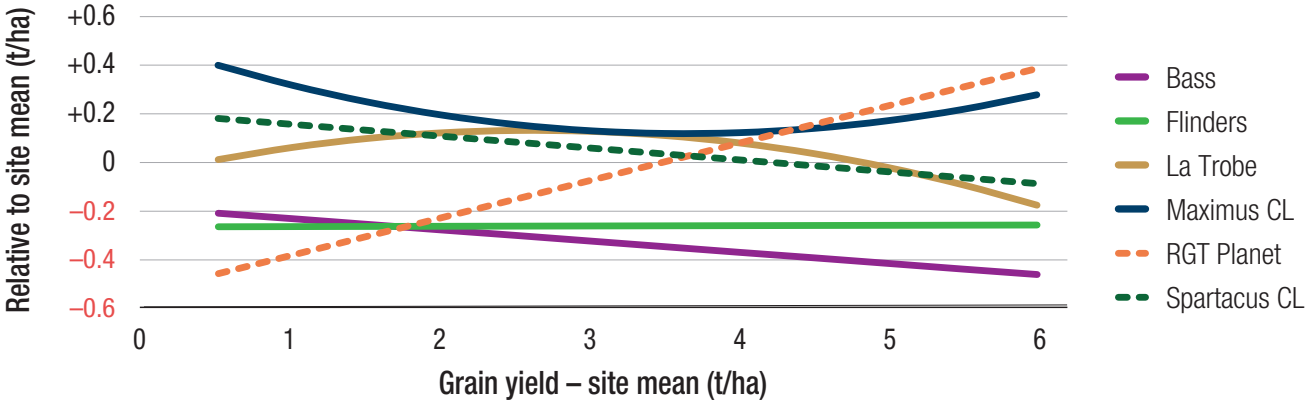

FIGURE 4. Fitted grain yield of Bass, Flinders, La Trobe, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT statewide tables of yields and grain quality (2018–2020). Each variety sown in all 65 trial-years of data, NVT Online **nvtonline.com.au**

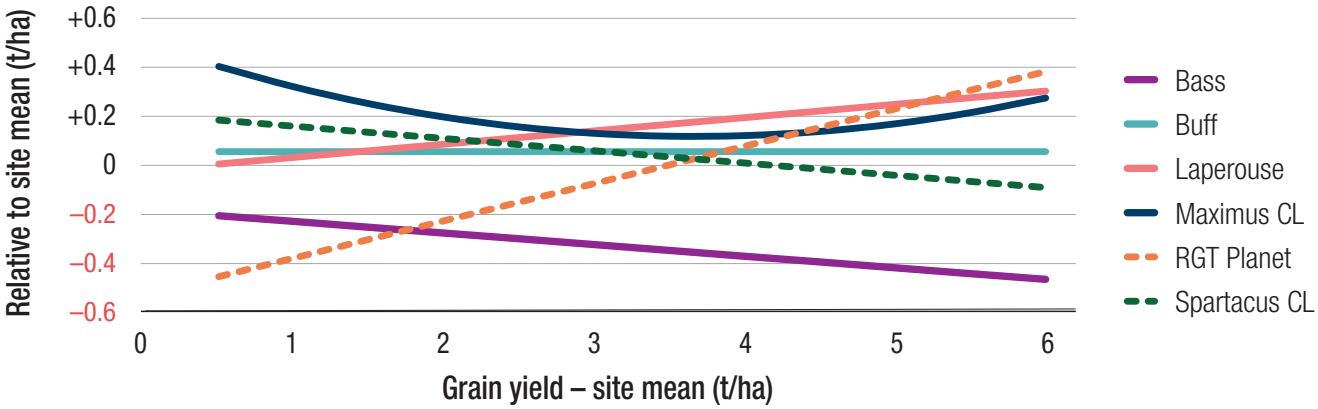

FIGURE 5. Fitted grain yield of Bass, Buff, Laperouse, Maximus CL, RGT Planet and Spartacus CL at different site means.

Source: based on NVT statewide tables of yields and grain quality (2018–2020). Each variety sown in all 65 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 5, the physical grain qualities (hectolitre weight, screenings through a 2.5mm slotted sieve and grain brightness) of a variety have been plotted relative to the site mean as the site mean increases (Figures 6–11). 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 yield and grain quality tables available at **nvtonline.com.au**.

Figures 6 and 7 compare the hectolitre weight of varieties segregated for malt in WA and those under Stage Two malting and brewing evaluation. Figures 8 and 9 present grain plumpness comparisons (percentage through a 2.5mm sieve), while Figures 10 and 11 depict grain brightness comparisons.

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 over the three years from 2018 to 2020 (Figure 6). 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 significantly lower, being 2–3kg/hL lower ($p<0.05$) than Bass. RGT Planet, therefore, 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. Those observations reflect the elongated shape of RGT Planet grains.

Of the two varieties in Stage Two Barley Australia accreditation trials, the hectolitre weight of Buff was lower than Bass by 2kg/hL (being similar to RGT Planet) in WA barley NVT sown since 2018 (Figure 7). Laperouse was between Bass and RGT Planet in the same trials and 0.8kg/hL lower than Bass. Laperouse is, therefore, an improvement in hectolitre weight to Compass and Leabrook, which also have Commander in their pedigree.

GRAIN QUALITY – GRAIN PLUMPNESS COMPARISONS

The benchmark malt variety for grain plumpness is Bass (Figure 8), showing lower screenings (percentage though a 2.5mm sieve) over a range of screenings levels than the 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 2020. Screenings of Spartacus CL were 3-6% less than La Trobe under the same agronomy. Maximus CL has an improved grain shape over La Trobe and Spartacus CL, resulting in lower screenings in WA barley NVT (2018–2020). 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 comparable to or higher than La Trobe. 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 treatments.

Of the two varieties in Stage Two Barley Australia accreditation trials, the grain plumpness of Buff was comparable to Spartacus CL but higher than Bass in WA barley NVT sown since 2018 (Figure 8). The grain plumpness of Laperouse tracked similarly to that of Bass as the site mean increased. Unlike Compass and Leabrook, Laperouse maintains its grain plumpness without compromising its hectolitre weight.

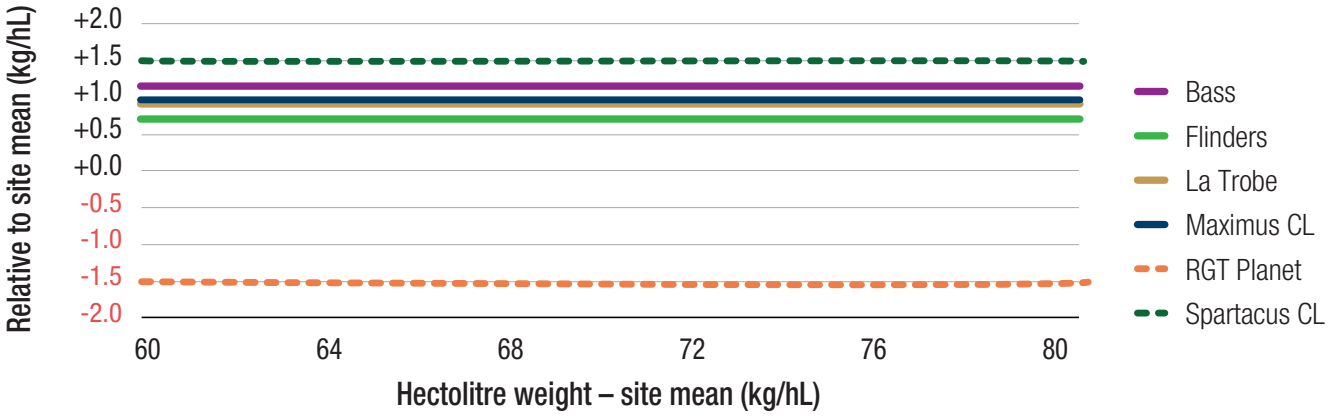

FIGURE 6. Fitted hectolitre weight of Bass, Flinders, La Trobe, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT statewide tables of yields and grain quality (2018–2020). Each variety sown in all 65 trial-years of data, NVT Online **nvtonline.com.au**

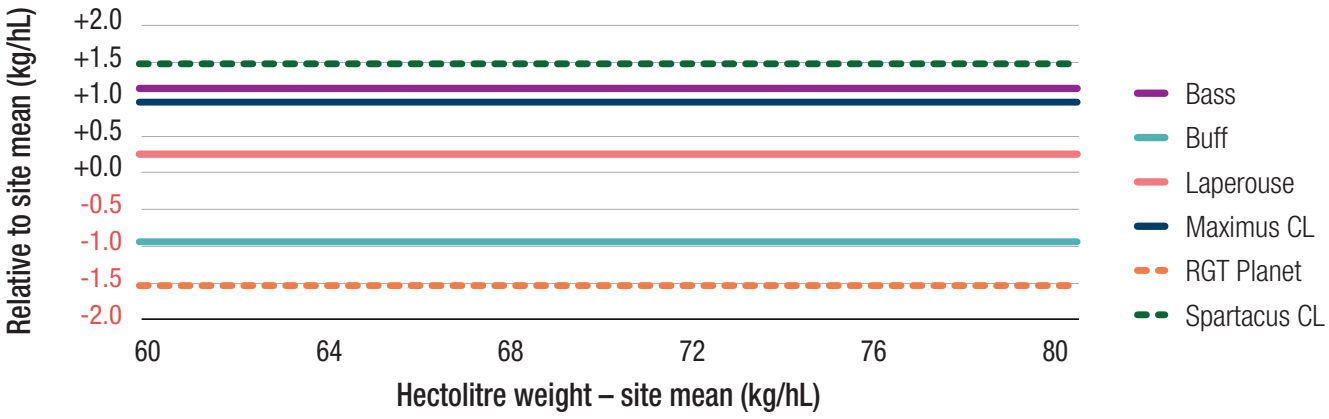

FIGURE 7. Fitted hectolitre weight of Bass, Buff, Laperouse, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT statewide tables of yields and grain quality (2018–2020). Each variety sown in all 65 trial-years of data, NVT Online **nvtonline.com.au**

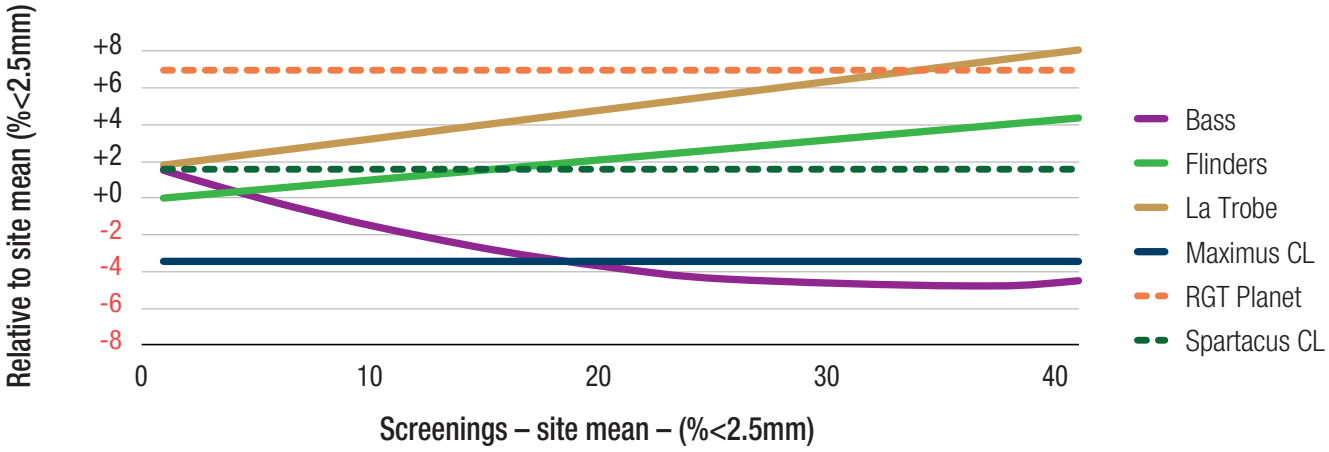

FIGURE 8. Fitted grain plumpness of Bass, Flinders, La Trobe, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT statewide tables of yields and grain quality (2018–2020). Each variety sown in all 65 trial-years of data, NVT Online **nvtonline.com.au**

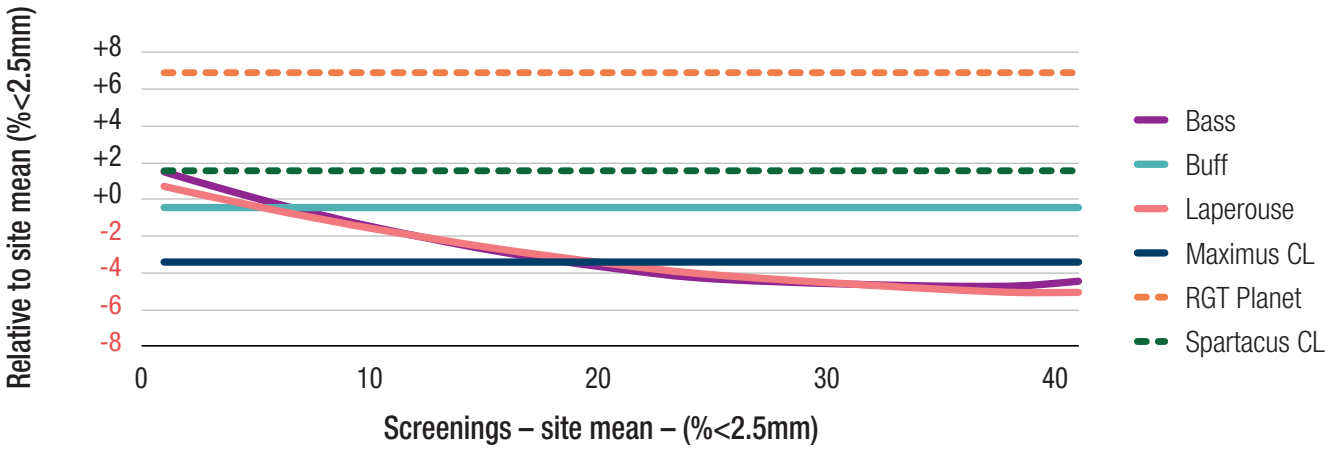

FIGURE 9. Fitted grain plumpness of Bass, Buff, Laperouse, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT statewide tables of yields and grain quality (2018–2020). Each variety sown in all 65 trial-years of data, NVT Online **nvtonline.com.au**

GRAIN QUALITY – GRAIN BRIGHTNESS COMPARISONS

At grain brightness levels below 60'L*', the benchmark malt variety since 2018 has been Spartacus CL (Figure 10). Longer-term, the grain brightness of Bass and Flinders has been equal to or better than Spartacus CL when the site brightness was below 60'L*'. Spartacus CL has a slight grain brightness advantage over La Trobe. The grain brightness advantage of Bass over La Trobe, typically up to 2'L*', has not been observed in recent seasons. The recently accredited malt variety Maximus CL was darker than Spartacus CL by just over 1'L*" across the 65 WA barley NVT sown from 2018 ($p<0.001$). Below 60'L*', RGT Planet was comparable to Bass and Flinders in the same trials. In the last three years, there have been only slight differences (≤1'L*') between varieties in grain brightness but much larger differences in packing efficiency (hectolitre weight) and grain plumpness (screenings through a 2.5mm slotted sieve).

Of the two varieties in Stage Two Barley Australia accreditation trials, the grain brightness of Buff was higher than Spartacus CL by 0.4'L*' across a range of grain brightness levels (Figure 11). The grain brightness of Laperouse was also good tracking at or above Spartacus CL in recent WA barley NVT (2018–2020) and very similar to that of Bass as the site mean increased. Compared to other Commander derived varieties, Laperouse appears to have whiter kernels than Compass and Leabrook.

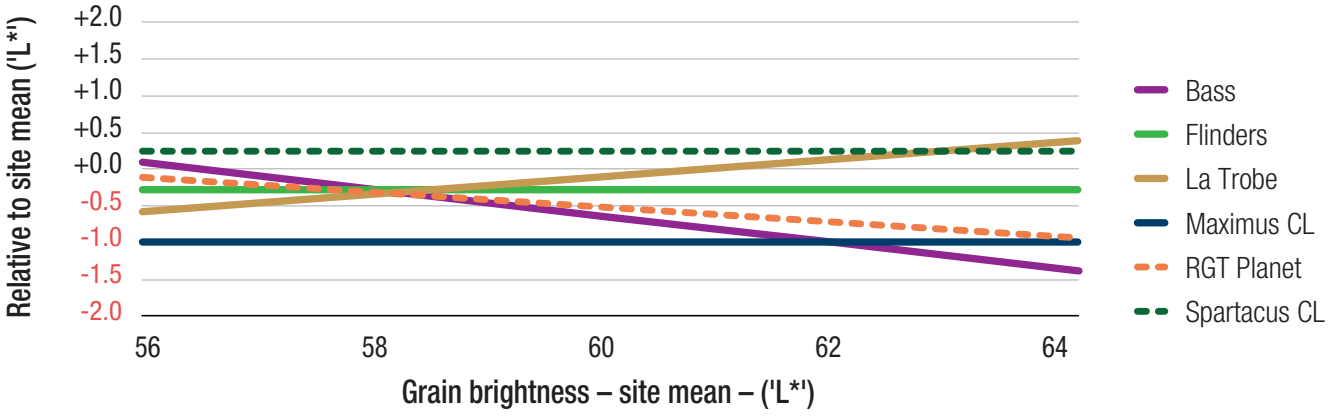

FIGURE 10. Fitted grain brightness of Bass, Flinders, La Trobe, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT statewide tables of yields and grain quality (2018–2020). Each variety sown in all 65 trial-years of data, NVT Online **nvtonline.com.au**

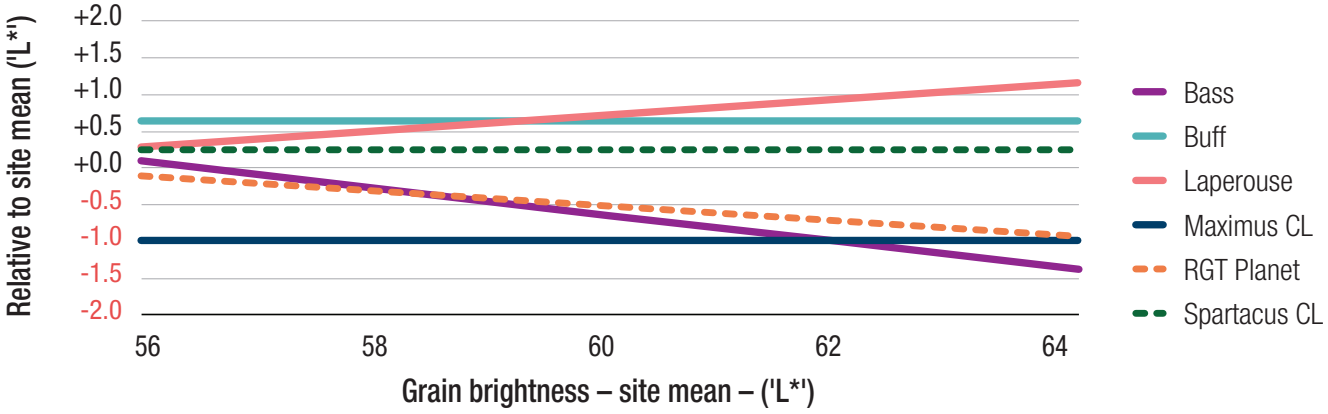

FIGURE 11. Fitted grain brightness of Bass, Buff, Laperouse, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT statewide tables of yields and grain quality (2018–2020). Each variety sown in all 65 trial-years of data, NVT Online **nvtonline.com.au**

Disease and pest resistance

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

Foliar disease abbreviations:

- NFNB = net-form of net blotch (previously labelled as net-type net blotch).
- SFNB = spot-form of 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.

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 both 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.

The two net blotches are renamed to align with eastern Australia, that is, from net-type (NFNB) to net-form (NFNB) and spot-type (SFNB) to spot-form (SFNB). The disease has not changed. It is only the terminology that has been updated.

Seedling ratings are applicable at early growth stages (two- to three-leaf stage) and are important for deciding on the use of 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 a high risk of initial infection if sown onto one- or two-year-old barley stubble.

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. 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.

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 2022 guide, there have been no significant changes in resistance scores due to a new pathotype.

NEW PATHOTYPE – NET-FORM OF NET BLOTCH (NFNB)

Be watchful for increasing NFNB with a new aggressive pathotype, named Oxford virulent, detected across the south coast. NFNB surveys in 2020 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. The best resistance in the varieties included in this sowing guide is Buff and Minotaur (MS as seedling and adult). Beast has some tolerance as an adult (MSS) but not as a seedling (SVS).

NEW VIRULENCE TO POWDERY MILDEW (PM)

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. Rosalind shows a susceptible reaction in the presence of PM with *MlLa* virulence. Other varieties potentially impacted include Compass, Leabrook, and Spartacus CL. Ratings in this guide do not reflect this change, but close monitoring of those varieties is recommended in mildew favourable environments. 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 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 needs arranging 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 the assessment of 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, contact Professor Robert Park via email at **robert.park@sydney.edu.au** or phone **+61 (0)2 9351 8800**.

Fungicide resistant isolates of NFNB, SFNB and PM are present in WA. To manage fungicide resistance and to reduce future resistance development, fungicide mixtures should contain different modes of action, including strobilurins (for example, 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. 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 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, and 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 seed.

The varieties with the highest scald risk are Beast (S), Commodus CL (S*p*), Laperouse (S), Litmus (SVS), Minotaur (VS) and Mundah (S). A concern going forward is that the widespread adoption of susceptible varieties could see scald re-emerge in prevalence as a severe disease affecting the performance of barley in WA. The use of seed dressings and in-crop fungicides plus avoiding sowing susceptible varieties in 'barley-on-barley' situations are essential considerations for managing scald.

NET-FORM OF NET BLOTCH (NFNB)

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

Populations of NFNB resistant to the triazole based DMI fungicide tebuconazole and some other types of triazole fungicides such as prothioconazole and epoxiconazole have been reported by the CCDM. Resistance has been observed in the central and southern regions. Populations exist in the Albany and Esperance regions with reduced sensitivity to the DMI fungicides tebuconazole and propiconazole. Fungicide management of NFNB to address current resistance issues and to reduce future resistance development increasingly requires the use of fungicide mixtures containing different modes of action, including strobilurins (e.g. azoxystrobin and pyraclostrobin) and SDHI (e.g. fluxapyroxad, benzovindiflupyr and bixafen). Fungicide management is often required to manage the disease when resistance in the variety is low or the pathotype changes.

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 (non-attacking) isolate is prevalent throughout the state. In contrast, the Beecher virulent (attacking) isolate is more common north of the Great Eastern Highway but 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 indicated increasing variation in the NFNB pathogen. Future surveys and pathotyping of isolates will establish if any new virulence exists in the state.

As there are different pathotypes of NFNB present 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, Beast, Buff, and Minotaur have slighter better resistance as adult plants, but only marginally (MS or MSS versus S). 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. This is due to the lack of resistance in commercially grown varieties.

SPOT-FORM OF NET BLOTCH (SFNB)

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

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). The 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 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, increasingly requires the use of fungicide mixtures and alternation of products including effective DMI ingredients and alternate modes of action including strobilurins (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.

Fathom (MR as a seedling and MRMS as an adult) has the best-combined seedling and adult resistance. Beast, Commodus CL, Compass, Cyclops, Laperouse, Leabrook and Maximus CL 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 leaf. 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 around 10%.

Genetic resistance is the best form of 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, 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 to PM. 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. The diversity in resistance genes and the presence of multiple genes in some varieties means that not all varieties will be rendered susceptible at the same time if mutations occur or the known mutations become widespread. 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 potentially impacted include 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 that carry genes different from *Rph3* or APR genes have some resistance. APR genes usually provide moderate levels of resistance. 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. Even though 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 may carry. LG Alestar may also possess additional APR genes (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 protects it late in the season, so it will still be vulnerable to rust infection before heading.

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. Symptoms can include whiteheads scattered throughout the crop but not in distinct patches as would occur 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, there are no fungicide options 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 do 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 on plant growth but does not reduce 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 they reach threshold levels in the crop (50% of tillers with 15 or more aphids).

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*) in 29% of paddocks. Nematode populations potentially limit yield in at least 54% 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 numbers and incorporating resistant crops and varieties to reduce their number. In this guide, the *P. neglectus* and *P. quasitereoides* nematode resistance scores are from WA observations only, from both glasshouse and field trials. Varieties with fewer than three observations or where there has been no field trial verification of the glasshouse rating receive provisional ratings.

CEREAL CYST NEMATODE (CCN)

Cereal cyst nematode (CCN, *Heterodea avenae*) is present in cropping regions around Geraldton and the Avon Valley around Northam, but it can occur sporadically across the WA wheatbelt. Unlike RLN, barley varieties are tolerant of CCN, so yield loss is limited even when the infection does occur. The planting of CCN resistant varieties retards nematode development, leading to lower nematode levels in the soil for subsequent crops.

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

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. Mundah) should be treated with a seed dressing active against powdery mildew to prevent early infection during the tillering phase. Rosalind and Spartacus CL may show a susceptible 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	MRMS	MSS	S	S	MSS	SVS
Flinders	MSS	MRMS	MS	S	S	R	MRMS (late APR)
La Trobe	MR	MS	MS	S	S	MS	S
Maximus CL	MR	MSS	MRMS	S	MSS	RMR	MSS
RGT Planet	MR	S	MRMS	SVS	S	R	MRMS (late APR)
Spartacus CL	MR	MS	MS	S	SVS	MRMS	MSS
Stage Two malt accreditation							
Buff	MSS	MS	MRMS	MS	S	S	S
Laperouse	S	MS	MS	S	MSS	MR	MSS
Deliverable as a feed variety							
Beast	S	MRMS	S	MSS	MSS	MR	MSS
Commodus CL	S*p*	MRMS*p*	MRMS*p*	S*p*	MSS*p*	MR*p*	S*p*
Compass	MS	MRMS	MS	S	MSS	MR	S
Cyclops	MR	MS	MRMS	S	MSS	R	S
Fathom	MR	S	MS	SVS	MRMS	MRMS	MRMS (late APR)
Leabrook	MSS	MRMS	MS	S	MSS	MR	MSS
LG Alestar	MSS	MRMS	MRMS	S	S	RMR	MRMS
Litmus	SVS	S	S	S	S	MR	S
Minotaur	VS	MRMS	MRMS	MS	S	MRMS	S
Mundah	S	S	MS	S	S	MSS	S
Rosalind	MSS	MS	MR	S	S	MRMS	MR
Scope CL	MS	MRMS	MRMS	S	S	R	MSS

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 and Spartacus CL may show a susceptible reaction to strains of PM present in 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	MSp	MSSp	S
La Trobe	Moderate	MSS	MS	MSS	R
Maximus CL	-	MRMS	-	-	R
RGT Planet	-	MRMS	MSS	MSSp	R*p*
Spartacus CL	Moderate	MS	S	MSSp	R
Stage Two malt accreditation					
Buff	-	MRMS	-	MSS*p*	S
Laperouse	-	MRMS	-	-	S
Deliverable as a feed variety					
Beast	-	MSS	-	-	MR
Commodus CL	-	MS*p*	-	-	-
Compass	High	MS	MSS	S	R
Cyclops	-	-	-	-	SVS
Fathom	Moderate	MRMS	MS*p*	MSS	R
Leabrook	-	MS	-	MS*p*	RMR
LG Alestar	-	MRMS	-	-	R*p*
Litmus	Low	S	-	MSS*p*	MS
Minotaur	-	-	-	-	MSS
Mundah	Moderate	MS	-	MS*p*	S
Rosalind	Moderate	MRMS	-	MSS*p*	R
Scope CL	High	MRMS	MSS	MS	S

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 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.

Variety snapshots

Variety snapshots are presented for:

- six varieties (Bass, Flinders, La Trobe, Maximus CL, RGT Planet and Spartacus CL) that can be delivered into malt segregations in WA at the 2022–2023 harvest (as per the GIWA Western Australian malt barley variety receival recommendations for the 2022–2023 harvest).
- two varieties undergoing Stage Two malt accreditation with Barley Australia (Buff and Laperouse).
- twelve varieties that can only be delivered into feed segregations (Beast, Commodus CL, Compass, Cyclops, Fathom, Leabrook, LG Alestar, Litmus, Minotaur, Mundah, Rosalind, and Scope 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 2016 to 2020. 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 v7.1.0.0. Data 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).

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 where very early = -15 to -4 days, early = -3 to +3 days, medium = +4 to +10 days, and late = +11 to +17 days maturity (days to Z49) relative to Stirling when sown on 25 May at Northam based on "FlowerPower" barley version v7.1.0.0 (normal season, 50% years). The maturity ranking with a late May sowing differs from 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 where short = 40–60mm, medium = 60–80mm, long = 80–100mm, and * = limited data available to rank the variety. The coleoptile length was measured after germinating seeds in rolled, moistened filter paper for 15 days at 15°C in the dark. DPIRD collected data.
- 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. Very short = <45cm, short = 45–55cm, medium = 55–65cm and tall = 65–75cm relative to varieties such as Stirling, Buloke and Scope CL at sites where their straw was between 65–75cm long. 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 where 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 was calculated and ranked using NVT trials (2005–2020) and DPIRD-GRDC funded barley agronomy trials (2006–2020). 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

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 90 WA barley NVT (2016–2020), Bass yielded less than RGT Planet in 70% of trials, the same in 26% and higher in 4%. Along with Flinders and Maximus CL, Bass has a better physical grain quality package than La Trobe, 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 over 2% of the state's barley acreage in 2020. Target production zones in 2022 are Kwinana-North (Midlands) and Kwinana-South. Limited segregation opportunities will be offered due to declining production.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	96	90	91	79	94
Agzone 2	93	95	92	88	88
Agzone 3	93	94	94	89	91
Agzone 4	-	72	96	87	87
Agzone 5	96	92	88	74	80
Agzone 6	94	107	96	89	89
Statewide	94	94	93	87	88

Disease resistance	Seedling	Adult
Scald	-	MRMS
NFNB (Beecher virulent)	MR	MRMS
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	+6	+2	+1	+3
Cunderdin	+8	+4	+3	+5
Katanning	+11	+7	+5	+8
Grass Patch	+8	+3	+3	+4

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

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 90 WA barley NVT (2018–2020), Flinders yielded less than RGT Planet in 70% of trials, the same in 22% and higher in 8%. Has good physical grain characteristics, being an improvement over La Trobe, 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 just over 2% of the state's barley acreage in 2020. Target production zones in 2022 are Albany-South and Esperance. Limited segregation opportunities will be offered due to declining production.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	-	91	89	73	96
Agzone 2	98	98	91	86	91
Agzone 3	100	99	97	92	94
Agzone 4	-	72	99	84	85
Agzone 5	-	97	94	79	82
Agzone 6	111	130	102	98	98
Statewide	101	98	94	90	91

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	+8	+5	+4	+7
Cunderdin	+10	+8	+7	+9
Katanning	+13	+10	+9	+12
Grass Patch	+10	+7	+7	+8

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

LA TROBE

DELIVERABLE AS A MALT VARIETY

Comments

La Trobe (tested as IGB1101) is a medium height, early spring, malt barley acceptable for export as grain and malt and now superseded for shochu. Best suited to environments with a yield potential below 4t/ha. Across 91 WA barley NVT (2016–2020), La Trobe yielded less than RGT Planet in 35% of trials, the same in 19% and higher in 46%. Better suited than RGT Planet to environments with a shorter grain-filling period. Like Spartacus CL, more responsive to applied nitrogen than other malt varieties segregated in WA. Fungicides may be required to manage smut, NFNB (Oxford virulent), SFNB and BLR. La Trobe was the third most popular barley variety in 2020, accounting for just under 9% of the state's barley acreage, but its popularity is declining. Due to reducing production volumes, niche segregations will be offered in Kwinana, Albany, and Esperance port zones. The 2022–2023 harvest marks the last harvest that La Trobe will be segregated in WA.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	102	101	103	103	101
Agzone 2	102	101	102	100	100
Agzone 3	103	103	101	101	101
Agzone 4	-	95	101	101	98
Agzone 5	102	102	101	96	99
Agzone 6	106	102	101	101	101
Statewide	102	102	102	100	101

Disease resistance	Seedling	Adult
Scald	-	MR
NFNB (Beecher virulent)	MRMS	MS
NFNB (Beecher avirulent)	MRMS	MS
NFNB (Oxford virulent)	S	S
SFNB	S	S
Powdery mildew	MSS	MS
Leaf rust (5457P-)	MS	S
BYD and CYD	MSS	MSS
RLN (*P. neglectus*)	MS	MS
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	+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
Grain protein deviation	Slightly higher

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

MAXIMUS CL

DELIVERABLE AS A MALT VARIETY

Comments

Maximus CL (tested as IGB1705T) is an IMI tolerant, medium height, early spring, malt barley. Maximus CL is under assessment for export as grain and as malt and for the manufacture of shochu in Japan. Maximus CL has a short coleoptile and should not be sown deep. Across 67 WA barley NVT (2018–2020), Maximus CL yielded less than RGT Planet in 22% of trials, the same in 18% and higher in 60%, performing better in environments that yield less than 4t/ha. It was competitive above 4t/ha. The WA NVT MET (2016–2020) suggests that Maximus CL has a yield advantage of 4% over Spartacus CL. Maximus CL grain is plumper than Spartacus CL grain with a similar hectolitre weight but a darker kernel. Maximus CL is a general improvement over Spartacus CL for NFNB (Beecher virulent and avirulent) as an adult, SFNB and PM. Fungicides may be required to manage NFNB (Oxford virulent). Maximus CL appears to have a low risk of head loss. Target production zones in 2022 are Kwinana, Albany and Esperance port zones. Limited segregation opportunities will be offered as the variety is new, and there is currently minimal customer demand.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	-	-	104	106	102
Agzone 2	-	-	103	102	104
Agzone 3	-	-	102	103	103
Agzone 4	-	-	105	108	100
Agzone 5	-	-	105	105	105
Agzone 6	-	-	104	106	107
Statewide	-	-	104	105	104

Disease resistance	Seedling	Adult
Scald	-	MR
NFNB (Beecher virulent)	MRMS	MSS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	S
SFNB	MSS	MSS
Powdery mildew	MR	RMR
Leaf rust (5457P-)	S	MSS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	S	S
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	+6	+1	+0	+4
Cunderdin	+5	+1	+0	+3
Katanning	+4	+0	-2	+2
Grass Patch	+5	+0	+0	+2

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

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

RGT PLANET(Þ)

DELIVERABLE AS A MALT VARIETY

Comments

RGT Planet (tested as SFR85-104) is a medium height, medium spring, malt barley preferred for export as grain and as malt but not for shochu. Accepted in most south-east Asian beer markets. 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 91 WA barley NVT (2016–2020), RGT Planet yielded less than Rosalind in 64% of trials, the same in 14% and higher in 22%. The physical grain quality package of RGT Planet is inferior to Bass, Flinders, Maximus CL and Spartacus CL, being comparable to La Trobe. Excellent resistance to PM (due to *mlo* gene) and good resistance to BLR (due to APR 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 2020, accounting for just under 20% of the state's barley acreage, and its popularity is holding. Target production zones in 2022 are Kwinana-North (Midlands), Kwinana-South, Albany, and Esperance port zones.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	109	95	101	86	107
Agzone 2	105	102	101	93	94
Agzone 3	114	116	107	103	104
Agzone 4	-	69	104	87	88
Agzone 5	127	108	103	78	79
Agzone 6	141	155	117	108	106
Statewide	116	107	105	97	96

Disease resistance	Seedling	Adult
Scald	-	MR
NFNB (Beecher virulent)	MRMS	S
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	SVS
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	MS
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	+3	+2	+2	+5
Cunderdin	+4	+4	+4	+6
Katanning	+7	+6	+6	+8
Grass Patch	+5	+3	+4	+6

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(Þ)

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 91 WA barley NVT (2016–2020), Spartacus CL yielded less than RGT Planet in 37% of trials, the same in 16% and higher in 46%. 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 2020, accounting for just under 48% of the state's barley acreage, and its popularity is increasing. Maximus CL will 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 2021 are Geraldton, Kwinana, Albany, and Esperance port zones.

Yield (% RGT Planet)	2016	2017	2018	2019	2020
Agzone 1	92	105	99	116	94
Agzone 2	95	98	99	108	106
Agzone 3	88	86	93	97	96
Agzone 4	-	144	96	115	113
Agzone 5	79	93	97	129	126
Agzone 6	71	65	86	93	94
Statewide	86	93	95	103	104

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-)	MSS	MSS
BYD and CYD	MS	MS
RLN (*P. neglectus*)	S	S
RLN (*P. quasitereoides*)	S	S
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	-3	-2	-2	-5
Cunderdin	-4	-4	-4	-6
Katanning	-7	-6	-6	-8
Grass Patch	-5	-3	-4	-6

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

BUFF

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 a competitor to feed and malt varieties on non-acidic soils, except where IMI chemistry is used. Across 46 WA barley NVT trials (2016–2017, 2019–2020), Buff has yielded less than Litmus in 11%, the same in 22% and higher in 67%. The grain quality package of Buff is okay, but not great, having a lower hectolitre weight, slightly higher screenings and brighter grain than 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. Buff has passed Stage One of the Barley Australia accreditation process. Currently undergoing evaluation in Stage Two, with the earliest accreditation date being March 2022.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	110	116	114	121	101
Agzone 2	122	109	106	103	100
Agzone 3	-	-	102	98	96
Agzone 4	-	78	128	147	95
Agzone 5	110	101	102	88	90
Agzone 6	-	-	110	105	99
Statewide	118	107	108	101	96

Disease resistance	Seedling	Adult
Scald	-	MSS
NFNB (Beecher virulent)	MS	MS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	MS	MS
SFNB	MSS	S
Powdery mildew	S	S
Leaf rust (5457P-)	SVS	S
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	MSS
RLN (*P. quasitereoides*)	MSS	S
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	-2	+1	+2	+3
Cunderdin	-3	+0	+1	+2
Katanning	-2	+0	+1	+2
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

* = limited data

LAPEROUSE

STAGE TWO MALT ACCREDITATION

Comments

Laperouse (tested as WI4952) is a medium height, medium spring barley under evaluation by Barley Australia. Performs well in a range of environments, better than RGT Planet when the site yield is below 4t/ha. Across 84 WA barley NVT (2016–2020), Laperouse yielded less than RGT Planet in 27% of trials, the same in 17% and higher in 56%. It has a better grain quality package than RGT Planet, with a higher hectolitre weight, plumper grain (similar to Bass), and greater brightness. Fungicides may be required to manage scald, NFNB (Oxford virulent) and BLR. Its weed competitiveness has not been evaluated. It appears to have good straw strength and a low head loss risk. Laperouse is currently in Stage Two of the Barley Australia accreditation process, with the earliest accreditation date being March 2023.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	107	-	108	109	104
Agzone 2	-	105	106	101	102
Agzone 3	110	109	105	103	105
Agzone 4	-	-	104	102	95
Agzone 5	110	108	104	90	100
Agzone 6	122	112	107	107	108
Statewide	111	106	106	102	103

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	MS	MS
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	S	S
SFNB	MRMS	MSS
Powdery mildew	MR	MR
Leaf rust (5457P-)	MS	MSS
BYD and CYD	MRMS	MRMS
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	+8	+2	+0	+3
Cunderdin	+9	+4	+2	+4
Katanning	+9	+4	+1	+5
Grass Patch	+9	+3	+2	+4

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

* = limited data

BEAST(b)

DELIVERABLE AS A FEED VARIETY

Comments

Beast (tested as AGTB0113) is a tall height, early spring barley. According to the breeder, Beast suits low to medium rainfall environments and has good initial canopy size, ground coverage, and a sound grain package. Lodging risk is similar to Compass. It has only been in public trials since 2019. Growers should be cautious in their expectations, due to the lack of public field trial data. Across 48 WA barley NVT (2019–2020), Beast yielded less than Rosalind in 22% of trials, the same in 65% and higher in 13%. Beast appears to have useful resistance to NFNB (Beecher virulent and Oxford virulent), SFNB and PM but may need management for scald, NFNB (Beecher avirulent) and BLR. Beast is in Stage One of Barley Australia accreditation but is being 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)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	115	103
Agzone 2	-	-	-	106	106
Agzone 3	-	-	-	105	106
Agzone 4	-	-	-	108	102
Agzone 5	-	-	-	103	109
Agzone 6	-	-	-	107	108
Statewide	-	-	-	106	107

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MRMS	S
NFNB (Oxford virulent)	SVS	MSS
SFNB	MS	MSS
Powdery mildew	MRMS	MR
Leaf rust (5457P-)	S	MSS
BYD and CYD	MSS	MSS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
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	-	-	-	-
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	Free to trade
EPR ($/t, excl. GST)	$4.00

COMMODUS CL(b)

DELIVERABLE AS A FEED VARIETY

Comments

Commodus CL (tested as IGB1908T) is an IMI tolerant, tall height, early spring barley. According to the breeder, Commodus CL suits low to medium rainfall areas and lighter soils has good early canopy size and ground coverage, high grain plumpness and is of a similar plant height to Compass. 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. Growers should be cautious in their expectations, due to the lack of public field trial data. Across 28 WA barley NVT (2020), Commodus CL yielded less than Rosalind in 71% of trials, the same in 29% and higher in 13%. Relative to Compass, Commodus CL yielded less than Compass in 29% of trials, the same in 71% and higher in 0%. Commodus CL appears to have useful resistance to NFNB (Beecher virulent and avirulent), SFNB and PM but may need management for scald, NFNB (Oxford avirulent) and BLR. Commodus CL is in Stage One of Barley Australia accreditation but is being 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)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	100
Agzone 2	-	-	-	-	98
Agzone 3	-	-	-	-	99
Agzone 4	-	-	-	-	95
Agzone 5	-	-	-	-	97
Agzone 6	-	-	-	-	99
Statewide	-	-	-	-	98

Disease resistance	Seedling	Adult
Scald	-	S*p*
NFNB (Beecher virulent)	MRMS*p*	MRMS*p*
NFNB (Beecher avirulent)	MRMS*p*	MRMS*p*
NFNB (Oxford virulent)	S*p*	S*p*
SFNB	MRMS*p*	MSS*p*
Powdery mildew	MR*p*	MR*p*
Leaf rust (5457P-)	MSS*p*	MS*p*
BYD and CYD	MS*p*	MSS
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	InterGrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl. GST)	$4.25

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 92 WA barley NVT (2016–2020), Compass yielded less than Rosalind in 65% of trials, the same in 30% and higher in 5%. Compass is susceptible to lodging, particularly in high yielding situations. Compass has shown good physical grain quality with high grain plumpness. It has good tolerance to NFNB (Beecher virulent) and PM. Fungicides may be required to control NFNB (Oxford virulent) and BLR. Compass, like Fathom, is one of the more weed competitive barley varieties. 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 twelfth most popular barley variety in 2020 but only accounted for just under 1% of the state's barley acreage.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	104	106	109	117	100
Agzone 2	105	102	106	105	101
Agzone 3	102	102	101	100	101
Agzone 4	-	94	104	112	101
Agzone 5	95	101	100	95	103
Agzone 6	100	85	99	98	99
Statewide	102	101	104	101	101

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	+0	-3	-3	+1
Cunderdin	+1	-1	-1	+3
Katanning	+4	+1	+1	+5
Grass Patch	+1	-2	+0	+2

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(Þ)

DELIVERABLE AS A FEED VARIETY

Comments

Cyclops (tested as AGTB0200) is a medium height, early spring barley. According to the breeder, Cyclops is adapted to various environments and has a competitive grain quality package. It has similar agronomic attributes (i.e. lodging and head loss risk) to 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 28 WA barley NVT (2020), Cyclops yielded less than Rosalind in 36% of trials, the same in 36% and higher in 28%. It looks to be a higher-yielding option in environments that yield more than 3t/ha. Cyclops appears to have useful resistance to scald, NFNB (Beecher virulent) and PM but may need NFNB (Oxford avirulent) and BLR management. Cyclops is in Stage One of Barley Australia accreditation but is being 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)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	107
Agzone 2	-	-	-	-	105
Agzone 3	-	-	-	-	109
Agzone 4	-	-	-	-	95
Agzone 5	-	-	-	-	104
Agzone 6	-	-	-	-	113
Statewide	-	-	-	-	106

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

FATHOM(b)

DELIVERABLE AS A FEED VARIETY

Comments

Fathom (tested as WI4483) is a medium height, medium spring, feed barley. Best suited to environments with a yield potential below 3t/ha and where there is a high risk of SFNB. Across 91 WA barley NVT (2016–2020), Fathom yielded less than Rosalind in 69% of trials, the same in 28% and higher in 3%. Fungicides may be required to manage early infections of NFNB and BLR. Fathom has the highest level of resistance to SFNB of current varieties. It is mixed for its head colour, having green and waxy green heads. Fathom is one of the more weed competitive barley varieties, similar to Compass and RGT Planet in eastern state weed competition trials. Fathom was the tenth most popular barley variety in 2020, accounting for just over 1% of the state's barley acreage.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	105	109	111	117	99
Agzone 2	109	104	105	103	98
Agzone 3	105	102	100	96	97
Agzone 4	-	83	113	125	97
Agzone 5	96	99	97	88	95
Agzone 6	105	89	101	97	96
Statewide	105	101	104	98	97

Disease resistance	Seedling	Adult
Scald	-	MR
NFNB (Beecher virulent)	S	S
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	SVS	SVS
SFNB	MR	MRMS
Powdery mildew	MS	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	+14	+8	+4	+5
Cunderdin	+13	+8	+4	+4
Katanning	+14	+7	+3	+4
Grass Patch	+14	+7	+5	+3

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

LEABROOK(b)

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 92 WA barley NVT (2016–2020), Leabrook yielded less than Rosalind in 55% of trials, the same in 36% and higher in 9%. Leabrook has shown good physical grain quality with high grain plumpness. It has good tolerance to NFNB (Beecher virulent) and PM. Fungicides may be required to control 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.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	108	105	111	115	103
Agzone 2	108	105	108	103	101
Agzone 3	108	108	105	102	104
Agzone 4	-	86	105	108	97
Agzone 5	103	106	102	88	100
Agzone 6	115	101	105	103	104
Statewide	108	105	107	101	102

Disease resistance	Seedling	Adult
Scald	-	MSS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MS	MS
NFNB (Oxford virulent)	MSS	S
SFNB	MSS	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	+1	-2	-2	+2
Cunderdin	+2	+0	+0	+4
Katanning	+5	+2	+2	+6
Grass Patch	+3	-1	+0	+3

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

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

* = limited data

LG ALESTAR(ᵇ)

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 powdery mildew and BLR are a problem. Across 56 WA barley NVT (2016, 2019–2020), LG Alestar yielded less than Rosalind in 93% of trials, the same in 7% and higher in 0%. LG Alestar grain has a white aleurone, even though one of its parents, Henley, has a blue aleurone. It has many similar agronomic attributes as 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 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 WA.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	99	-	-	72	96
Agzone 2	99	-	-	85	88
Agzone 3	101	-	-	91	92
Agzone 4	-	-	-	89	83
Agzone 5	112	-	-	72	74
Agzone 6	116	-	-	97	95
Statewide	103	-	-	88	87

Disease resistance	Seedling	Adult
Scald	-	MSS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MRMS	MRMS
NFNB (Oxford virulent)	S	S
SFNB	S	S
Powdery mildew	RMR	RMR
Leaf rust (5457P-)	MS	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	+9	+6	+5	+7
Cunderdin	+10	+7	+7	+8
Katanning	+12	+9	+8	+11
Grass Patch	+10	+7	+7	+8

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(ᵇ)

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 46 WA barley NVT (2016–2017, 2019–2020), Litmus yielded less than Buff in 67% of trials, the same in 22% and higher in 11%. 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 2020, accounting for under 2% 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)	2016	2017	2018	2019	2020
Agzone 1	104	110	-	108	98
Agzone 2	111	99	-	101	90
Agzone 3	105	102	-	-	87
Agzone 4	-	80	-	157	100
Agzone 5	103	85	-	-	-
Agzone 6	106	113	-	-	-
Statewide	106	97	-	94	86

Disease resistance	Seedling	Adult
Scald	-	SVS
NFNB (Beecher virulent)	S	S
NFNB (Beecher avirulent)	MSS	S
NFNB (Oxford virulent)	S	S
SFNB	S	S
Powdery mildew	MR	MR
Leaf rust (5457P-)	S	S
BYD and CYD	S	S
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MSS	MSS
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	-5	-4	-2
Cunderdin	-9	-6	-4	-2
Katanning	-8	-5	-4	-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

MINOTAUR

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 and offers some improvements in physical grain quality, delivering a higher hectolitre weight. It has only been in public trials since 2020. Growers should be cautious in their expectations, due to the lack of public field trial data. Across 28 WA barley NVT (2020), Minotaur yielded less than Rosalind in 46% of trials, the same in 43% and higher in 11%. It looks to be a higher-yielding option in environments that yield more than 5t/ha. As an alternate to RGT Planet, Minotaur yielded less in 0% of trials, the same in 43% and higher in 57%. Minotaur appears to have useful resistance to NFNB (Beecher virulent and avirulent) and PM but may need management for scald, NFNB (Oxford avirulent) and BLR. Minotaur is in Stage One of Barley Australia accreditation but is being 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)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	107
Agzone 2	-	-	-	-	102
Agzone 3	-	-	-	-	106
Agzone 4	-	-	-	-	95
Agzone 5	-	-	-	-	91
Agzone 6	-	-	-	-	111
Statewide	-	-	-	-	102

Disease resistance	Seedling	Adult
Scald	-	VS
NFNB (Beecher virulent)	MRMS	MRMS
NFNB (Beecher avirulent)	MR	MRMS
NFNB (Oxford virulent)	MS	MS
SFNB	S	S
Powdery mildew	S	MRMS
Leaf rust (5457P-)	S	S
BYD and CYD	-	-
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

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 97% of trials, the same in 3% 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 and BLR. Mundah appears to have similar weed competitiveness to Compass and Fathom, although it has not been tested side by side in the same trials. Mundah was the eleventh most popular barley variety in 2019, accounting for 1% of the state's barley acreage.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	-	95	99	94	96
Agzone 2	-	93	97	96	88
Agzone 3	-	96	95	90	90
Agzone 4	-	79	105	109	96
Agzone 5	-	89	88	81	77
Agzone 6	-	98	96	84	80
Statewide	-	93	97	90	88

Disease resistance	Seedling	Adult
Scald	-	S
NFNB (Beecher virulent)	S	S
NFNB (Beecher avirulent)	MSS	MS
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	MS
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	-10	-10	-8	-4
Cunderdin	-10	-9	-8	-4
Katanning	-8	-8	-7	-2
Grass Patch	-9	-10	-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

ROSALIND

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 is the yield benchmark for barley in WA, regularly out-yielding Spartacus CL. Across 92 WA barley NVT (2016–2020), Rosalind yielded less than Spartacus CL in 0% of trials, the same in 15% and higher in 85%, with an overall yield advantage of 8% 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 91 WA barley NVT (2016–2020), Rosalind yielded less than RGT Planet in 22% of trials, the same in 14% and higher in 64%, with an overall advantage of 5% in the statewide MET. Good straw strength and head retention. Fungicides may be required to manage NFNB (Oxford virulent), SFNB, and where *MLIa* virulent PM is present. Its weed competitiveness is unknown. Rosalind was the fourth most popular barley variety in 2020, accounting for just over 5% of the state's barley acreage, being more prevalent in southern cropping areas than northern cropping areas. The popularity of Rosalind is growing.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	107	110	111	117	106
Agzone 2	111	105	108	107	106
Agzone 3	111	110	105	107	105
Agzone 4	-	107	114	123	105
Agzone 5	111	104	108	109	103
Agzone 6	117	111	108	108	105
Statewide	112	107	108	108	106

Disease resistance	Seedling	Adult
Scald	-	MSS
NFNB (Beecher virulent)	MR	MS
NFNB (Beecher avirulent)	MR	MR
NFNB (Oxford virulent)	MSS	S
SFNB	MSS	S
Powdery mildew	MSS	MRMS
Leaf rust (5457P-)	MRMS	MR
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	MS	MS
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	-1	+0	+3
Cunderdin	-2	-2	-1	+1
Katanning	-2	-2	-2	+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

SCOPE CL

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 70 WA barley NVT (2016–2020), Scope CL yielded less than Spartacus CL in 66% of trials, the same in 24% and higher in 10%. 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 Kwinana Port Zone and was the fifth most popular barley variety across WA in 2020, accounting for just under 5% of the state's barley acreage.

Yield (% Spartacus CL)	2016	2017	2018	2019	2020
Agzone 1	99	101	100	97	94
Agzone 2	102	98	96	94	91
Agzone 3	97	95	94	89	89
Agzone 4	-	75	109	116	92
Agzone 5	92	91	-	-	-
Agzone 6	94	95	-	-	-
Statewide	98	95	97	91	90

Disease resistance	Seedling	Adult
Scald	-	MS
NFNB (Beecher virulent)	MR	MRMS
NFNB (Beecher avirulent)	MR	MRMS
NFNB (Oxford virulent)	S	S
SFNB	MSS	S
Powdery mildew	MR	R
Leaf rust (5457P-)	S	MSS
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MSS	MSS
RLN (*P. quasitereoides*)	MS	MS
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	+11	+7	+4	+6
Cunderdin	+11	+7	+5	+6
Katanning	+13	+8	+5	+7
Grass Patch	+12	+6	+5	+5

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

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

Notes

CANOLA

By Jackie Bucat, DPIRD

New for 2022

A new herbicide tolerance type, with a combination of both triazine tolerance (TT) and LibertyLink® (LL), will be available for 2022. There are twelve new variety releases including two open pollinated TT varieties, the first since 2015, and a new winter maturity release (see Table 1 for a list of all new releases).

InVigor® LT 4530P is triazine tolerant (TT) combined with LibertyLink® (LL). Varieties with LibertyLink® are tolerant of Liberty registered herbicide, with the active ingredient glufosinate. LibertyLink® allows in-crop use of a Group 10 herbicide, a new mode of action for Australian broadacre crops. This may be a useful tool to combat resistance, for example where ryegrass is resistant to clethodim or glyphosate. InVigor LT 4530P is an early-mid (4) maturity, with the PodGuard® trait. It has been released by BASF.

RGT Capacity TT is an early-mid (4) maturity TT variety being commercialised by Seed Force. It was among the highest yielding varieties of the Early series NVT and is moderately susceptible (MS) to blackleg.

Nutrien Ag Solutions has released two new open pollinated TT varieties, early-mid maturity (4) variety **DG Bidgee TT** and a mid-late maturity (6) variety **DG Murray TT**, which is similar maturity to ATR Wahoo. Bidgee is short for Murrumbidgee, following a river naming theme for Nutrien Ag Solutions TT canola varieties. DG Murray has been in the NVT since 2019, while DG Bidgee TT was entered for the first time in 2021. DG Bidgee TT has been rated MR to blackleg, while DG Murray TT has a rating of RMR. Both varieties are from a new blackleg group (H). The higher blackleg ratings, compared with ATR Bonito, will increase the level of variety resistance, and the different blackleg group will help to further reduce disease severity.

The new GT varieties achieved the highest yields in the Early and the Mid series NVT. **Nuseed Emu TF** achieved the highest predicted yields in the GT Early series, for all Agzones (1,2 and 4). It is an early (3) maturity variety, with the TruFlex® trait and has a MRMS blackleg rating. Nuseed Emu TF also has a relatively high oil content, 0.6% above the average of all GT varieties (Table 2).

In the Mid GT trials, new variety **Pioneer 44Y30 RR** was equal highest yielding, alongside InVigor® R 4520P. Pioneer 44Y30 RR has an early-mid (4) maturity with a MR blackleg rating. It is a Roundup Ready® (RR) variety.

Nutrien Ag Solutions has also released two GT varieties, **DG Lofty TF** and **DG Bindo TF**, following a mountain naming theme for the GT releases. Both varieties have the TruFlex® trait. DG Lofty is an early maturity variety, while DG Bindo TF is mid maturity. As 2021 was their first entry into the NVT, NVT data is not yet available for these varieties. Small quantities of seed will be commercially available in 2022.

Pacific Seeds has released **Hyola Battalion XC** with combined GT (TruFlex®) + CL resistance. Hyola Battalion XC is an early maturity variety with a R blackleg rating. It has the additional advantage of handling imidazolinone soil residuals and imidazolinone boom spray contamination as well as two modes of action for enhanced weed control.

Pioneer 45Y95 CL and **Hyola Equinox CL** are two new mid maturity CL varieties. Pioneer 45Y95 CL achieved the highest predicted CL yields for the state but was only included in the 2018 NVT trials and has not yet been assessed for blackleg rating. Hyola Equinox CL has a R blackleg resistance rating.

RGT Nizza CL is a new winter grain and graze variety from Seed Force.

TABLE 1. New variety releases and canola herbicide tolerance groups

Herbicide tolerance	Abbreviation	Description	2021 variety releases		
			Name	Maturity	NVT data
Triazine tolerant	TT	Tolerant of selected triazine herbicides. Some varieties open pollinated.	• DG Bidgee TT (OP) • DG Murray TT (OP) • RGT Capacity TT	4 6 4	– 2019–2020 2019–2020
Triazine tolerant and glyphosate tolerant	TT+GT	Dual tolerance of TT and GT herbicides.	–	–	–
Triazine tolerant and Clearfield® tolerant	TT+CL	Dual tolerance of TT and CL herbicides. Intended for use in case of soil residues, and for use as either TT or CL or a combination where required.	–	–	–
Triazine tolerant and LibertyLink® tolerant	TT+LL	Dual tolerance of LibertyLink® (LL) and TT. LL has tolerance of Liberty® (glufosinate) herbicide.	• InVigor® LT 4530P	4.5	2020
Glyphosate tolerant	GT (RR or TF)	Tolerant of Monsanto glyphosate herbicide. Includes both Roundup Ready® and TruFlex® varieties.	• DG Bindo TF • DG Lofty TF • Nuseed Emu TF • Pioneer 44Y30 RR	5 3 3 4	– – 2019–2020 2020
Glyphosate tolerant and Clearfield® tolerant	GT+CL	Dual tolerance of GT and CL herbicides. Intended for use in case of soil residues, and for use as either GT or CL tolerance or a combination where required.	• Hyola® Battalion XC	3.5	2020
Clearfield® tolerant	CL	Tolerant of imidazolinone (IMI) herbicides, marketed as Clearfield®.	• Hyola® Equinox CL • Pioneer 45Y95 CL	5 5	2020 2018
Conventional canola	CC	Only tolerant to clopyralid and grass selective herbicides.	–	–	–
Clearfield® tolerant	CL	Winter maturity, commonly used for grain and graze.	• RGT Nizza CL	8.5	N/A

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

Note: 2021 season is first year of NVT for DG Bidgee TT, DG Bondo TF and DG Lofty TF. NVT data will be available online after 2021 harvest.

Twenty-one canola varieties have been withdrawn from sale:

- **TT varieties:** ATR Gem, DG 670TT, Hyola 350TT, Hyola 559TT, InVigor T3510, Pioneer 44T02 TT, Pioneer 45T03 TT, SF Turbine TT.
- **GT varieties:** DG 408RR, GT 41, GT 42, Hyola 404RR, Pioneer 43Y23, Pioneer 43Y29.
- **CL varieties:** Banker CL, Pioneer 44Y90 CL, Saintly CL.
- **Dual herbicide tolerance varieties:** TT+GT Hyola 530XT, TT+CL Hyola 580CT, GT+CL Hyola 540XC.
- **Winter grain and graze CL variety:** SF Edimax CL.

Choosing a canola variety

Considerations when selecting canola varieties:

- Determine the appropriate type of herbicide tolerance required as successful weed control is a key benefit from growing canola. Damage from imidazolinone (IMI) soil residues can be avoided by using CL or CL herbicide tolerant combinations, where appropriate.
- Target varieties with proven high yields and reliability across seasons and yield ranges. The GRDC NVT data is a source of high-quality scientific data (Tables 4 to 13).
- Select the highest blackleg resistance rating possible to support integrated blackleg management (Table 2).
- Match maturity to sowing time. Use longer maturity varieties with early sowings and shorter maturity varieties with later sowings or target a variety that is adaptable to most sowing times.
- Balance risk with profit, such as using high-yielding hybrid TT varieties where there is high yield potential, and lower yielding, low cost, open pollinated (OP) varieties in low yield or high-risk situations.
- Consider likely oil content, especially with early sowing when oil benefits are likely to be greatest. However, generally yield impacts crop profit more than oil concentration (Table 2).
- Consider the advantages of either the TruFlex® trait (where glyphosate control options can be extended to the start of flowering) or PodGuard® trait (which reduces pod shatter at maturity), to your system.

Current canola varieties available for 2022

Canola varieties are available with a range of herbicide tolerances (TT, GT and CL) and in double combinations of TT+GT, TT+CL, GT+CL and a new combination TT+LL (Table 1). Varieties with a combination of herbicide tolerance are often referred to as having 'stacked' tolerance. There is very little conventional canola grown in WA, due to lack of chemical options for radish control. Ryegrass control is also difficult due to its widespread resistance to group A grass herbicides in the WA wheatbelt.

Canola is available as open pollinated (OP) or hybrid breeding types. Open pollinated seed is created through self-pollination. Harvested OP seed is often retained on-farm for use at sowing. Only TT and conventional canola are available for purchase as OP varieties (Table 2). Hybrid seed is produced from managed crosses between different canola parent lines and must be purchased each year.

Varieties are available with a wide range of harvest maturities, from early (3) to mid-late (6) and winter types (Table 2). It is generally recommended that variety maturity is matched with season length. Use later maturity varieties in longer season environments or with early seeding to make maximum use of the long growing season and reduce the risk of frost at the end of flowering and during grain fill. Conversely, use shorter maturity varieties in short growing environments or with late seeding, as these can produce relatively high yields in a short period of time before terminal drought. However, recent DPIRD research has shown that an adaptable early-mid variety can be relatively high yielding at both early and late seeding times (**grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2021/02/when-to-take-advantage-of-early-seeding-opportunities-for-canola-in-wa**).

The GT group includes both TruFlex® and Roundup Ready® types (Table 2). 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 suitability of herbicides 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 2). PodGuard® reduces seed shatter at maturity, which can reduce seed shatter loss with direct heading and reduce seed loss risk from later harvesting.

TABLE 2. 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	Blackleg group	PodGuard®	EPR $/t	Release year	Seed access
TT (OP)	AFP Cutubury	4	-	-	-	-	4	2020	Agronomy for Profit
TT (OP)	ATR Bonito	4	0.7	MS	A	-	5	2013	Nuseed
TT (OP)	ATR Mako	4	-1.3	MR-MS	A	-	5	2015	Nuseed
TT (OP)	ATR Stingray	3	0.3	MR-MS	C	-	-	2011	Nuseed
TT (OP)	ATR Wahoo	6	0.2	MS	A	-	5	2013	Nuseed
TT (OP)	DG Bidgee TT	4	-	MR	H	-	5	2021	Nutrien Ag Solutions
TT (OP)	DG Murray TT	6	0.7	R-MR	H	-	5	2021	Nutrien Ag Solutions
TT	Hyola® Blazer TT	4.5	0.1	R	ADF	-	-	2020	Pacific Seeds
TT	HyTTec® Trident	3	0.1	R	AD	-	10	2019	Nuseed
TT	HyTTec® Trifecta	5	0.2	R	ABD	-	10	2020	Nuseed
TT	HyTTec® Trophy	4	-0.2	R-MR	AD	-	10	2017	Nuseed
TT	InVigor® T 4510	4.5	-0.8	MR-MS	BF	-	-	2016	BASF
TT	InVigor® T 6010	6	-0.2	MS	BC	-	-	2020	BASF
TT	RGT Capacity TT	4	-0.6	MS	B	-	10	2021	Seed Force
TT	SF Dynatron TT	5	0.6	MS	BC	-	10	2020	Seed Force
TT	SF Ignite TT	5	-0.7	MR-MS	BF	-	10	2017	Seed Force
TT	SF Spark TT	3	0.6	MR	ABDS	-	10	2018	Seed Force
TT (OP)	Yetna	4	-	-	-	-	4	2015	Agronomy for Profit
TT+RR	BASF 3000 TR	4	-0.1	MS-S	B	-	-	2016	BASF
TT+CL	Hyola® Enforcer CT	5	-0.1	R	ADF	-	-	2020	Pacific Seeds
TT+LL	InVigor® LT 4530P	4.5	-1.0	MR	R	P	-	2021	BASF
GT (TF)	DG Lofty TF	3	-	-	-	-	-	2021	Nutrien Ag Solutions
GT (TF)	DG Bindo TF	5	-	-	-	-	-	2021	Nutrien Ag Solutions
GT (TF)	Hyola® 410XX	4.5	1.1	R-MR	ABD	-	-	2018	Pacific Seeds
GT (RR)	InVigor® R 3520	3	0.0	MR	?	-	-	2017	BASF
GT (TF)	InVigor® R 4022P	4	0.1	MR-MS	ABC	P	-	2019	BASF
GT (TF)	InVigor® R 4520P	4.5	-0.8	MS	BF	P	-	2020	BASF
GT (RR)	InVigor® R 5520P	5.5	-0.2	MR-MS	ABC	P	-	2016	BASF
GT (TF)	Nuseed Condor TF	5	0.9	R	ABD	-	-	2020	Nuseed
GT (TF)	Nuseed Emu TF	3	0.6	MR-MS	AB	-		2021	Nuseed
GT (RR)	Nuseed GT-53	5	-0.3	R	ABDF	-	-	2016	Nuseed
GT (TF)	Nuseed Raptor TF	4	0.2	R	AD	-	-	2019	Nuseed
GT (RR)	Pioneer 44Y27 RR	4	-0.2	MR	B	-	-	2017	Pioneer
GT (RR)	Pioneer 44Y30 RR	4	0.2	MR	AB	-	-	2021	Pioneer
GT (RR)	Pioneer 45Y28 RR	5	1.0	MR	BC	-	-	2018	Pioneer

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

Varieties are hybrid except where OP specified.

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

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

Oil content averages: TT = 44.5, GT = 45.0 and CL = 45.3 (data from 2016-2020 NVT).

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

^= provisional result.

Blackleg information from GRDC Blackleg Management Guide 2021 Spring Fact Sheet, see further information at: grdc.com.au/GRDC-FS-BlacklegManagementGuide

[Table 2. continued following page...]

TABLE 2. 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	Blackleg group	PodGuard®	EPR $/t	Release year	Seed access
GT(TF)+CL	Hyola® Battalion XC	3.5	-0.8	R	ADF ^	-	-	2021	Pacific Seeds
GT(TF)+CL	Hyola® Garrison XC	4	0.0	R	ADF	-	-	2020	Pacific Seeds
CL	Hyola® Equinox CL	5	0.6	R	ADF	-	-	2021	Pacific Seeds
CL	Pioneer 43Y92 CL	3	-0.4	R-MR	B	-	-	2017	Pioneer
CL	Pioneer 44Y94 CL	4	1.5	R-MR	BC	-	-	2020	Pioneer
CL	Pioneer 45Y93 CL	5	1.0	R-MR	BC	-	-	2018	Pioneer
CL	Pioneer 45Y95 CL	5	0.8	-	C	-	-	2021	Pioneer
Winter (CL)	Hyola® 970CL	9	-	R	H	-	-	2018	Pacific Seeds
	Hyola® Feast CL	8	-	R	H	-	-	2020	Pacific Seeds
	Phoenix CL	8.5	-	R	B	-	-	2018	AGF Feeds
	RGT Nizza CL	8	-	R	B	-	12	2021	Seed Force

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

Varieties are hybrid except where OP specified.
Herbicide tolerance: TT = Triazine Tolerant, GT = Glyphosate Tolerant (RR = Roundup Ready type, TF = TruFlex® type), LL = LibertyLink (glufosinate tolerant), CL = Clearfield (Imidazolinone tolerant).
Harvest maturity key: 3 = early, 4 = early-mid, 5 = mid, 6 = mid-late (provided by seed companies).
Oil content averages: TT = 44.5, GT = 45.0 and CL = 45.3 (data from 2016-2020 NVT).
Blackleg resistance rating key: R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible.
^= provisional result.
Blackleg information from GRDC Blackleg Management Guide 2021 Spring Fact Sheet, see further information at: grdc.com.au/GRDC-FS-BlacklegManagementGuide

A price premium is paid for oil content above 42% (bonification payment). The relative oil content of current varieties is shown in Table 2. Varieties with relatively high oil content are:

- TT- ATR Bonito, DG Murray TT, SF Dynatron TT and SF Spark TT
- GT- Hyola 410XX, Pioneer 45Y28, Nuseed Condor TF and Nuseed Emu TF
- CL- Pioneer 44Y94 CL and Pioneer 45Y93.

The blackleg resistance rating is the best variety defence against blackleg. Varieties with a resistant (R) blackleg rating are available in all herbicide tolerance types (Table 2). Resistance groups are a secondary consideration, and the recommendation is to change resistance groups entirely (no shared letters) where monitoring has identified yield loss and the same cultivar has been grown for three or more years. Limiting canola rotation to one year in three remains the primary method to combat blackleg. Refer to the GRDC Blackleg management guide (**grdc.com.au/GRDC-FS-BlacklegManagementGuide**) for more information.

All canola varieties have plant breeder rights and are not free to trade. Canola seed must be purchased from registered commercial sellers (Table 2). Harvested TT canola can be retained on-farm for use as seed but retained seed from hybrid crops will not be the same as the parents and is likely to have reduced performance.

Some varieties have and end point royalty (EPR) to be paid per tonne of harvested grain sold. Traditionally this only applied to OP varieties, to help recoup costs on farmer grown seed. However, EPRs now also apply to many hybrid TT varieties (Table 2).

Most canola varieties grown in WA are spring types, however some winter types are also available (Table 2). Winter canola can be grown as a dual-purpose crop, for both grazing and grain production. Winter types need a long period of cold (vernalisation) before flowering initiation. This provides a longer opportunity for grazing the vegetative crop, compared with shorter maturity cultivars (spring types). Winter varieties are only suitable for cooler southern areas. For example, Hyola 970CL did not flower when grown at South Perth, as there was not enough cold to supply its vernalisation requirements. Winter varieties are not included in the NVT, so yield data is not reported in this guide.

The National Variety Trials (NVT) program and MET analysis

The purpose of the NVT program is to assist Australian grain growers decide which varieties to grow, through provision of independent comparative information about commercially available varieties. Varieties are grown side by side under standardised protocols. Information is generated for yield, disease resistance ratings and quality. The results of the WA canola trials are reported here. The NVT program is a GRDC investment.

Long Term MET results are the most accurate and reliable means of interpreting NVT data. Generating the MET data involves two stages of analysis. First, the data is analysed from each individual NVT trial with herbicide tolerance trials (TT, GT or CL) at the same location analysed together to reduce variability in the results.

In the second stage of the analysis, all raw plot data and spatial models from the single site analysis of individual NVT sites are combined spatially (across all sites in Australia) and temporally (across growing seasons) to produce the multi-environment trial (MET) dataset. In this analysis, relationships between variety performances are established by comparing results from similar environments. Any issues with variable establishment or variable sites (e.g. different soil types or insect attack in one part of a trial) are accounted for by linkages between environments, so there is little effect on the yield predictions of affected varieties. Results of all trials in Australia are combined to generate a 'long-term MET predicted yield' for each variety in each trial.

The MET analysis generates a predictive yield even when a variety is not present in a trial. This is achieved by comparing the variety's performance with other varieties in similar environments to the trial/s in question (as shown in shaded cells in Tables 4–13). The predictive yield capacity of the MET analysis is extremely useful as new canola varieties are often released with limited NVT testing.

Predicted yields from individual NVTs are available from nvtonline.com.au under the 'trial results' tab. The long-term MET predicted yields are available at NVT Online (nvt.grdc.com.au) by accessing the 'yield reporter' tab and are presented here in Tables 4–13.

In this guide MET results are presented when the variation explained by the MET data model over all the trials is at least 80% (termed 'data accuracy' for NVT online) and the Variance Accounted For (VAF) in individual trials is at least 25%. Where the VAF is less than 25%, the results might not reflect variety differences. Data accuracy of 80% and VAF of 25% are the default settings on NVT online, although they can be adjusted.

MET values are displayed where varieties were present in at least two trials (Tables 4–13).

A five-year weighted average has been calculated from the MET data for each Agzone (Tables 5–8 and 10–13) and for the Statewide results (Table 4 and 9) for the Early and Mid series. Caution should be exercised when looking at the weighted average as it masks varietal performance over seasons within an Agzone.

NVT Results 2016–2020

This guide presents predicted yields from the long-term Multi-Environment Trial (MET) analysis of all WA National Variety Trials (NVT) from 2016–2020. There were 204 canola trials in WA during this period.

Locations of the canola variety trials are shown in Figure 1. NVT 'Early' trials are sown in shorter-season environments in northern and eastern areas that generally suit short-maturity varieties, largely in Agzones 1, 2, 4 and 5. While 'Mid' trials are sown in longer-season environments, that may suit longer maturity varieties, largely in Agzones 2, 3 and 6.

The Early- and Mid-series trials have similar sowing times. These were the last week of April for most trials in 2016, the end of April to mid-May in 2017, around 25 May in 2018 (apart from a few in late April), late April to 7 June in 2019 and early May in 2020.

Table 3 lists the location of the WA trials and the table numbers relating to their data in this guide. NVT data aggregated over the state is presented in Table 4 for the Early-series and in Table 9 for the Mid-series trials. Additional Agzone data is presented in Tables 5–8 for the Early-series trials and Tables 10–13 for the Mid-series trials.

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

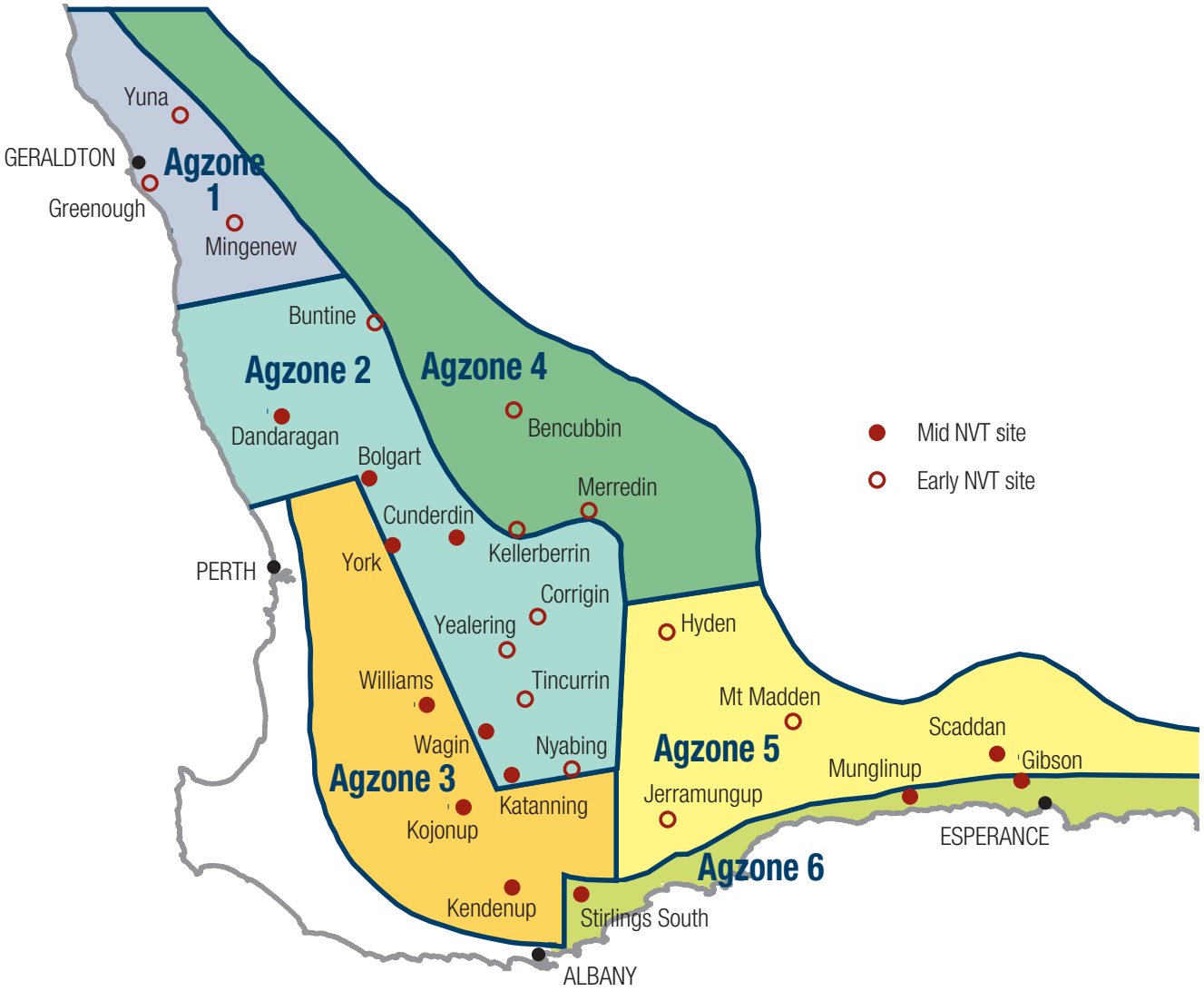

FIGURE 1. Location of Mid and Early series canola NVT across Western Australian Agzones

TABLE 3. Table reference, Agzone location and trial number for Early and Mid series WA canola NVT 2016–2020

NVT Series	Herbicide tolerance	Statewide	Agzone 1	Agzone 2	Agzone 3	Agzone 4	Agzone 5	Agzone 6
Early		Table 4	Table 5	Table 6	-	Table 7	Table 8	-
	TT	(41)	(8)	(13)	-	(9)	(11)	-
	GT	(32)	(8)	(11)	-	(9)	(4)*	-
	CL	(10)	(5)*	-	-	(3)*	(2)*	-
Mid		Table 9	-	Table 10	Table 11	-	Table 12	Table 13
	TT	(51)	-	(19)	(14)	-	(5)	(13)
	GT	(38)	-	(15)	(11)	-	(1)*	(11)
	CL	(25)	-	(7)*	(12)*	-	-	(7)*

* Data not presented in the guide, refer to NVT online for information.

RESULTS FOR EARLY SERIES NVT

TT and TT combination varieties

HyTTec Trident was the highest yielding TT variety in the NVT long-term yield predictions for Agzones 1, 2, 4 and 5 (Tables 5–8), and combined Agzones (Table 4). HyTTec Trident has early maturity (3) and has the highest blackleg rating (R). After HyTTec Trident, the highest yielding early-mid (4 or 4.5) maturity group varieties were InVigor T 4510, the new variety, RGT Capacity TT, and HyTTec Trophy. InVigor T 4510 and HyTTec Trophy have been tested across most seasons, (2016 to 2020), so yield results are considered to be more accurate. The mid (5) maturity SF Dynatron TT has comparable yield predictions to the early-mid varieties mentioned. However, RGT Capacity TT and SF Dynatron TT have a blackleg rating of MS.

The NVT yields of the OP variety ATR Bonito were 28% lower than HyTTec Trident and around 20% lower than the other hybrids discussed above (Table 4). Yield differences may be slightly less on-farm, when using the best practice OP agronomy (large seed and high seeding rates). NVT data for new TT OP varieties will be available online after the 2021 harvest. Leading hybrids are likely to be most profitable for situations of high yield potential. OP varieties are likely to be suitable for lower yield or high-risk situations and a guaranteed seed supply, given seed can be retained on farm.

In addition to TT, a range of herbicide tolerance combinations are available: TT+CL (i.e. Hyola Enforcer CT) for imidazolinone residue concerns and for additional weed control, TT+GT (i.e. BASF 3000TR) and TT+LL (i.e. InVigor LT 4530P), which can be used to help combat resistant weeds. In certain situations, the weed control benefits of these varieties will outweigh their lower yields compared to straight TT varieties.

GT and GT combination varieties

The new variety Nuseed Emu TF achieved the highest predicted yields of the GT varieties for the Early series NVT (Tables 4–8). Nuseed Emu TF is an early (3) maturity variety, with the TruFlex® trait and a relatively high oil content (0.6% above the average for GT varieties).

In the early-mid maturity group, Pioneer 44Y27 RR achieved the highest yields, while in the mid (5) maturity group Nuseed Condor TF delivered the highest yields followed by Pioneer 45Y28 RR. Pioneer 44Y27 RR has been tested in 31 trials over all seasons (2016 to 2020), so the results are robust. Nuseed Condor TF has the TruFlex® trait and a blackleg resistance rating of R. Both Nuseed Condor TF and Pioneer 45Y28 RR have relatively high oil content, around 1% higher than the average of all GT varieties (Table 2).

A range of varieties achieved yields within 5% of each other: the early maturity InVigor R 3520, early-mid varieties InVigor R 4022P, Hyola 410XX, InVigor R 4520P and the mid maturity variety GT-53, although yields were slightly lower than varieties already discussed in this section (Table 4).

The new GT+CL variety Hyola Battalion XC has a shorter maturity and slightly higher yields than Hyola Garrison XC (Table 4).

TABLE 4. Yield of canola varieties in EARLY^ series NVT (AGZONES 1, 2, 4 and 5 combined), expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

WA EARLY TT and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		2.04	1.60	1.47	1.00	1.70	-
		Variety	No. trials	(9)	(8)	(7)	(8)	(9)	(41)
TT	3	HyTTec Trident	(27)	121	120	124	121	119	**121**
TT	3	SF Spark TT	(18)	105	103	108	104	106	**105**
TT (OP)	3	ATR Stingray	(19)	88	89	87	88	89	**88**
TT	4.5	InVigor T 4510	(41)	112	112	112	112	110	**112**
TT	4	RGT Capacity TT	(10)	112	112	112	112	110	**112**
TT	4	HyTTec Trophy	(26)	110	112	110	112	108	**110**
TT	4.5	Hyola Blazer TT	(11)	106	114	101	112	102	**107**
TT (OP)	4	ATR Bonito	(41)	93	93	93	93	94	**93**
TT	5	SF Dynatron TT	(17)	110	114	109	113	108	**111**
TT+CL	5	Hyola Enforcer CT	(14)	100	104	96	103	98	**100**
TT+GT (RR)	4	BASF 3000 TR	(25)	98	93	102	94	101	**98**
TT+LL	4.5	InVigor LT 4530P	(9)	103	105	102	105	102	**103**
WA EARLY GT and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		2.30	1.89	1.85	1.06	1.71	-
		Variety	No. trials	(7)	(6)	(5)	(6)	(8)	(32)
GT (TF)	3	Nuseed Emu TF	(10)	116	114	122	114	122	**118**
GT (RR)	3	InVigor R 3520	(32)	103	102	105	102	105	**103**
GT (RR)	4	Pioneer 44Y27 RR	(31)	111	111	111	110	111	**111**
GT (TF)	4	InVigor R 4022P	(14)	106	106	103	105	103	**105**
GT (TF)	4.5	Hyola 410XX	(14)	104	103	104	103	104	**104**
GT (TF)	4.5	InVigor R 4520P	(14)	102	103	99	102	99	**101**
GT (TF)	4	Nuseed Raptor TF	(11)	99	100	96	99	96	**98**
GT (TF)	5	Nuseed Condor TF	(6)	112	112	106	111	105	**109**
GT (RR)	5	Pioneer 45Y28 RR	(6)	107	108	103	107	104	**106**
GT (RR)	5	Nuseed GT-53	(16)	101	101	100	101	100	**101**
GT (TF)+CL	3.5	Hyola Battalion XC	(8)	101	100	101	100	101	**101**
GT (TF)+CL	4	Hyola Garrison XC	(14)	99	99	96	99	95	**98**

Varieties grouped by herbicide tolerance type, then major maturity group, and listed in decreasing yield. Source: NVT Online, **nvtonline.com.au**

^ EARLY series NVT trials are sown in shorter season environments (see Figure 1).

Varieties with only a single successful trial are not included.

Shaded cells indicate variety was not present in trials, value shown is predicted yield from MET analysis.

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

TABLE 5. Yield of canola varieties in AGZONE 1 EARLY^ series NVT, expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

AGZONE 1 EARLY TT and combinations									
Herbicide tolerance	**Harvest maturity**	**Year**		**2016**	**2017**	**2018**	**2019**	**2020**	**2016–2020**
		Site mean yield (t/ha)		**2.95**	**1.15**	**1.50**	**1.07**	**2.38**	**-**
		Variety	**No. trials**	**(2)**	**(2)**	**(1)**	**(2)**	**(1)**	**(8)**
TT	3	HyTTec Trident	(5)	123	131	121	122	115	**124**
TT	3	SF Spark TT	(3)	102	108	110	105	105	**106**
TT	4.5	InVigor T 4510	(8)	115	117	109	112	107	**113**
TT	4	HyTTec Trophy	(5)	116	115	104	112	106	**112**
TT	4.5	Hyola Blazer TT	(2)	123	108	88	110	100	**109**
TT (OP)	4	ATR Bonito	(8)	92	90	94	93	96	**93**
TT	5	SF Dynatron TT	(3)	119	115	101	112	105	**112**
TT+CL	5	Hyola Enforcer CT	(2)	109	99	89	102	97	**101**
TT+GT (RR)	4	BASF 3000 TR	(7)	87	98	110	95	102	**97**
AGZONE 1 EARLY GT and combinations									
Herbicide tolerance	**Harvest maturity**	**Year**		**2016**	**2017**	**2018**	**2019**	**2020**	**2016–2020**
		Site mean yield (t/ha)		**3.11**	**1.29**	**1.48**	**1.33**	**2.54**	**-**
		Variety	**No. trials**	**(2)**	**(2)**	**(1)**	**(2)**	**(1)**	**(8)**
GT (TF)	3	Nuseed Emu TF	(2)	103	124	136	112	116	**116**
GT (RR)	3	InVigor R 3520	(8)	98	104	110	102	104	**103**
GT (RR)	4	Pioneer 44Y27 RR	(8)	112	115	112	110	108	**112**
GT (TF)	4	InVigor R 4022P	(3)	111	106	98	105	102	**106**
GT (TF)	4.5	InVigor R 4520P	(3)	110	102	92	103	99	**103**
GT (TF)	4.5	Hyola 410XX	(3)	104	105	104	103	103	**104**
GT (TF)	4	Nuseed Raptor TF	(3)	106	97	89	100	97	**99**
GT (TF)	5	Nuseed Condor TF	(2)	123	113	95	111	104	**112**
GT (RR)	5	Pioneer 45Y28 RR	(2)	114	108	97	107	102	**107**
GT (RR)	5	Nuseed GT-53	(5)	102	100	98	101	100	**101**
GT (TF)+CL	4	Hyola Garrison XC	(3)	105	97	89	99	97	**99**

Varieties grouped by herbicide tolerance type, then major maturity group, and listed in decreasing yield. Source: NVT Online, **nvtonline.com.au**

^ EARLY series NVT trials are sown in shorter season environments (see Figure 1).

Varieties with only a single successful trial are not included.

Shaded cells indicate variety was not present in trials, value shown is predicted yield from MET analysis.

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

TABLE 6. Yield of canola varieties in AGZONE 2 EARLY^ series NVT, expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

AGZONE 2 EARLY TT and combinations									
Herbicide tolerance	**Harvest maturity**	**Year**		**2016**	**2017**	**2018**	**2019**	**2020**	**2016–2020**
		Site mean yield (t/ha)		**1.96**	**1.77**	**1.64**	**0.97**	**2.09**	**-**
		Variety	**No. trials**	**(3)**	**(2)**	**(3)**	**(2)**	**(3)**	**(13)**
TT	3	HyTTec Trident	(10)	117	119	123	121	119	**120**
TT	3	SF Spark TT	(6)	105	104	107	108	104	**106**
TT (OP)	3	ATR Stingray	(9)	91	89	87	89	90	**89**
TT	4.5	InVigor T 4510	(13)	109	111	112	110	111	**111**
TT	4	RGT Capacity TT	(4)	109	111	112	110	110	**110**
TT	4	HyTTec Trophy	(8)	107	111	110	107	110	**109**
TT	4.5	Hyola Blazer TT	(4)	101	110	102	97	107	**103**
TT (OP)	4	ATR Bonito	(13)	95	94	93	94	94	**94**
TT	5	SF Dynatron TT	(5)	106	112	109	106	110	**109**
TT+LL	4.5	InVigor LT 4530P	(3)	102	104	103	101	103	**103**
TT+GT (RR)	4	BASF 3000 TR	(10)	101	95	101	104	97	**100**
TT+CL	5	Hyola Enforcer CT	(4)	97	102	97	94	101	**98**
AGZONE 2 EARLY GT and combinations									
Herbicide tolerance	**Harvest maturity**	**Year**		**2016**	**2017**	**2018**	**2019**	**2020**	**2016–2020**
		Site mean yield (t/ha)		**2.06**	**1.96**	**1.88**	**1.01**	**2.05**	**-**
		Variety	**No. trials**	**(3)**	**(2)**	**(2)**	**(2)**	**(2)**	**(11)**
GT (TF)	3	Nuseed Emu TF	(3)	117	111	122	126	120	**119**
GT (RR)	3	InVigor R 3520	(11)	104	101	105	106	104	**104**
GT (RR)	4	Pioneer 44Y27 RR	(10)	109	110	112	111	112	**111**
GT (TF)	4	InVigor R 4022P	(4)	103	106	104	102	105	**104**
GT (TF)	4.5	Hyola 410XX	(4)	103	103	104	104	104	**104**
GT (TF)	4.5	InVigor R 4520P	(4)	99	103	100	97	101	**100**
GT (TF)	4	Nuseed Raptor TF	(4)	97	100	96	94	97	**97**
GT (TF)	5	Nuseed Condor TF	(2)	105	112	108	103	110	**107**
GT (RR)	5	Pioneer 45Y28 RR	(2)	103	107	104	101	106	**104**
GT (RR)	5	Nuseed GT-53	(9)	100	101	100	99	100	**100**
GT (TF)+CL	3.5	Hyola Battalion XC	(2)	101	100	101	102	101	**101**
GT (TF)+CL	4	Hyola Garrison XC	(4)	97	100	96	94	97	**97**

Varieties grouped by herbicide tolerance type, then major maturity group, and listed in decreasing yield. Source: NVT Online, **nvtonline.com.au**

^ EARLY series NVT trials are sown in shorter season environments (see Figure 1).

Varieties with only a single successful trial are not included.

Shaded cells indicate variety was not present in trials, value shown is predicted yield from MET analysis.

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

TABLE 7. Yield of canola varieties in AGZONE 4 EARLY^ series NVT, expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

AGZONE 4 EARLY TT and combinations									
Herbicide tolerance	**Harvest maturity**	**Year**		**2016**	**2017**	**2018**	**2019**	**2020**	**2016–2020**
		Site mean yield (t/ha)		**1.99**	**2.04**	**1.59**	**0.72**	**1.23**	**-**
		Variety	**No. trials**	**(1)**	**(1)**	**(2)**	**(2)**	**(3)**	**(9)**
TT	3	HyTTec Trident	(8)	132	125	121	123	124	**124**
TT	3	SF Spark TT	(5)	114	106	106	102	109	**107**
TT (OP)	3	ATR Stingray	(7)	82	86	88	87	87	**87**
TT	4	RGT Capacity TT	(3)	115	114	112	114	112	**113**
TT	4.5	InVigor T 4510	(9)	114	114	112	114	112	**113**
TT	4	HyTTec Trophy	(5)	108	112	110	116	108	**111**
TT	4.5	Hyola Blazer TT	(3)	86	108	105	122	96	**104**
TT (OP)	4	ATR Bonito	(9)	91	92	93	92	93	**92**
TT	5	SF Dynatron TT	(5)	104	112	110	118	106	**110**
TT+LL	4.5	InVigor LT 4530P	(3)	100	104	103	107	101	**103**
TT+GT (RR)	4	BASF 3000 TR	(6)	113	97	99	88	106	**100**
TT+CL	5	Hyola Enforcer CT	(4)	85	100	99	109	93	**98**
AGZONE 4 EARLY GT and combinations									
Herbicide tolerance	**Harvest maturity**	**Year**		**2016**	**2017**	**2018**	**2019**	**2020**	**2016–2020**
		Site mean yield (t/ha)		**2.23**	**2.32**	**1.97**	**0.84**	**1.38**	**-**
		Variety	**No. trials**	**(1)**	**(1)**	**(2)**	**(2)**	**(3)**	**(9)**
GT (TF)	3	Nuseed Emu TF	(3)	146	118	116	104	129	**121**
GT (RR)	3	InVigor R 3520	(9)	112	103	103	99	107	**104**
GT (RR)	4	Pioneer 44Y27 RR	(9)	116	112	110	111	112	**112**
GT (TF)	4.5	Hyola 410XX	(5)	105	104	103	103	104	**104**
GT (TF)	4	InVigor R 4022P	(5)	99	106	104	110	101	**104**
GT (TF)	4.5	InVigor R 4520P	(5)	91	102	101	108	96	**100**
GT (TF)	4	Nuseed Raptor TF	(2)	87	98	98	105	93	**97**
GT (TF)	5	Nuseed Condor TF	(2)	97	111	108	120	102	**108**
GT (TF)+CL	3.5	Hyola Battalion XC	(3)	104	101	101	99	102	**101**
GT (TF)+CL	4	Hyola Garrison XC	(5)	87	98	98	104	93	**96**

Varieties grouped by herbicide tolerance type, then major maturity group, and listed in decreasing yield. Source: NVT Online, **nvtonline.com.au**

^ EARLY series NVT trials are sown in shorter season environments (see Figure 1).

Varieties with only a single successful trial are not included.

Shaded cells indicate variety was not present in trials, value shown is predicted yield from MET analysis.

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

TABLE 8. Yield of canola varieties in AGZONE 5 EARLY^ series NVT, expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

AGZONE 5 EARLY TT and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		1.61	1.68	0.65	1.28	1.53	-
		Variety	No. trials	(3)	(3)	(1)	(2)	(2)	(11)
TT	3	HyTTec Trident	(4)	120	114	150	119	118	**121**
TT	3	SF Spark TT	(4)	106	99	115	101	106	**104**
TT (OP)	3	ATR Stingray	(3)	89	92	73	89	90	**89**
TT	4.5	InVigor T 4510	(11)	110	110	126	113	109	**112**
TT	4	HyTTec Trophy	(8)	108	113	122	114	107	**112**
TT	4.5	Hyola Blazer TT	(2)	101	122	108	120	101	**111**
TT	4	RGT Capacity TT	(2)	110	110	126	112	109	**112**
TT (OP)	4	ATR Bonito	(11)	94	95	85	93	94	**93**
TT	5	SF Dynatron TT	(4)	107	115	121	116	107	**112**
TT+LL	4.5	InVigor LT 4530P	(2)	102	106	106	106	102	**104**
TT+CL	5	Hyola Enforcer CT	(4)	97	110	95	108	97	**102**
TT+GT (RR)	4	BASF 3000 TR	(2)	102	87	100	89	101	**95**

Varieties grouped by herbicide tolerance type, then major maturity group, and listed in decreasing yield. Source: NVT Online, **nvtonline.com.au**

^ EARLY series NVT trials are sown in shorter season environments (see Figure 1).

Varieties with only a single successful trial are not included.

Shaded cells indicate variety was not present in trials, value shown is predicted yield from MET analysis.

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

RESULTS FOR MID SERIES NVT

TT and TT combination varieties

The three TT varieties with the highest predicted yields from the Mid series all have a resistant (R) blackleg rating (bare seed). The mid maturity variety HyTTec Trifecta achieved the highest yields, followed by Hyola Blazer TT (early-mid maturity) and HyTTec Trident (early maturity), which achieved comparable yields. There was a very similar pattern across the individual Agzones 2, 3, 5 and 6 (Tables 10–13), and the combined statewide results (Table 9).

SF Dynatron TT yielded just 4% less than HyTTec Trifecta and had a relatively high oil content (Table 2). However, SF Dynatron TT has a low blackleg rating of MS and should be avoided or used with a good blackleg management package in areas with high rainfall and high blackleg risk.

Other high-yielding varieties in the Mid series trials included (in decreasing order) the early-mid maturity varieties HyTTec Trophy, RGT Capacity TT and InVigor T 4510 and the mid-late maturity InVigor T 6010. InVigor T 6010 and RGT Capacity TT have a blackleg rating of MS.

DG Murray TT was the highest yielding OP variety in the Mid series. There was an 18% yield gap between DG Murray TT and the highest yielding hybrid (HyTTec Trident), but only a 5% difference between DG Murray and the lowest yielding hybrid (Tables 9–13). OP yield differences may be slightly less on-farm, when using the best practice OP agronomy (large seed and high seeding rate). In the medium and high rainfall zones, OP varieties are likely to be restricted to lower yielding or high-risk sites, or where preferred hybrid seed is not available. DG Murray TT has a blackleg resistance rating of R-MR, compared with MS for ATR Bonito. In addition, DG Murray TT has a totally different blackleg group (H), so swapping from ATR Bonito to DG Murray TT will greatly improve blackleg resistance.

Herbicide combination varieties Hyola Enforcer CT (TT+CL) and InVigor LT 4530P (TT+LL) have yield expectations close to some single tolerance TT hybrids (Tables 9–3).

GT and GT combination varieties

In the longer season Mid series GT trials, early-mid maturity varieties InVigor R 4520P and the new variety Pioneer 44Y30 RR achieved the highest predicted yields, particularly in the high rainfall Agzones 3 and 6 (Tables 11 and 13). InVigor R 4520P has the benefits of both TruFlex® and PodGuard® traits, but it has a moderately susceptible (MS) blackleg rating (bare seed). In Agzones 3 and 6, mid maturity varieties Pioneer 45Y28 RR and Nuseed Condor TF were equal third highest yielding. Both varieties have relatively high oil content. Nuseed Condor TF also has the TruFlex® trait and a blackleg rating of R, bare seed. Both Pioneer 44Y30 RR and Pioneer 54Y28 RR have a blackleg rating of MR.

Other high yielding early-mid maturity varieties were Nuseed Raptor TF, InVigor R 4022P, Pioneer 44Y27 RR and the mid maturity variety Nuseed GT-53. Nuseed Raptor TF and Nuseed GT-53 have a R blackleg rating. Nuseed Raptor TF and InVigor R 4022P have the TruFlex® trait and InVigor R 4022P also has the PodGuard® trait.

In Agzone 2, varieties displayed a closer range of predicted yields with only 6% difference between seven varieties: early-mid maturity varieties InVigor R 4520P, Pioneer 44Y27 RR, Nuseed Raptor TF, InVigor R 4022P, mid maturity varieties Nuseed Condor TF, Pioneer 45Y28 RR and early maturity variety Nuseed Emu TF (Table 10). Nuseed Emu TF was only present in two Mid series trials, both with mean yields below 1t/ha.

CL varieties

The new mid maturity variety Pioneer 45Y95 CL achieved the highest predicted yields in the CL trials, although this variety has only been tested in the 2018 NVT. Other CL varieties with high predicted yields were the early-mid maturity variety Pioneer 44Y94 CL and the mid maturity variety Pioneer 45Y93 CL (Table 9).

TABLE 9. Yield of canola varieties in MID^ series NVT (AGZONES 2, 3, 5 and 6 combined), expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

WA MID TT and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		2.51	1.90	2.10	1.90	2.64	-
		Variety	No. trials	(9)	(12)	(10)	(12)	(8)	(51)
TT	3	HyTTec Trident	(20)	120	115	123	113	117	**117**
TT	3	SF Spark TT	(10)	104	103	105	103	103	**104**
TT (OP)	3	ATR Stingray	(16)	92	94	91	95	93	**93**
TT	4.5	Hyola Blazer TT	(9)	119	119	114	117	116	**117**
TT	4	HyTTec Trophy	(36)	117	115	116	114	115	**115**
TT	4	RGT Capacity TT	(11)	114	113	112	112	112	**113**
TT	4.5	InVigor T 4510	(51)	112	110	112	110	111	**111**
TT (OP)	4	ATR Bonito	(45)	93	95	92	96	95	**94**
TT	5	HyTTec Trifecta	(25)	122	120	120	118	119	**120**
TT	5	SF Dynatron TT	(12)	118	117	115	115	115	**116**
TT	5	SF Ignite TT	(48)	110	111	104	109	107	**108**
TT	6	InVigor T 6010	(13)	111	113	106	112	109	**110**
TT (OP)	6	DG Murray TT	(9)	99	100	97	99	98	**99**
TT (OP)	6	ATR Wahoo	(14)	96	99	91	98	95	**96**
TT+CL	5	Hyola Enforcer CT	(17)	111	109	111	108	109	**110**
TT+GT (RR)	4	BASF 3000 TR	(10)	94	92	99	94	96	**95**
TT+LL	4.5	InVigor LT 4530P	(8)	108	108	107	108	108	**108**
WA MID GT and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		2.73	2.07	2.28	2.23	2.72	-
		Variety	No. trials	(6)	(8)	(6)	(10)	(8)	(38)
GT (TF)	3	Nuseed Emu TF	(2)	102	98	108	99	103	**102**
GT (RR)	3	InVigor R 3520	(13)	95	93	101	95	98	**96**
GT (TF)	4.5	InVigor R 4520P	(18)	115	116	110	114	112	**114**
GT (RR)	4	Pioneer 44Y30 RR	(6)	116	114	114	112	113	**114**
GT (TF)	4	Nuseed Raptor TF	(19)	110	107	109	106	107	**108**
GT (TF)	4	InVigor R 4022P	(18)	107	108	105	107	106	**107**
GT (RR)	4	Pioneer 44Y27	(33)	107	104	108	104	106	**106**
GT (TF)	4.5	Hyola 410XX	(19)	100	98	102	99	100	**100**
GT (TF)	5	Nuseed Condor TF	(17)	112	111	110	109	109	**110**
GT (RR)	5	Pioneer 45Y28 RR	(16)	112	111	109	109	108	**110**
GT (RR)	5	Nuseed GT-53	(38)	106	103	106	103	104	**104**
GT (RR)	5.5	InVigor R 5520P	(33)	99	102	96	102	99	**100**
GT (TF)+CL	3.5	Hyola Battalion XC	(4)	103	100	104	100	102	**102**
GT (TF)+CL	4	Hyola Garrison XC	(18)	103	102	104	102	102	**102**
WA MID CL									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		2.97	2.00	2.32	2.42	3.24	-
		Variety	No. trials	(4)	(7)	(6)	(5)	(3)	(25)
CL	3	Pioneer 43Y92 CL	(10)	107	106	107	103	106	**106**
CL	4	Pioneer 44Y94 CL	(7)	118	117	115	111	114	**115**
CL	5	Pioneer 45Y95 CL	(5)	119	119	114	113	113	**116**
CL	5	Pioneer 45Y93 CL	(15)	113	116	107	113	108	**112**
CL	5	Hyola Equinox CL	(3)	107	105	108	102	106	**106**

Varieties grouped by herbicide tolerance type, then major maturity group, and listed in decreasing yield. Source: NVT Online, **nvt.grdc.com.au**

^ MID series NVT trials are sown in longer season environments (see Figure 1).

Varieties with only a single successful trial are not included.

Shaded cells indicate variety was not present in trials, value shown is predicted yield from MET analysis.

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

TABLE 10. Yield of canola varieties in AGZONE 2 MID^ series NVT, expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

AGZONE 2 MID Triazine tolerant (TT) and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		2.61	2.01	2.09	1.46	1.87	-
		Variety	No. trials	(5)	(4)	(4)	(5)	(1)	(19)
TT	3	HyTTec Trident	(11)	119	115	122	119	112	**118**
TT	3	SF Spark TT	(6)	104	103	105	104	103	**104**
TT (OP)	3	ATR Stingray	(12)	92	94	91	93	96	**93**
TT	4	HyTTec Trophy	(14)	115	113	114	114	110	**114**
TT	4	RGT Capacity TT	(3)	112	111	109	111	111	**111**
TT	4.5	InVigor T 4510	(19)	111	110	109	111	113	**110**
TT (OP)	4	ATR Bonito	(14)	93	95	92	95	99	**94**
TT (OP)	4	ATR Mako	(11)	93	93	94	93	92	**93**
TT	5	HyTTec Trifecta	(8)	120	117	116	116	110	**117**
TT	5	SF Dynatron TT	(6)	116	113	111	113	109	**113**
TT	5	SF Ignite TT	(17)	108	107	102	102	96	**104**
TT (OP)	6	DG Murray TT	(2)	99	99	98	96	91	**98**
TT+CL	5	Hyola Enforcer CT	(4)	110	108	110	109	106	**109**
TT+GT (RR)	4	BASF 3000 TR	(10)	95	96	100	100	107	**98**
AGZONE 2 MID Glyphosate tolerant GT and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		2.75	1.87	2.08	1.66	0.86	-
		Variety	No. trials	(4)	(3)	(3)	(4)	(1)	(15)
GT (TF)	3	Nuseed Emu TF	(2)	103	104	109	110	140	**109**
GT (RR)	3	InVigor R 3520	(11)	97	99	102	103	130	**102**
GT (TF)	4.5	InVigor R 4520P	(5)	115	116	106	112	98	**111**
GT (RR)	4	Pioneer 44Y27 RR	(15)	107	106	108	107	116	**108**
GT (TF)	4	Nuseed Raptor TF	(5)	108	106	110	106	104	**107**
GT (TF)	4	InVigor R 4022P	(5)	107	109	101	108	104	**106**
GT (TF)	4.5	Hyola 410XX	(5)	100	99	103	100	107	**101**
GT (TF)	5	Nuseed Condor TF	(5)	111	110	108	108	101	**109**
GT (RR)	5	Pioneer 45Y28 RR	(5)	110	108	107	106	95	**107**
GT (RR)	5	Nuseed GT-53	(15)	105	102	107	103	103	**104**
GT (RR)	5.5	InVigor R 5520P	(10)	100	102	93	99	89	**98**
GT (TF)+CL	4	Hyola Garrison XC	(5)	103	101	104	102	102	**102**

Varieties grouped by herbicide tolerance type, then major maturity group, and listed in decreasing yield. Source: NVT Online, **nvt.grdc.com.au**

^ MID series NVT trials are sown in longer season environments (see Figure 1).

Varieties with only a single successful trial are not included.

Shaded cells indicate variety was not present in trials, value shown is predicted yield from MET analysis.

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

TABLE 11. Yield of canola varieties in AGZONE 3 MID^ series NVT, expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

AGZONE 3 MID Triazine tolerant (TT) and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		3.13	2.06	2.47	2.45	3.09	-
		Variety	No. trials	(2)	(3)	(3)	(3)	(3)	(14)
TT	3	HyTTec Trident	(3)	124	118	123	111	118	**118**
TT	3	SF Spark TT	(3)	105	103	105	102	104	**104**
TT (OP)	3	ATR Stingray	(2)	91	93	91	96	93	**93**
TT	4.5	Hyola Blazer TT	(3)	126	128	118	122	113	**121**
TT	4	HyTTec Trophy	(10)	122	120	117	115	114	**117**
TT	4	RGT Capacity TT	(5)	119	119	113	114	111	**115**
TT	4.5	InVigor T 4510	(14)	116	115	112	111	111	**113**
TT (OP)	4	ATR Bonito	(13)	92	95	92	97	94	**94**
TT (OP)	4	ATR Mako	(8)	89	89	92	92	93	**91**
TT	5	HyTTec Trifecta	(9)	129	128	122	121	117	**123**
TT	5	SF Dynatron TT	(4)	124	124	117	119	113	**119**
TT	5	SF Ignite TT	(14)	114	117	107	115	104	**111**
TT	6	InVigor T 6010	(6)	117	120	109	117	106	**114**
TT (OP)	6	DG Murray TT	(4)	98	99	98	100	97	**98**
TT (OP)	6	ATR Wahoo	(7)	96	100	94	103	93	**97**
TT+CL	5	Hyola Enforcer CT	(6)	113	111	111	108	109	**110**
TT+LL	4.5	InVigor LT 4530P	(3)	112	112	107	109	107	**109**
AGZONE 3 MID Glyphosate tolerant GT and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		3.38	2.33	2.45	2.63	3.37	-
		Variety	No. trials	(1)	(2)	(2)	(3)	(3)	(11)
GT (TF)	4.5	InVigor R 4520P	(6)	118	119	112	116	111	**115**
GT (RR)	4	Pioneer 44Y30 RR	(3)	119	117	115	112	113	**114**
GT (TF)	4	Nuseed Raptor TF	(7)	113	110	110	107	106	**108**
GT (TF)	4	InVigor R 4022P	(6)	107	109	106	107	107	**107**
GT (RR)	4	Pioneer 44Y27 RR	(10)	108	106	108	102	106	**105**
GT (TF)	4.5	Hyola 410XX	(7)	100	99	101	98	100	**99**
GT (TF)	5	Nuseed Condor TF	(6)	115	114	111	111	108	**111**
GT (RR)	5	Pioneer 45Y28 RR	(6)	116	114	110	111	107	**111**
GT (RR)	5	Nuseed GT-53	(11)	108	105	106	103	103	**104**
GT (RR)	5.5	InVigor R 5520P	(11)	98	101	97	103	99	**100**
GT (TF)+CL	4	Hyola Garrison XC	(6)	105	103	104	102	102	**103**

Varieties grouped by herbicide tolerance type, then major maturity group, and listed in decreasing yield. Source: NVT Online, **nvt.grdc.com.au**

^ MID series NVT trials are sown in longer season environments (see Figure 1).

Varieties with only a single successful trial are not included.

Shaded cells indicate variety was not present in trials, value shown is predicted yield from MET analysis.

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

TABLE 12. Yield of canola varieties in AGZONE 5 MID^ series NVT, expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

AGZONE 3 MID Triazine tolerant (TT) and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		1.49	1.32	1.31	0.80	2.22	-
		Variety	No. trials	(1)	(1)	(1)	(1)	(1)	(5)
TT	3	HyTTec Trident	(3)	108	120	120	125	124	**119**
TT (OP)	3	ATR Stingray	(2)	97	91	92	90	90	**92**
TT	4	HyTTec Trophy	(4)	108	112	114	117	118	**114**
TT	4.5	Hyola Blazer TT	(2)	106	112	108	114	118	**112**
TT	4.5	InVigor T 4510	(5)	109	106	112	113	112	**110**
TT (OP)	4	ATR Bonito	(5)	99	91	94	92	91	**93**
TT	5	SF Dynatron TT	(2)	108	110	111	115	117	**112**
TT	5	SF Ignite TT	(4)	100	105	98	103	107	**103**
TT+CL	5	Hyola Enforcer CT	(2)	104	109	109	112	112	**109**

TABLE 13. Yield of canola varieties in AGZONE 6 MID^ series NVT, expressed as a percentage of site mean yield for each trial year (2016–2020), and the weighted average over the five-year period

AGZONE 6 MID Triazine tolerant (TT) and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		1.81	1.82	1.94	2.45	2.58	-
		Variety	No. trials	(1)	(4)	(2)	(3)	(3)	(13)
TT	3	HyTTec Trident	(3)	125	112	125	110	115	**115**
TT	4.5	Hyola Blazer TT	(3)	121	117	117	117	122	**118**
TT	4	HyTTec Trophy	(8)	119	113	120	112	116	**115**
TT	4	RGT Capacity TT	(2)	114	111	117	111	114	**113**
TT	4.5	InVigor T 4510	(13)	112	108	117	109	111	**111**
TT (OP)	4	ATR Bonito	(13)	91	96	93	97	95	**95**
TT (OP)	4	ATR Mako	(6)	92	94	89	93	92	**92**
TT	5	HyTTec Trifecta	(8)	125	118	124	117	122	**120**
TT	5	SF Ignite TT	(13)	110	111	104	111	114	**111**
TT	6	InVigor T 6010	(6)	111	112	109	113	115	**112**
TT (OP)	6	DG Murray TT	(3)	100	101	94	100	101	**100**
TT (OP)	6	ATR Wahoo	(6)	96	101	88	101	101	**99**
TT+CL	5	Hyola Enforcer CT	(5)	112	107	112	106	109	**108**
TT+LL	4.5	InVigor LT 4530P	(3)	107	106	112	107	108	**108**
AGZONE 6 MID Glyphosate tolerant GT and combinations									
Herbicide tolerance	Harvest maturity	Year		2016	2017	2018	2019	2020	2016–2020
		Site mean yield (t/ha)		2.00	2.10	2.52	2.57	2.74	-
		Variety	No. trials	(1)	(3)	(1)	(3)	(3)	(11)
GT (TF)	4.5	InVigor R 4520P	(6)	112	114	118	113	115	**114**
GT (RR)	4	Pioneer 44Y30 RR	(3)	113	111	119	111	113	**112**
GT (TF)	4	Nuseed Raptor TF	(6)	112	106	108	105	109	**107**
GT (TF)	4	InVigor R 4022P	(6)	104	106	111	106	106	**106**
GT (RR)	4	Pioneer 44Y27 RR	(7)	106	102	109	102	104	**104**
GT (TF)	4.5	Hyola 410XX	(6)	101	98	100	98	99	**99**
GT (RR)	5	Pioneer 45Y28 RR	(5)	112	110	110	109	112	**110**
GT (TF)	5	Nuseed Condor TF	(6)	112	109	112	108	111	**110**
GT (RR)	5	Nuseed GT-53	(11)	108	103	104	102	105	**104**
GT (RR)	5.5	InVigor R 5520P	(11)	96	103	100	103	101	**102**
GT (TF)+CL	3.5	Hyola Battalion XC	(2)	105	99	101	99	101	**100**
GT (TF)+CL	4	Hyola Garrison XC	(6)	105	102	102	101	103	**102**

Varieties grouped by herbicide tolerance type, then major maturity group, and listed in decreasing yield. Source: NVT Online, **nvt.grdc.com.au**

^ MID series NVT trials are sown in longer season environments (see Figure 1).

Varieties with only a single successful trial are not included.

Shaded cells indicate variety was not present in trials, value shown is predicted yield from MET analysis.

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

WA canola varieties grown in 2016–2021

The proportion of open pollinated (OP) TT canola has decreased in WA being replaced in part by GT varieties, which increased to a high of 37% of the total canola area in the 2021 season. Hybrid TT varieties have also increased in area, from 2% in 2017 to 23% in the 2021 growing season, at the expense of OP TT varieties. The area sown to Clearfield remains low at 3% and the area of various dual herbicide combinations (TT+GT, TT+CL, GT+CL) remains minor, at a total of 4% in 2021 (Table 14).

TABLE 14. Proportion (% area planned for sowing) of canola herbicide systems in WA (2016–2021)

Herbicide tolerance	2016	2017	2018	2019	2020	2021
TT OP	72	78	67	53	46	33
TT Hy	2	2	5	10	17	23
GT	23	18	26	34	32	37
CL	2	1	1	2	3	3
Combinations	2	1	1	1	3	4

Source: CBH Group

Different proportions of herbicide tolerant canola varieties are planted across WA port zones (Figure 2). The highest proportion of GT use is in the Geraldton port zone, which increased to 82% in the 2021 growing season. Contributing factors to this increase are the long history of wheat-lupin rotation in Geraldton port zone, leading to some triazine resistant weeds, the historically high proportion of cropping with higher reliance on grass selective sprays, and increased group A resistance, compared with southern mixed farming systems. Conversely, the proportion of TT crops increases from northern to southern port zones, with a low of 11% at Geraldton to a high of 86% at Esperance. Further, the use of hybrid TT varieties has increased in the higher rainfall zones of Albany and Esperance, with significant increases since 2017. For example, in the Esperance zone, 50% of the canola area was sown to hybrid TT varieties in the 2021 growing season.

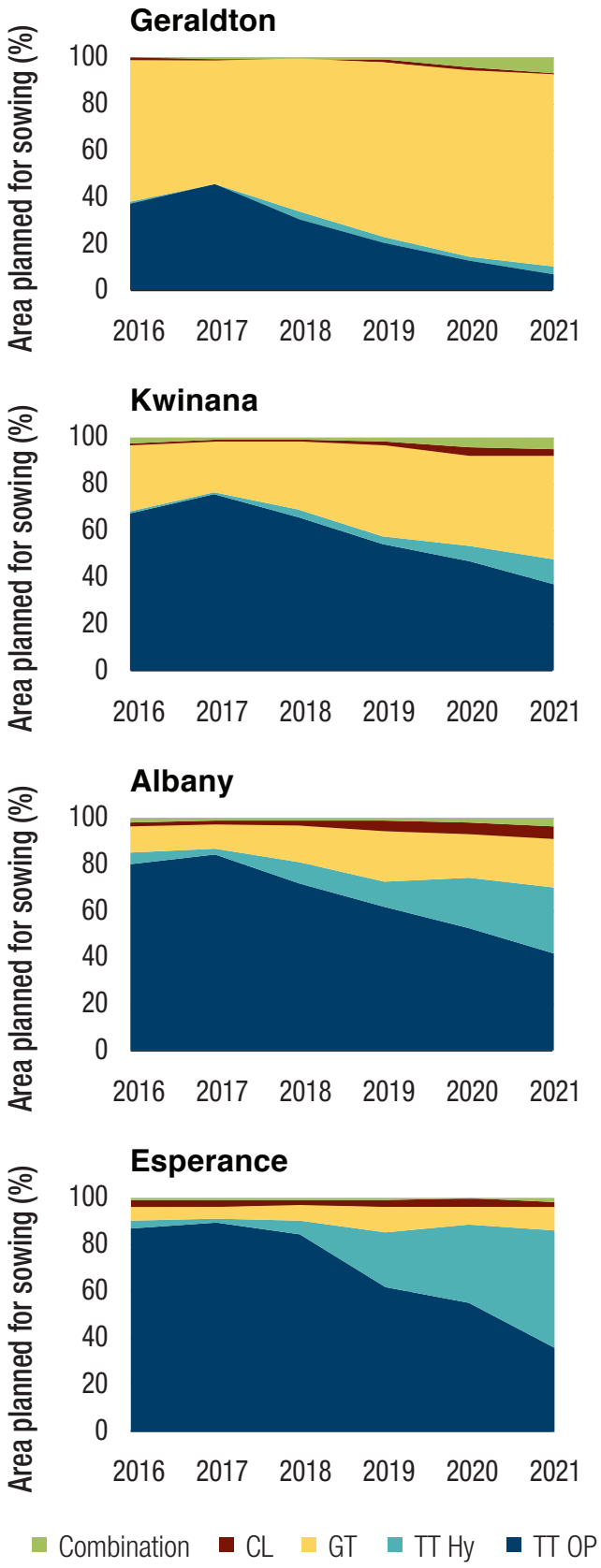

FIGURE 2. Proportion (% area) of canola herbicide systems in CBH port zones: Geraldton, Kwinana, Albany and Esperance

Source: CBH Group

Despite the reduction in area sown to OP canola, ATR Bonito remained the most widely grown canola variety in WA during 2021 at 26% of the total canola area. HyTTec Trident was the second most popular variety and increased in area quickly after its release in 2019 to reach 11% in 2021.

There has been a relatively quick adoption of the TruFlex® trait with five varieties sown over 0.5% of the total canola area, including the GT+CL combination varieties, Hyola 540XC and Hyola 530XC (Table 15).

The 28 canola varieties shown in Table 15 represent more than 94% of the total canola area. A further 49 canola varieties were grown in 2021 over the remaining 6% canola area.

TABLE 15. Proportion (% area) of canola varieties planned to be sown in WA (2016-2021)

Variety	Tolerance	2017	2018	2019	2020	2021
ATR Bonito	TT OP	54.5	53.0	39.1	34.6	26.4
HyTTec Trident	TT hybrid	-	-	-	5.2	11.3
Pioneer 44Y27 RR	GT (RR)	-	1.7	6.8	5.5	7.1
HyTTec Trophy	TT hybrid	-	0.0	2.3	5.9	5.6
Nuseed GT-53	GT (RR)	1.4	3.7	3.6	3.5	4.4
Pioneer 43Y29 RR	GT (RR)	-	-	3.1	3.4	3.6
ATR Stingray	TT OP	12.7	6.7	6.1	5.5	3.5
Pioneer 43Y23 RR	GT (RR)	5.4	7.9	7.4	4.8	3.2
Nuseed Raptor TF	GT (TF)	-	-	-	1.0	3.1
Hyola 404RR	GT (RR)	4.8	8.4	5.4	3.6	2.8
InVigor R 4022P	GT (TF)	-	-	-	0.8	2.7
Hyola 410XX	GT (TF)	-	-	1.0	2.5	2.6
Pioneer 45Y28 RR	GT (RR)	-	-	-	1.2	2.5
InVigor T 4510	TT hybrid	0.1	1.9	3.5	3.1	2.5
InVigor R 3520	GT (RR)	-	0.0	0.5	0.5	1.8
Hyola 540XC	GT+CL	-	-	-	1.0	1.7
DG 408RR	GT (RR)	-	0.3	2.8	2.8	1.3
HyTTec Trifecta	TT hybrid	-	-	-	0.3	1.2
ATR Mako	TT OP	2.5	2.7	3.5	2.1	1.1
Pioneer 44Y94 CL	CL	-	-	-	-	0.9
InVigor R 5520P	GT (RR)	0.1	0.6	1.0	0.9	0.8
AFP Cutubury	TT OP	-	0.0	0.2	0.5	0.7
Hyola 580CT	TT+CL	-	-	0.3	1.1	0.7
Hyola Enforcer CT	TT+CL	-	-	-	-	0.7
Pioneer 44Y90 CL	CL	0.1	0.8	1.2	0.9	0.6
Hyola 530XT	TT+GT	-	-	-	0.1	0.6
Pioneer 45Y93 CL	CL	-	-	0.1	0.9	0.6
Pioneer 43Y92 CL	CL	-	0.0	0.4	1.3	0.6

Varieties over 0.05% planned area sown in 2021 shown. Source: CBH Group

Canola seeding and establishment

Calculating canola seeding rate requires:

- Seed size, in seeds/kg (available from seed supplier)
- Germination % (available from seed supplier)
- Target density (see Table 16)
- An estimate of field establishment (FE) (see Table 17)

Seeding rate formula:

$$\text{Seed rate (kg/ha)} = \frac{\text{target density (plants/m}^2\text{) x 10,000}}{\text{FE (\%) x seeds per kg x germination (\%)}}$$

(Use the decimal format for FE and germination in manual calculations, for example 0.75) or use the online DPIRD seeding rate calculator at agric.wa.gov.au/n/4319

Target density

Optimum canola density varies with rainfall zone and canola type. In the medium rainfall zone the optimum density is 25–40 plants/m² for hybrid seed and 40–50 plants/m² for OP varieties. (Table 16). The optimum canola density is lower for hybrid seed than OP seed, largely due to the higher cost of hybrid seed.

TABLE 16. Optimum canola density (plants/m²) for WA rainfall zones

	Low rainfall	Medium rainfall	High rainfall
Hybrid	25-35	25-40	40-60
OP	30-40	40-50	50-70

Source: B French, M Seymour and R Malik (DPIRD)

Estimating field establishment

Field establishment (FE) relates to the proportion of viable seeds that emerge after sowing and varies with conditions at seeding and canola type. Hybrids generally have better establishment than open pollinated varieties. Under reasonable seeding conditions hybrid seed can be expected to achieve 65% field emergence while OP seed will likely achieve 50% field establishment (Table 17). DPIRD research has shown that seed size explains part of this difference as hybrid seed is often larger than OP seed. Seeding rates may need to be increased if seeding conditions are poor.

TABLE 17. Expected field establishment (%) for hybrid and open pollinated (OP) seed

	Seeding conditions			
	Excellent	Reasonable	Dry sown	Tough
Hybrid	80	65	60	< 45
OP	65	50	45	< 35

Seed size and seeding rates

Canola seed size varies with variety and season. Generally, hybrids have larger seed than OP varieties. The common range of canola seed sizes is shown in Table 18, along with example seeding rates for reasonable seeding conditions in the medium rainfall zone.

It is recommended that harvested OP seed be graded over a 2mm sieve to select large seed for seeding, even though large quantities of seed (>100t) may need to be graded. Note the increase in seeding rate with increasing seed size, which means OP seeding rates should be a minimum of 4.6kg/ha when seed is graded over a 2mm sieve.

TABLE 18. Hybrid and OP canola seeding rates for a range of seed sizes in the medium rainfall zone of WA

Seed size	Seeds/kg	Seeds/10cm	Seed size (mg)*	Seed diameter (mm)	Hybrid seeding rate** (kg/ha)	OP seeding rate*** (kg/ha)
Very small	350,000	61	2.9	1.6	1.4	2.7
Small	300,000	58	3.3	1.7	1.6	3.1
Medium	250,000	54	4	1.8	1.9	3.7
Large	200,000	50	5	2	2.4	4.6
Very large	150,000	46	6.7	2.2	3.2	6.2

*Seed size (mg) = one thousand seed weight (g).
**Hybrid seed target density 30 plants/m² and field establishment of 65%.
***Open pollinated (OP) target density 45 plants/m² and field establishment of 50%.
NOTE: a germination rate of 98% was used for both seed types.

Measure seed size in retained OP seed

Use the DPIRD guide at agric.wa.gov.au/n/4274 to estimate retained OP seed size by lining up seed along a 10cm ruler length.

Check field establishment

Check field establishment by counting all plants in a single one-metre row length. Do at least 10 counts at random over the paddock and calculate the average. Use the appropriate multiplication factor from Table 19 to convert from plants/m row to plants/m². For example, at 12-inch row spacing the multiplication factor is 3.3. If the average number of plants per metre of row is nine, then there are 30 plants/m² (3.3 x 9).

TABLE 19. Multiplication factors required to convert canola plants/m row to plants/m² for a range of row spacings

Row spacing (cm)	Row spacing (inches)	Multiplication factor	Plants/m row at 30 plants/m²
17.5	7	5.7	5.3
20.0	8	5.0	6.0
22.5	9	4.4	6.8
25.0	10	4.0	7.5
27.5	11	3.6	8.3
30.5	12	3.3	9.0
38.0	15	2.6	11.5

COMMERCIAL CANOLA SEED COMPANIES

Pacific Seeds

hyola.com.au

Steve Lamb +61 (0)429 619 103
Dan McGrath +61 (0) 448 014 892
Justin Kudnig +61 (0)408 408 616

Agronomy for Profit

Peter Norris +61 (0)428 850 850

BASF

myseed.com.au/canola

Michael Allingame +61 (0)437 454 283

Nuseed

nuseed.com.au

Andrew Suverijn +61 (0)409 484 702
Andrew Royce +61 (0)427 466 916
Michael Hickey +61 (0)438 913 106

Pioneer Brand Seeds

pioneerseeds.com.au

Peter Bostock +61 (0)427 549 826
Erinn McCartney +61 (0)400 557 076
Tony Munns +61 (0) 429 861 092
Rob Bagley +61 (0) 428 212 652
Owen Boxall +61 (0) 428 899 024

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

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

David Clegg +61 (0)408 630 641

Seed Force

seedforce.com

David Leah +61 (0)447 565 457

REGISTERED TRADEMARKS

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- Hyola® is registered trademark of Pacific Seeds Pty Limited.
- Clearfield®, InVigor® and Podguard® are registered trademarks of BASF Agricultural Solutions Seed US LLC.
- HyTTec® is a published trademark of Nuseed Pty Ltd.

Canola varieties with the registered trademarks of Hyola®, HyTTec® and InVigor® are presented in Table 2. Thereafter the trademark symbol has been omitted.

ABBREVIATIONS

CC	Conventional Canola
CL	Clearfield®
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

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- Growers who host the NVT trials and GRCD NVT service providers, Living Farm and Kalyx.
- The canola NVT oil data analysis was done by Andrew van Burgel, DPIRD.
- Blackleg information was reproduced from the GRDC Fact Sheet, 2020 Spring Blackleg Management Guide. Acknowledgement to the team at Marcroft Grains Pathology.
- Variety harvest maturity was provided from company fact sheets/technical notes or directly from company representatives. Company representatives were also cooperative in checking the document.

OATS

Introduction

Blakely Paynter, Georgie Troup, Helene Metzinger, and Kylie Chambers (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 1–12; Figures 1–7).

Many oat grain varieties are available for delivery into the Co-Operative Bulk Handling (CBH) system. CBH delivery grades 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 six 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 bulletin.

No new oat varieties (milling or hay) were released in 2021. Lines with milling potential are being evaluated in National Variety Trials (NVT), while the Australian Exporters Company (AEXCO) is evaluating hay-only lines for potential release in 2023.

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 2022 – WHAT SHOULD I GROW?

The popularity of Bannister continues to increase, and in 2020, Bannister was sown on the same area as Carrolup, Wandering and Williams combined (Figure 1). In 2021, Bannister increased to just under 50% of the area planted to oats suitable for delivery as grain (not shown). Growers reduced the area sown to Carrolup, Wandering and Williams to accommodate the increased planting of Bannister. There was a slight increase in Bilby plantings, while the Pallinup area remained stable at half that sown to Wandering.

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 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. For high disease-risk areas, the recently released hay-only variety Koorabup and the dual-purpose variety Williams are recommended. In other areas, the dual-purpose varieties Carrolup and Yallara are also suitable for export hay production.

Kingbale may have a fit for rotations where imidazolinone (IMI) residues exist.

Kingbale

- Kingbale is a single gene, IMI tolerant oat suitable for export hay.
- Kingbale has similar agronomic characteristics to the export-hay variety Wintaroo.
- Targeted for sowing into soil with IMI residues from previous crops and for Immediately Before Sowing (IBS) use with Sentry® (imazapic + imazapyr) herbicide.
- The Australian Pesticides and Veterinary Medicines Authority (APMVA) has approved the use of Sentry® for IBS use with Kingbale oats for seed and hay production. However, a grain registration is yet to be received.

Kingbale seed will be available from InterGrain's network of Seedclub members and resellers for planting in 2022, pending receipt of a grain registration. Farmer to farmer trading of Kingbale seed will not be allowed, as with IMI tolerant wheat and barley varieties.

More information is listed below and in the factsheets at the end of the oat section of this bulletin.

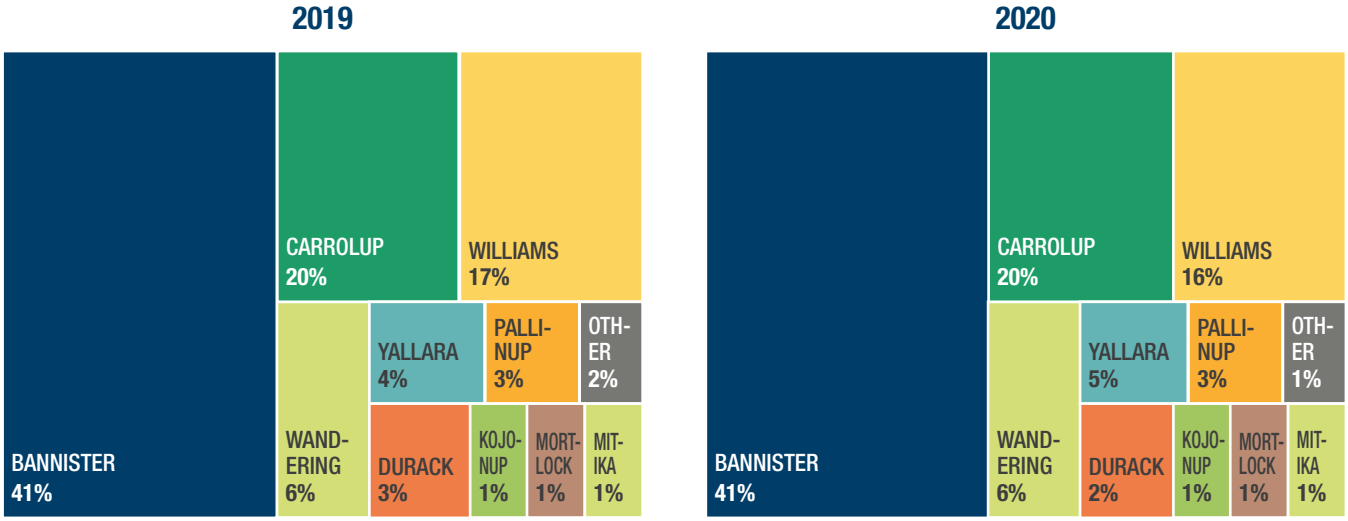

FIGURE 1. Popularity (per cent of oat area) of the top ten oat varieties plus the combined area sown to the other seven varieties delivered in WA in 2019 and 2020. The top ten varieties occupied 98% and 99% of the area planted to barley in 2019 and 2020, respectively, while the top five varieties occupied 88% and 92%, respectively.

Source: grower estimates as provided to CBH

TABLE 1. Suitability of oat varieties for grain (Oat1, Oat2, OWAN) and hay

Variety	Oat1	Oat2	OWAN	Hay
Bannister	✓	✓	-	✓
Bilby	✓	✓	-	-
Brusher	-	-	-	✓
Carrolup	✓	✓	-	✓
Durack	-	✓	-	✓
Forester	-	-	-	✓
Kangaroo	-	-	-	✓
Kingbale	-	-	-	✓
Kojonup	✓	✓	-	✓
Koorabup	-	-	-	✓
Kowari	✓	✓	-	-
Mitika	✓	✓	-	-
Mulgara	-	-	-	✓
Swan	-	-	-	✓
Tammar	-	-	-	✓
Tungoo	-	-	-	✓
Wandering	-	✓	✓	-
Williams	✓	✓	-	✓
Winjardie	-	-	-	✓
Wintaroo	-	-	-	✓
Yallara	✓	✓	-	✓

Source: GIWA and AEXCO

OTHER CONSIDERATIONS FOR OAT GROWERS

Changes in disease pathogens

No new disease pathotypes affecting oats have been detected in WA in recent years.

Early sowing reduces the risk of screenings

Early April sowing and variety selection are critical tools for meeting recently introduced Oat2 delivery standards for milling oats.

A screening limit introduced in 2019–2020 for 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 when and how much nitrogen (N) was applied.

TABLE 2. Summary of oat variety traits comparing six grain-oat varieties

Trait	Bannister	Carrolup	Durack	Wandering	Williams	Yallara
First year in variety trials in WA	2006	1993	2010	1997	2006	2003
State-wide MET yield (% site mean)[1]	112%	91%	89%	110%	109%	92%
Maturity relative to Carrolup (sown in late May)[2]	+3 days	-	-7 days	+1 days	+2 days	-2 days
Deliverable as	Oat1	Oat1	Oat2	Oat2	Oat1	Oat1
Suitable for export hay	Yes	Yes	Yes	No	Yes	Yes
Oat Septoria[3]	MSS	S	SVS	MSS	MS	MSS
Oat leaf rust	RMR	VS	MR	VS	MR	MR
Oat stem rust	MS	S	S	SVS	MSS	MSS
Barley and cereal yellow dwarf	MS	MSS	MSS	MS	MS	MS

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 (2016–2020). 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 determine 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 susceptle, MRMS = moderately resistant - moderately susceptible, MR = moderately resistant, RMR = resistant - moderately resistant, R = resistant, - = no data available

Tips for nitrogen fertiliser

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

If growing oats to deliver milling oat grain, the recommended N strategy is to apply one-third of the N fertiliser needed at seeding and two-thirds at 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.

As more N is applied to grain crops, the risk of high screenings and low hectolitre weight increases. The grain of Carrolup and Williams is more sensitive to increasing N than Bannister. 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 ten weeks after seeding. As with grain oats, late N can be applied as early as six weeks after sowing. To maximise quality, late N should be applied before stem elongation.

For hay crops, high rates of N can reduce hay quality through increased fibre production (both acid detergent fibre, ADF and neutral detergent fibre, NDF) and lower concentration of water-soluble carbohydrates (WSC). Excessive N application can also occasionally result in hay with nitrate-nitrogen levels greater than 500 ppm, which is unacceptable to many hay markets (AEXCO, aexco.com.au/producing-quality-oat-hay-chapters/)

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 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.

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:

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

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. If the crop ripens and dries evenly (to less than 12% moisture), direct harvesting is the most economical way to harvest oats for grain. If the oat crop is uneven in 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. Delaying harvest by three weeks reduced grain yield by 10% and, at six weeks, by 25%. All 12 varieties responded similarly to the harvest delay in that study for both grain yield and grain quality.

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 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. Where disease pressure is lower, or when 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 in Bannister but applying late fungicides is unreliable.

Using fungicides to protect hay quality in the swath

When applied using label recommendations, foliar fungicide application for in-crop disease control may provide some off-target benefit in reducing post-cutting colonisation and staining by saprophytic fungi.

Rainfall during the windrow curing process encourages the growth of saprophytic fungi, which feed on dead or decaying leaf tissue, causing hay discolouration. This, in turn, reduces hay visual quality. DPIRD, with the support of AgriFutures (project number PRJ-011029), has been examining the value of late-season fungicides on swath quality. The research suggests that foliar fungicides should be applied as needed for in-crop disease control and that effective disease control will influence hay quality through retained green leaf area. Fungicide (strobilurin and demethylation inhibitor, DMI) application can reduce saprophytic fungal colonisation of bleached (senescent) leaf material in the windrow but will not affect green leaf retention or hay nutritive quality parameters post-weathering. However, strobilurin chemistries have shown a higher and more consistent reduction in saprophytic growth than DMIs.

Please note: it is vital to avoid unnecessary fungicide applications and follow the label recommendations for rates and withholding periods to avoid chemical residues in the hay, which could jeopardise export hay markets.

Grain – yield and quality

Blakely Paynter (DPIRD)

GRAIN YIELD

The 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 as 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 (2016–2020) 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.

Agzones were developed by DPIRD through statistical analysis to group environmental regions with similar crop performance in WA.

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 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 for the period 2016 to 2020 helps explain the variability in relative varietal performance across seasons. While Agzones is 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 used 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. A quadratic polynomial was fitted to the data if the quadratic trend was significant ($p<0.05$). If the linear trend (but not the quadratic trend) was significant ($p<0.05$), a linear polynomial was fitted to the data. If neither the quadratic nor the linear trend was significant, the grain yield response of a variety was deemed to run parallel to the site-mean yield at the average deviation for that variety. It is worth noting that 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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		4.11	3.15	3.46	2.67	2.69	3.23
Variety	(No. trials)	(6)	(7)	(6)	(7)	(4)	(30)
Deliverable as Oat1							
Bannister	(30)	118	112	111	107	104	**111**
Bilby	(30)	105	106	104	106	107	**106**
Carrolup	(30)	91	91	92	88	86	**90**
Kojonup	(30)	105	102	97	90	88	**97**
Kowari	(30)	97	101	98	100	104	**100**
Mitika	(30)	94	98	94	95	100	**96**
Williams	(30)	111	109	110	106	96	**107**
Yallara	(30)	92	89	93	93	92	**92**
Deliverable as Oat2							
Durack	(30)	82	90	90	93	96	**90**
Wandering	(30)	118	105	107	107	110	**109**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		4.11	4.07	3.02	3.19	2.95	3.53
Variety	(No. trials)	(4)	(4)	(4)	(4)	(2)	(18)
Deliverable as Oat1							
Bannister	(18)	111	113	112	111	109	**111**
Bilby	(18)	101	101	102	101	106	**102**
Carrolup	(18)	95	99	96	99	88	**96**
Kojonup	(18)	97	107	102	108	94	**102**
Kowari	(18)	94	95	96	97	101	**96**
Mitika	(18)	91	93	93	96	96	**94**
Williams	(18)	108	115	113	109	105	**111**
Yallara	(18)	100	97	96	97	92	**97**
Deliverable as Oat2							
Durack	(18)	88	89	89	90	91	**89**
Wandering	(18)	115	106	107	107	109	**109**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		3.72	3.43	2.06	1.11	1.12	2.29
Variety	(No. trials)	(1)	(1)	(1)	(1)	(1)	(5)
Deliverable as Oat1							
Bannister	(5)	112	123	106	101	88	**106**
Bilby	(5)	104	109	106	101	124	**109**
Carrolup	(5)	90	86	86	90	56	**82**
Kojonup	(5)	96	110	82	73	55	**83**
Kowari	(5)	97	100	99	93	127	**103**
Mitika	(5)	93	97	92	86	117	**97**
Williams	(5)	107	107	107	107	66	**99**
Yallara	(5)	95	86	94	105	73	**91**
Deliverable as Oat2							
Durack	(5)	87	78	93	95	111	**93**
Wandering	(5)	116	125	108	109	106	**113**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		2.79	2.84	3.05	1.77	2.14	2.42
Variety	(No. trials)	(1)	(2)	(1)	(2)	(2)	(8)
Deliverable as Oat1							
Bannister	(8)	123	124	110	97	112	**112**
Bilby	(8)	106	109	104	104	106	**106**
Carrolup	(8)	90	87	91	88	88	**88**
Kojonup	(8)	105	108	92	78	95	**95**
Kowari	(8)	94	99	97	101	99	**99**
Mitika	(8)	89	94	92	95	94	**93**
Williams	(8)	123	117	111	100	106	**110**
Yallara	(8)	88	84	95	97	93	**91**
Deliverable as Oat2							
Durack	(8)	79	79	90	101	87	**88**
Wandering	(8)	113	115	108	101	116	**111**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		1.82	3.56	4.82	4.45	3.50	3.63
Variety	(No. trials)	(1)	(1)	(1)	(1)	(1)	(5)
Deliverable as Oat1							
Bannister	(5)	147	118	123	116	131	**127**
Bilby	(5)	112	106	102	106	113	**108**
Carrolup	(5)	91	95	97	92	86	**92**
Kojonup	(5)	135	115	112	108	123	**119**
Kowari	(5)	96	100	91	100	104	**98**
Mitika	(5)	88	98	88	97	99	**94**
Williams	(5)	156	118	123	111	125	**127**
Yallara	(5)	65	85	94	88	71	**81**
Deliverable as Oat2							
Durack	(5)	68	87	79	87	78	**80**
Wandering	(5)	96	101	114	109	106	**105**

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 (2016–2020), and the weighted average over the five-year period (where there are four or more observations)

Year		2016	2017	2018	2019	2020	2016–2020
Site mean yield (t/ha)		3.80	3.40	3.29	2.70	2.56	3.17
Variety	(No. trials)	(13)	(15)	(13)	(15)	(10)	(66)
Deliverable as Oat1							
Bannister	(66)	117	115	112	108	109	**112**
Bilby	(66)	104	105	104	104	108	**105**
Carrolup	(66)	92	93	93	92	85	**91**
Kojonup	(66)	103	105	99	96	94	**100**
Kowari	(66)	96	99	97	99	103	**99**
Mitika	(66)	92	96	93	96	99	**95**
Williams	(66)	112	112	112	107	102	**109**
Yallara	(66)	94	90	94	94	88	**92**
Deliverable as Oat2							
Durack	(66)	84	88	89	92	91	**89**
Wandering	(66)	116	108	108	107	110	**110**

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

TABLE 9. Direct comparisons between two varieties (yield difference compared using least significant difference, p=0.05, calculated using standard errors from single-site MET) – how many times (as a per cent) was variety A (comparator variety) lower-yielding, the same yield or higher-yielding than variety B (base variety) when sown together in WA oat NVT?

Variety A	Percentage of trials			Number of trials	Comparison years	Comparison
	Variety A is lower yielding than Variety B	Variety A and B yield the same	Variety A is higher yielding than Variety B			
Variety B: Bannister						
Bilby	74%	15%	11%	66	2016–2020	Bilby < Bannister
Carrolup	92%	5%	3%	66	2016–2020	Carrolup < Bannister
Durack	89%	3%	8%	66	2016–2020	Durack < Bannister
Kojonup	85%	14%	2%	66	2016–2020	Kojonup < Bannister
Kowari	86%	5%	9%	66	2016–2020	Kowari < Bannister
Mitika	89%	3%	8%	66	2016–2020	Mitika < Bannister
Wandering	39%	36%	24%	66	2016–2020	Wandering ≤ Bannister
Williams	44%	44%	12%	66	2016–2020	Williams ≤ Bannister
Yallara	85%	9%	6%	66	2016–2020	Yallara < Bannister
Variety B: Carrolup						
Bannister	3%	5%	92%	66	2016–2020	Bannister > Carrolup
Bilby	9%	9%	82%	66	2016–2020	Bilby > Carrolup
Durack	47%	29%	24%	66	2016–2020	Durack ≤ Carrolup
Kojonup	17%	18%	65%	66	2016–2020	Kojonup ≥ Carrolup
Kowari	17%	14%	70%	66	2016–2020	Kowari > Carrolup
Mitika	18%	33%	48%	66	2016–2020	Mitika ≥ Carrolup
Wandering	3%	14%	83%	66	2016–2020	Wandering > Carrolup
Williams	3%	6%	91%	66	2016–2020	Williams > Carrolup
Yallara	15%	42%	42%	66	2016–2020	Yallara ≥ Carrolup

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

The highest yielding oat varieties in WA are Bannister, Wandering, and Williams (Tables 3 to 8), although Wandering cannot be delivered into the Oat1 grade. Bannister and Williams have an advantage over Wandering above 3.5t/ha, while Wandering has an advantage below 1.5t/ha (Figure 2). Since 2016, Bannister has performed better than Williams in above 3t/ha environments and, but the same below 3t/ha (Figure 3), outyielding Williams in four out of every ten WA oat NVT (Table 9). Over the long-term (2012–2020), however, 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 (Figure 3). Kowari is mid-pack for yield potential between Carrolup and Bannister. Kowari was higher yielding than Carrolup in 70% of WA oat NVT since 2016 and lower yielding than Bannister in 85% of trials (Table 9).

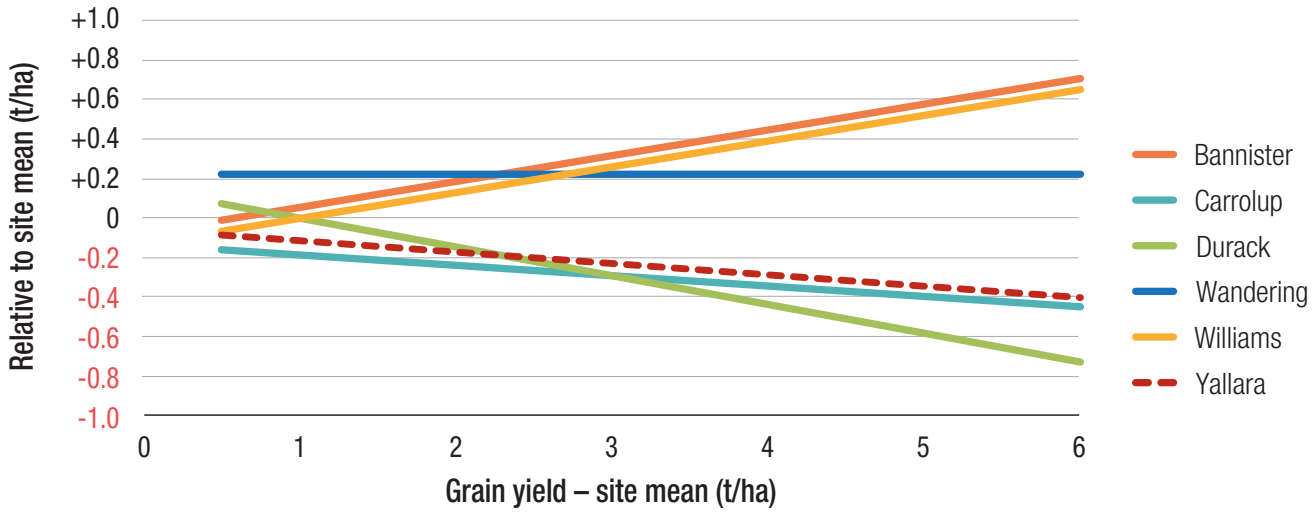

FIGURE 2. Fitted grain yield of Bannister, Carrolup, Durack, Wandering, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2012–2020). Each variety sown in all 100 trial-years of data, NVT Online, **nvtonline.com.au**.

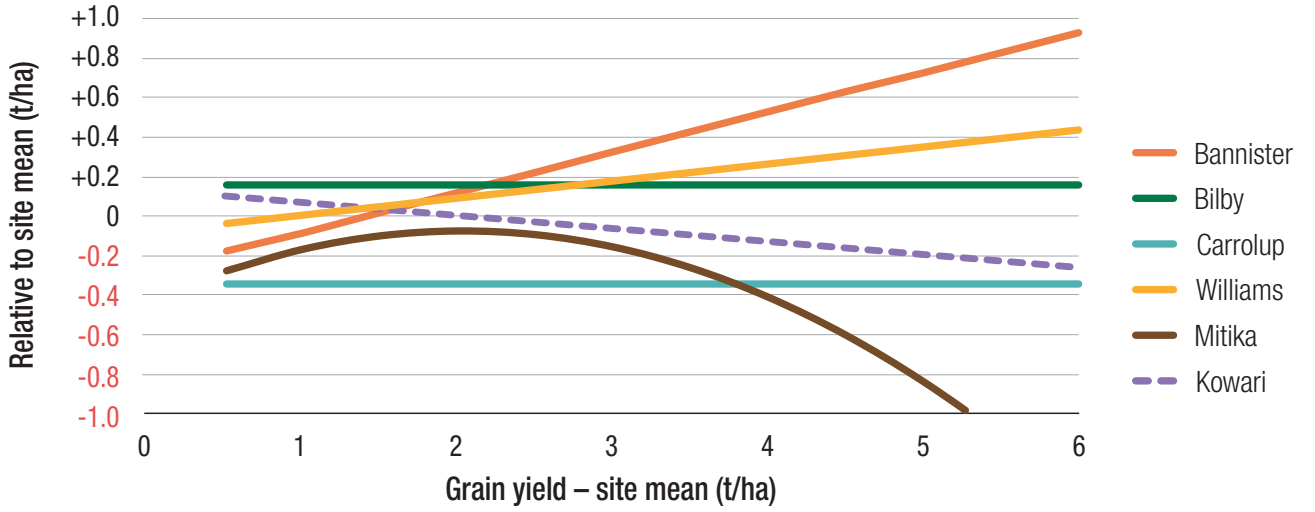

FIGURE 3. Fitted grain yield of Bannister, Bilby, Carrolup, Kowari, Mitika, and Williams at different site means.

Source: based on NVT statewide tables of yields and grain quality (2016–2020). 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 – including the hectolitre weight and percentage of screenings compared to known benchmark varieties. The 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 as the site mean increases in Figures 4 to 7. The deviation from the site mean was then 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 yield and grain quality tables available at nvtonline.com.au.

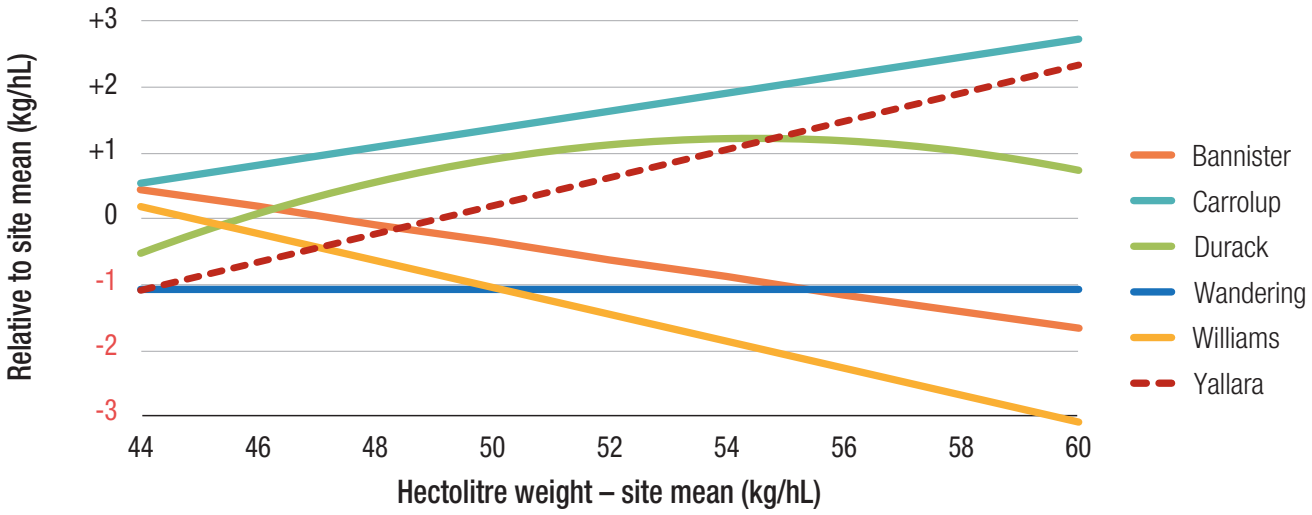

FIGURE 4. Fitted hectolitre weight of Bannister, Carrolup, Durack, Wandering, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2012–2020). Each variety sown in all 73 trial-years of data, NVT Online, nvtonline.com.au.

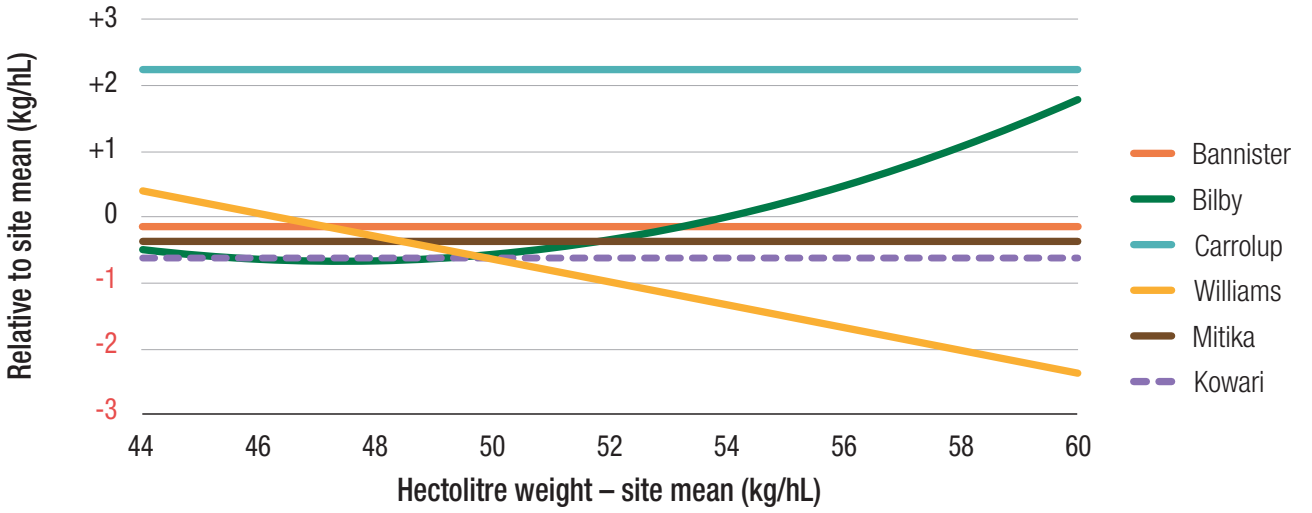

FIGURE 5. Fitted hectolitre weight of Bannister, Bilby, Carrolup, Kowari, Mitika, and Williams at different site means.

Source: based on NVT statewide tables of yields and grain quality (2016–2020). 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 85% of WA oat NVT (Table 9). Across 66 statewide NVT trials (2016–2020), Yallara averaged 82% of the yield of Bannister (Table 8).

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 a slight improvement over Williams (Figures 4 and 5). Bilby and Kowari, like Bannister, have inferior hectolitre weight relative to Carrolup (Figure 5).

The benchmark varieties for grain plumpness are Kowari, Mitika, 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 receival standards. Bannister is an improvement over Williams but is not as plump as Kowari, Mitika or Yallara. Bilby, Durack and Wandering have a slight plumpness advantage over Bannister.

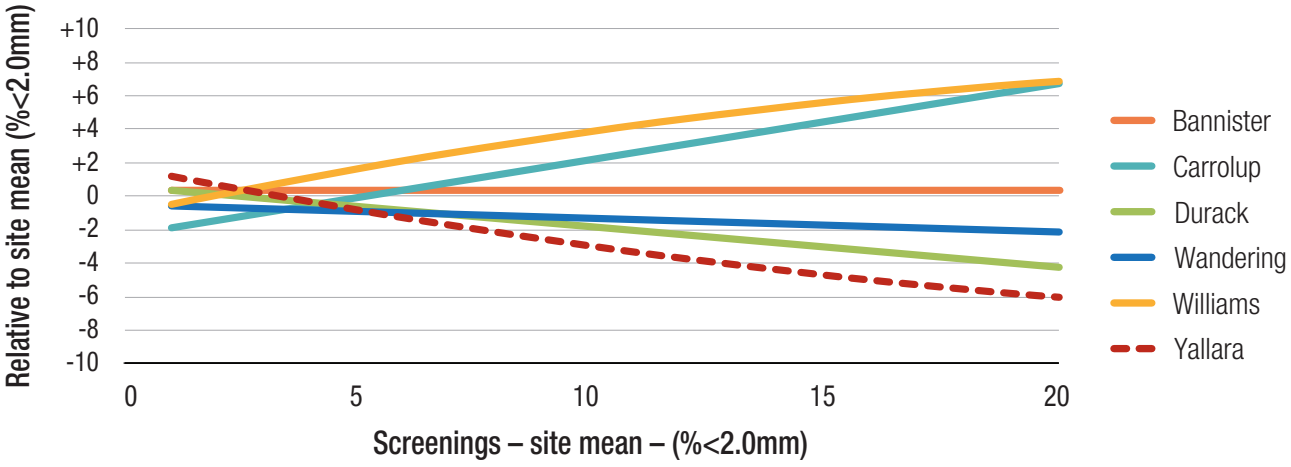

FIGURE 6. Fitted grain plumpness of Bannister, Carrolup, Durack, Wandering, Williams and Yallara at different site means.

Source: based on NVT statewide tables of yields and grain quality (2012–2020). Each variety sown in all 70 trial-years of data, NVT Online, **nvtonline.com.au**.

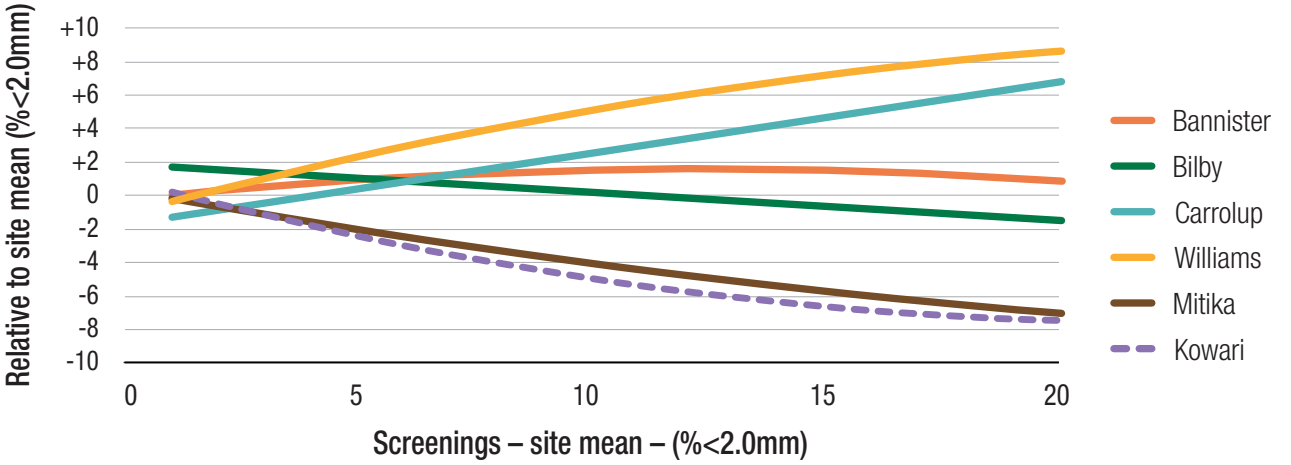

FIGURE 7. Fitted grain plumpness of Bannister, Bilby, Carrolup, Kowari, Mitika, and Williams at different site means.

Source: based on NVT statewide tables of yields and grain quality (2016–2020). Each variety sown in all 48 trial-years of data, NVT Online, **nvtonline.com.au**.

Hay – yield and quality

Blakely Paynter, Georgie Troup, and Helene Metzinger (DPIRD)

Until the end of 2020, the National Oat Breeding Program (NOBP) was responsible for developing and evaluating oat varieties for export hay. In 2021, the breeding program at the NOBP transitioned to the commercial cereal breeding company InterGrain. InterGrain will now be responsible for the national development of milling oat grain and export oaten hay varieties.

The NOBP coordinated about eight oaten hay variety trials each year, with two located in WA. Table 10 presents hay yield and quality comparisons for various varieties, some of which are also deliverable as milling oats and others that are only suitable as hay varieties. The quality measures predicted by near-infrared analysis (NIR) include digestibility, 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). InterGrain generated data will be included in the 2023 edition of the DPIRD crop sowing guide. The analysis in Table 10 does not include data from the 2020 season as it was not available when writing this bulletin.

TABLE 10. Average hay yield and hay quality (predicted by near-infrared analysis, NIR) in National Oat Breeding Program trials in WA from 2014 to 2019, except NDFDom30, which was done from 2017 to 2019

Variety	Hay yield (t/ha)	Digestibility (% dm)	WSC[1] (% dm)	ADF (% dm)	NDF (% dm)	NDFDom30 (% dm)
(No. trials)	(13)	(9)	(11)	(10)	(11)	(5)
Deliverable as Oat1						
Bannister	6.6	69.6	32.6	27.1	47.6	59.2
Bilby	-	-	-	-	-	-
Carrolup	6.3	66.9	31.7	28.8	49.0	55.4
Kojonup	-	-	-	-	-	-
Kowari	-	-	-	-	-	-
Mitika	-	-	-	-	-	-
Williams	6.3	67.3	30.7	28.5	49.6	56.1
Yallara	6.8	67.9	32.0	28.2	48.4	54.6
Deliverable as Oat2						
Durack	6.2	66.7	30.2	28.6	49.4	53.0
Wandering	6.8	69.0	32.9	27.3	48.0	58.4
Hay-only variety						
Brusher	7.2	68.4	32.8	28.0	48.2	57.0
Forester	6.4	70.3	34.2	28.1	46.3	-
Kingbale	-	-	-	-	-	-
Koorabup	6.5	67.1	29.1	29.0	50.8	56.0
Mulgara	6.7	68.1	31.7	28.1	48.7	58.5
Swan	7.2	66.5	30.7	29.1	50.4	52.7
Tammar	6.2	68.0	30.6	28.8	49.7	-
Tungoo	6.7	68.2	31.9	28.4	48.7	-
Winjardie	7.0	66.9	31.3	28.7	49.8	55.7
Wintaroo	7.1	67.4	30.6	29.0	50.0	56.6

Source: National Oat Breeding Program

[1]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, and - = no data available.

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

In NOBP trials, Brusher and Swan achieved the highest hay yield, about 0.4 to 1.0t/h more than the dual-purpose milling varieties Bannister, Carrolup, Durack, Wandering, Williams, and Yallara. Forester hay oat delivered the best overall hay quality, with high digestibility, high WSC, and low fibre (ADF and NDF). No data has been presented for Kingbale, but based on its breeding pedigree, it is likely to test similarly to Wintaroo. Wintaroo, presumably Kingbale too, requires close monitoring around cutting time as it tends to stay greener longer. It is crucial to monitor the stems as they tend to turn white while the top remains green. Before growing oats for export hay, it is essential to arrange a contract with an exporter.

Bannister hay was the best of the dual-purpose varieties, with improved digestibility, higher WSC and lower fibre 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. Carrolup and Williams are the preferred varieties for export hay of the dual-purpose varieties.

Cutting at or just before watery ripe (Z71) will achieve optimum yield and quality. However, there is a window of five to seven days after Z71 before hay quality starts to fall. The window provides growers' room so they or their contractor can cut on time. Rainfall events of 10mm or more post-cutting can drastically reduce quality.

Good colour and 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 doesn't 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.

The typical quality standards targeted to meet different export hay requirements in WA are outlined in Table 11. Premium grade one 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. Export hay requires the nil presence of toxic plants and double gees. Most processors have a limit of 1% by weight of broadleaf plants and 5% of other cereals/ryegrass/wild oats. There is zero-tolerance of foreign material, such as dirt, stones, sticks, insects, wool, wire and carcases in export hay.

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 is subjected to compulsory sampling and testing designed to ensure minimum risk of contamination by the bacterium (*Rathayibacter toxicus*) that causes 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.

A maximum of 10% disease-affected leaves is allowed by most processors. Check withholding periods on labels of all fungicides before use. 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 maximum residue limits (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

Disease and virus resistance data is presented in Table 12 and again in the variety snapshots. Leaf disease ratings in this guide are for adult-stage resistance ratings, and adult plant ratings are applicable 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. 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. For the hay-only varieties, Koorabup was the only hay variety screened by DPIRD in 2020. Limited data is available for the other hay-only varieties. In 2021, DPIRD began screening a selected number of hay-only varieties for NVT, including Brusher, Kingbale, Mulgara, Tungoo and Wintaroo. Updated resistance data applicable to WA for those varieties will appear in the 2023 edition of the DPIRD crop sowing guide.

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 2022 guide, there have been no significant changes in resistance scores due to a new pathotype.

PATHOTYPE SURVEILLANCE AND FUNGICIDE RESISTANCE

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 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 Shanker 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, contact Dr Will Cuddy via email at will.cuddy@dpi.nsw.gov.au or phone +61 (0)2 9351 8871.

OAT SEPTORIA

Oat Septoria begins as small dark-brown to purple, oval or elongated spots on leaves. Spots grow into larger light or dark-brown blotches with surrounding yellow areas that can cover and kill the entire leaf. Infection may spread to leaf sheaths and through these to stems, where greyish-brown or shiny black lesions may cause lodging. Dark-brown blotches can also occur on the head. In some varieties, the

fungus can sometimes cause a dark discolouration of the grain when unseasonably late rain occurs.

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 Western Australia. It occurs throughout the cereal growing areas and is most severe in the high rainfall areas. In extreme cases, Septoria may cause up to 50% yield loss and crop lodging, but losses of around 10% are more common in high rainfall areas. Tall or slow-maturing oats are less likely to be affected by the disease than short (dwarf) or fast-maturing varieties. Septoria reduces hay yield, quality, and appearance and is a significant constraint to hay production. Oat Septoria does not infect wheat, and wheat Septoria does not infect oats.

Most oat varieties are rated as MS or below to Septoria. Williams (MS) has the best resistance of the milling oat varieties, and Koorabup (MRMS) has the best resistance of the hay-only varieties (of those with resistance data presented).

OAT LEAF RUST (OLR)

OLR appears on leaves as small, circular to oval pustules, containing orange to yellow powdery spores. Under heavy infection, pustules can also occur on stems and heads. As the crop matures, pustules darken and produce black spores embedded in leaf tissue. The spore masses in the pustules are readily dislodged.

Leaf rust (*Puccinia coronata* var. *avenae*), also known as crown rust, causes losses of up to 50% in forage, hay and grain yield. It may also reduce forage and hay palatability. The word ‘crown’ refers to the shape of spores produced by this fungus, not the disease symptoms. Leaf rust develops most rapidly in temperatures of 15–22°C under moist conditions. OLR does not infect wheat, and wheat leaf rust does not infect oats.

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.

OAT STEM RUST (OSR)

OSR appears as elongated pustules containing reddish-brown powdery spores, mainly on stems and potentially on the leaves and head in heavy infections. The spore masses in the pustules can dislodge readily.

Stem rust (*Puccinia graminis* f.sp. *avenae*) is a fungal foliar disease of oats that can cause up to 90% yield loss and reduce grain quality in susceptible varieties. It reduces hay yield, quality and appearance. Widespread outbreaks are very damaging but rare, and regional outbreaks are more common, causing losses over limited areas. 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 stem rust 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.

Milling oat varieties are rated as MS or below to OSR. Varieties with the best resistance are the hay-only varieties Mulgara (MRMS) and Wintaroo (MR). The performance of other hay-only varieties is unknown at this stage.

RED LEATHER LEAF (RLL)

RLL appears as small, pale blue coloured lesions with a red/red-brown edge, typically during the tillering stages. 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 (*Spermospora avenae*) has not been detected or confirmed in WA. RLL suspected samples should be sent to DPIRD Diagnostic Laboratory Services (DDLS) marked Grain Guard. For more information about plant disease testing, sample submission forms and sampling techniques, contact DDLS via email at **DDLS@dpird.wa.gov.au** or phone +61 (0)8 9368 3533.

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. Whiteheads are not observed in oats. The browning at the base of infected tillers is the most reliable indicator of crown rot in oats.

Seed dressings are registered to suppress crown rot. However, there are no fungicide options

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.

Research in Western Australia 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 oats observed an average yield loss to crown rot of 4% in milling oats. No differences in tolerance were observed among the oat varieties evaluated.

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 on plant growth but does not reduce 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 they 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/CYD, except Brusher (MRMS).

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*) in 29% of paddocks. Nematode populations potentially limit the yield of barley and wheat in at least 54% of infested paddocks. Yield loss in oat crops has not been tested.

Oat variety resistance trials are underway in WA. DPIRD, with GRDC investment, commenced screening a select number of oat varieties for their resistance to *P. neglectus* and *P. quasitereoides* in 2021. Provisional resistance data relevant to Western Australia for those select varieties will appear in the 2023 edition of the DPIRD crop sowing guide. In general, oats are more resistant than wheat to *P. neglectus* and more susceptible than wheat to *P. quasitereoides*.

CEREAL CYST NEMATODE (CCN)

Cereal cyst nematode (CCN, *Heterodea avenae*) is present in cropping regions around Geraldton and the Avon Valley around Northam, but it can occur sporadically across the WA wheatbelt. CCN is not a significant constraint to oaten hay production in WA because of the short growing season. However, CCN numbers can build up in the crop to threaten subsequent cereal crops.

Unlike barley, oat varieties do not tolerate CCN, and some yield loss can be expected when infection occurs. CCN resistance and tolerance ratings sourced from SARDI indicate that Bannister and Durack have the best tolerance to CCN of the milling oat varieties. At the same time, Mulgara, Tammar, Tungoo and Wintaroo are moderately tolerant among the hay-only varieties (Table 12).

The planting of CCN-resistant oat varieties retards nematode development, leading to lower nematode levels in the soil for subsequent crops. The milling oat varieties, Bannister, Durack, and Yallara, retard CCN numbers. Among the hay-only varieties, Brusher, Mulgara, Tammar, Tungoo and Wintaroo retard CCN numbers.

TABLE 12. Oat leaf disease, virus and nematode resistance profiles when grown in WA

Disease[1]	Oat septoria	Oat leaf rust	Oat stem rust	Barley and cereal yellow dwarf[4]	CCN resistance	CCN tolerance
Pathotype[2]	Mixed	0001-2 [4,7]	94-1,2,4	–	–	–
Growth stage[3]	Adult	Adult	Adult	Seedling and Adult	Seedling and Adult	Seedling and Adult
Deliverable as Oat1						
Bannister	MSS	RMR	MS	MS	R	MI
Bilby	S	MR	S	MS*p*	S	-
Carrolup	S	VS	S	MSS	S	I
Kojonup	SVS	SVS	MSS	MS	VS	I
Kowari	SVS	R	S	MSS	S	-
Mitika	SVS	MR	S	S	VS	I
Williams	MS	MR	MSS	MS	S	I
Yallara	MSS	MR	MSS	MS	R	I
Deliverable as Oat2						
Durack	SVS	MR	S	MSS	R	MI
Wandering	MSS	VS	SVS	MS	VS	I
Hay-only variety						
Brusher	SVS	-	-	MRMS	R	MI
Forester	MSS	-	-	MS	MS	MI
Kingbale	-	-	-	-	R*p*	-
Koorabup	MRMS	MRMS	MSS	MSS	S	-
Mulgara	-	MR	MRMS	MSS	R	MT
Swan	-	-	-	-	MR	I
Tammar	-	-	-	-	MR	MT
Tungoo	-	-	-	-	R	MT
Winjardie	SVS	SVS	-	MSS	S	I
Wintaroo	MSS	SVS	MR	MS	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, and - = 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.

Variety snapshots

Blakely Paynter and Georgie Troup (DPIRD)

Variety snapshots are presented for:

- seven dual-purpose varieties (Bannister, Carrolup, Durack, Kojonup, Wandering, Williams, and Yallara) that are 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.
- ten hay-only varieties (Brusher, Forester, Kingbale, Koorabup, Mulgara, Swan, Tammar, Tungoo, 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 their 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 in the period 2016 to 2020. 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).

Disease and nematode resistance ratings are sourced from Table 12 and presented for the adult growth stages of the plant (if known). DPIRD collects disease resistance data for grain varieties under a service agreement with GRDC for the NVT system. Disease data for the hay varieties (except Koorabup) supplied by the NOBP.

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/**). 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 v7.0.4.1. 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).

Agronomic traits are tabulated based on published data generated by NOBP in their annual newsletters (**pir.sa.gov.au/research/research_specialties/crop_sciences/crop_improvement**), data collected by DPIRD, research findings from the DPIRD-GRDC co-funded projects DAW00107, DAW00227, and DAW1901-002RTX and in some cases, directly from the breeder. Data presented includes:

- Plant type is based on the genetic background of the variety. Data sourced from NOBP.
- Coleoptile and coleoptile + mesocotyl length. Short = 40–60mm, medium = 60–80mm, long = 80–100mm, very long = 100–120mm, and extremely long = >120mm. Oat seedlings emerge by elongation of the mesocotyl and coleoptile (in wheat and barley, it is only through elongation of the coleoptile) so oats can safely be sown deeper than wheat and barley. The coleoptile and mesocotyl length were measured after germinating seeds in rolled, moistened filter paper for 15 days at 15°C in the dark. DPIRD collected data.
- Hull lignin ratings are based on data published by NOBP. Hull lignin is an empirical phloroglucinol test where colour develops or does not. 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(ф)

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 NOBP trials with improved hay yield. While its hay yields are lower than Brusher, hay quality in NOBP trials were comparable. Bannister is the most widely sown oat variety in WA, occupying two in every five oat-ha.

Grain yield (% Carrolup)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	130	123	121	122	121
Agzone 3	117	114	117	112	124
Agzone 4	124	143	123	112	157
Agzone 5	137	143	121	110	127
Agzone 6	162	124	127	126	152
State-wide	127	124	120	117	128
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	RMR				
Stem rust	MS				
BYD and CYD	MS				
'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	+2	+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	+0	+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)	$2.30				

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 one in every five oat-ha.

Grain yield (% Bannister)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	77	81	83	82	83
Agzone 3	86	88	86	89	81
Agzone 4	80	70	81	89	64
Agzone 5	73	70	83	91	79
Agzone 6	62	81	79	79	66
State-wide	79	81	83	85	78
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	VS				
Stem rust	S				
BYD and CYD	MSS				
'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	-2	-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)	No EPR payable				

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. Dual purpose (milling grain and hay) variety. 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 leaf rust. 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 occupying about 1% of the planted area to oats.

Grain yield (% Bannister)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	89	91	87	84	85
Agzone 3	87	95	91	97	86
Agzone 4	86	89	77	72	63
Agzone 5	85	87	84	80	85
Agzone 6	92	97	91	93	94
State-wide	88	91	88	89	86
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	SVS				
Stem rust	MSS				
BYD and CYD	MS				
'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)	$2.25				

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 the best overall foliar disease resistance of milling and dual-purpose varieties, slightly better than Yallara to oat Septoria. 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 water-soluble carbohydrates 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 one in every six oat-ha.

Grain yield (% Bannister)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	94	97	99	99	92
Agzone 3	97	102	101	98	96
Agzone 4	96	87	101	106	75
Agzone 5	100	94	101	103	95
Agzone 6	106	100	100	96	95
State-wide	96	97	100	99	94
Disease resistance	**Rating**				
Septoria	MS				
Leaf rust	MR				
Stem rust	MSS				
BYD and CYD	MS				
'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	Barenbrug				
EPR ($/t, excl GST)	$2.30				

YALLARA(þ)

OAT1 GRAIN AND HAY VARIETY

Comments

Yallara (tested as SV97001-13-4) is a medium spring, mid-tall milling oat variety suitable for export hay. Grain yields are similar to Carrolup, with improved disease resistance. Yallara grain has a slightly lower hectolitre weight than Carrolup grain but improved grain plumpness (lower screenings). Yallara has bright grain and high grain digestibility, making it suitable for the horse racing industry. 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 stem rust, with good resistance to leaf rust. Yallara is the fifth most popular oat variety in WA, occupying 5% of the area sown to oats.

Grain yield (% Bannister)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	78	79	84	87	88
Agzone 3	90	86	86	87	84
Agzone 4	85	70	89	104	83
Agzone 5	72	68	86	100	83
Agzone 6	44	72	76	76	54
State-wide	80	78	84	87	81
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	MR				
Stem rust	MSS				
BYD and CYD	MS				
'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)	$2.00				

DURACK(þ)

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 stem rust. Durack was the seventh most popular oat variety in 2020 but occupying only 2% of the area sown to oats.

Grain yield (% Bannister)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	69	80	81	87	92
Agzone 3	79	79	79	81	83
Agzone 4	78	63	88	94	126
Agzone 5	64	64	82	104	78
Agzone 6	46	74	64	75	60
State-wide	72	77	79	85	83
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	MR				
Stem rust	S				
BYD and CYD	MSS				
'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)	$2.30				

WANDERING

OAT2 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 susceptible to leaf rust and stem rust. Wandering is the fourth most popular oat variety, occupying 6% of the area sown to oats in 2019 and 2020.

Grain yield (% Bannister)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	100	94	96	100	106
Agzone 3	104	94	96	96	100
Agzone 4	104	102	102	108	120
Agzone 5	92	93	98	104	104
Agzone 6	65	86	93	94	81
State-wide	99	94	96	99	101
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	VS				
Stem rust	SVS				
BYD and CYD	MS				
'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)	No EPR payable				

BILBY(ɬ)

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. Bilby has high ß-glucan and lower oil than other dwarf varieties with bright grain. Bilby is susceptible to oat Septoria and stem rust. Bilby occupies less than 1% of the area sown to oats and is not expected to grow in popularity.

Grain yield (% Bannister)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	89	95	94	99	103
Agzone 3	91	89	91	91	97
Agzone 4	93	89	100	100	141
Agzone 5	86	88	95	107	95
Agzone 6	76	90	83	91	86
State-wide	89	91	93	96	99
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	MR				
Stem rust	S				
BYD and CYD	MSS*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	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)	$2.50				

KOWARI(b)

OAT1 GRAIN VARIETY

Comments

Kowari (tested as SV03198-18) is a medium spring, medium height milling oat variety not suitable for export hay. Kowari is an alternate to Bilby, but with lower yield potential, similar hectolitre weight and improved grain plumpness (lower screenings). Kowari 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 of their products as it has a higher level of grain ß-glucan. Kowari is susceptible to oat Septoria and stem rust. Kowari grain has low hull lignin, which improves feed grain quality. Kowari occupies less than 0.5% of the area sown to oats.

Grain yield (% Bannister)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	82	90	88	93	100
Agzone 3	85	84	86	87	93
Agzone 4	87	81	93	92	144
Agzone 5	76	80	88	104	88
Agzone 6	65	85	74	86	79
State-wide	82	86	87	92	94
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	R				
Stem rust	S				
BYD and CYD	MSS				
'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	Mitika/WAOAT2099				
Breeder / Seed licensee	SARDI / Barenbrug				
Access to seed	Barenbrug				
EPR ($/t, excl GST)	$2.50				

MITIKA(b)

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 stem rust. Mitika has improved feed quality due to low husk lignin and high grain digestibility. Mitika is a minor variety occupying less than 1% of the area planted to oats.

Grain yield (% Bannister)	2016	2017	2018	2019	2020
Agzone 1	-	-	-	-	-
Agzone 2	80	88	85	89	96
Agzone 3	82	82	83	86	88
Agzone 4	83	79	87	85	133
Agzone 5	72	76	84	98	84
Agzone 6	60	83	72	84	76
State-wide	79	83	83	89	91
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	MR				
Stem rust	S				
BYD and CYD	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	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)	$2.00				

BRUSHER(ϕ)

HAY VARIETY

Comments

Brusher (tested as SV87103-109) is a tall, medium spring hay 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 Wintaroo with thinner stems and lower fibre levels. It also has improved digestibility, metabolisable energy and water-soluble carbohydrates than Wintaroo. Brusher has improved hay yield and quality relative to Carrolup and is the most widely sown hay-only variety cut for export hay. Brusher is susceptible to oat Septoria and suitable for sowing in lower rainfall areas. Specialist hay varieties require more 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)	7.2	6.3
Digestibility (% dm)	68.4	66.9
WSC (% dm)	32.8	31.7
ADF (% dm)	28.0	28.8
NDF (% dm)	48.2	49.0
NDFDom30 (% dm)	57.0	55.4

Disease resistance	Rating
Septoria	SVS
Leaf rust	-
Stem rust	-
BYD and CYD	MRMS

'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)	$2.00

FORESTER(ϕ)

HAY VARIETY

Comments

Forester (tested as SV97200-3) is a tall, very late spring hay 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. 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)	6.4	6.3
Digestibility (% dm)	70.3	66.9
WSC (% dm)	34.2	31.7
ADF (% dm)	28.1	28.8
NDF (% dm)	46.3	49.0
NDFDom30 (% dm)	-	55.4

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

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+35	+32	+28	+27	+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	+30	+26	+25	+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	OT285/OX92;056-4
Breeder / Seed licensee	SARDI / AEXCO
Access to seed	AEXCO seed distributor
EPR ($/t, excl GST)	$2.00

KINGBALE(ϕ)

HAY VARIETY

Comments

Kingbale (tested as GIA17010-I) is a single gene, imidazolinone (IMI) tolerant, hay oat variety. Preliminary data shows Kingbale has a similar agronomic and disease profile to Wintaroo. Kingbale was developed through mutation breeding from Wintaroo by Grains Innovation Australia (GIA). InterGrain are 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 have registered the Sentry® herbicide for pre-plant incorporation by seeding (IBS) for seed and hay, although there is currently no registration for use in grain. Kingbale cannot be sprayed post-emergent with an IMI herbicide. If the Sentry® application for on-farm grain use is approved, Kingbale seed will be available from InterGrain's network of Seedclub members and resellers for planting in 2022. Farmer to farmer trading of Kingbale seed will not be allowed, as with IMI tolerant wheat and barley varieties.

Hay yield and quality	Kingbale	Carrolup
Hay Yield (t/ha)	-	6.3
Digestibility (% dm)	-	66.9
WSC (% dm)	-	31.7
ADF (% dm)	-	28.8
NDF (% dm)	-	49.0
NDFDom30 (% dm)	-	55.4

Disease resistance	Rating
Septoria	-
Leaf rust	-
Stem rust	-
BYD and CYD	-

'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)	$3.65

KOORABUP(ϕ)

HAY VARIETY

Comments

Koorabup (tested as 05096-32) is a new medium spring, hay 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 Septoria resistance. It has a comparable grain yield to Carrolup, allowing ease of bulk-up for next year's hay crop. Koorabup hay yields are lower than Brusher and Wintaroo and close to Mulgara. It has better lodging and shattering resistance than Wintaroo and Brusher and is similar to Mulgara.

Hay yield and quality	Koorabup	Carrolup
Hay Yield (t/ha)	6.5	6.3
Digestibility (% dm)	67.1	66.9
WSC (% dm)	29.1	31.7
ADF (% dm)	29.0	28.8
NDF (% dm)	50.8	49.0
NDFDom30 (% dm)	56.0	55.4

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

'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	+5	+6

'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	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)	$2.00

MULGARA(Þ)

HAY VARIETY

Comments

Mulgara (tested as SV96025-7) is a tall, medium spring hay oat variety. Mulgara reaches watery ripe at a similar time to Brusher and about 3 days later than Carrolup across a range of sowing dates. Mulgara has excellent resistance to rust but a current resistance rating for oat Septoria is not available. It is an improvement compared to Wintaroo for lodging, shattering resistance and early vigour. Hay yield in NOBP trials was an improvement over Carrolup, but lower than Brusher. Hay digestibility is better than Carrolup but similar for water soluble carbohydrates and fibre. Mulgara has excellent hay colour and resists brown leaf tipping.

Hay yield and quality	Mulgara	Carrolup
Hay Yield (t/ha)	6.7	6.3
Digestibility (% dm)	68.1	66.9
WSC (% dm)	31.7	31.7
ADF (% dm)	28.1	28.8
NDF (% dm)	48.7	49.0
NDFDom30 (% dm)	58.5	55.4

Disease resistance	Rating
Septoria	-
Leaf rust	MR
Stem rust	MRMS
BYD and CYD	MSS

'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)	$2.00

SWAN

HAY VARIETY

Comments

Swan (tested as Oat 3) is a tall, medium spring, hay 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)	7.2	6.3
Digestibility (% dm)	66.5	66.9
WSC (% dm)	30.7	31.7
ADF (% dm)	29.1	28.8
NDF (% dm)	50.4	49.0
NDFDom30 (% dm)	52.7	55.4

Disease resistance	Rating
Septoria	-
Leaf rust	-
Stem rust	-
BYD and CYD	-

'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)	No EPR payable

TAMMAR

HAY VARIETY

Comments

Tammar (tested as SV96098-24) is a medium-tall, late hay oat variety. 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 NOBP trials were comparable to Carrolup, with improved digestibility but water-soluble carbohydrates. Tammar has excellent early vigour, lodging and shattering resistance.

Hay yield and quality	Tammar	Carrolup
Hay Yield (t/ha)	6.2	6.3
Digestibility (% dm)	68.0	66.9
WSC (% dm)	30.6	31.7
ADF (% dm)	28.8	28.8
NDF (% dm)	49.7	49.0
NDFDom30 (% dm)	-	55.4

Disease resistance	Rating
Septoria	-
Leaf rust	-
Stem rust	-
BYD and CYD	-

'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)	$2.00

TUNGOO

HAY VARIETY

Comments

Tungoo (tested as SV95137-6-3) is a medium-tall, late season hay oat variety. 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 NOBP trials were slightly above Carrolup, with improved digestibility and similar quality for water-soluble carbohydrates and fibre. Tungoo grain has low hull lignin, which improves feed grain quality.

Hay yield and quality	Tungoo	Carrolup
Hay Yield (t/ha)	6.7	6.3
Digestibility (% dm)	68.2	66.9
WSC (% dm)	31.9	31.7
ADF (% dm)	28.4	28.8
NDF (% dm)	48.7	49.0
NDFDom30 (% dm)	-	55.4

Disease resistance	Rating
Septoria	-
Leaf rust	-
Stem rust	-
BYD and CYD	-

'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	+8	+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	+6	+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)	$2.00

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)	7.0	6.3
Digestibility (% dm)	66.9	66.9
WSC (% dm)	31.3	31.7
ADF (% dm)	28.7	28.8
NDF (% dm)	49.8	49.0
NDFDom30 (% dm)	55.7	55.4

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

'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)	No EPR payable

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. While it is moderately resistant to stem rust, it is very susceptible to leaf rust. 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)	7.1	6.3
Digestibility (% dm)	67.4	66.9
WSC (% dm)	30.6	31.7
ADF (% dm)	29.0	28.8
NDF (% dm)	50.0	49.0
NDFDom30 (% dm)	56.6	55.4

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

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Carrolup				
	10-Apr	20-Apr	10-May	20-May	10-Jun
Northam	+7	+7	+7	+7	+6
Katanning	+7	+7	+7	+6	+7

'FlowerPower' predicted days to watery ripe (Z71)	Relative to Brusher				
	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	MIOLRP-86-3/Echidna//Wallaroo
Breeder / Seed licensee	SARDI / AEXCO
Access to seed	AEXCO seed distributor
EPR ($/t, excl GST)	$2.00

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Notes

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), 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 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. • PBA Bendoc x IMI herbicides increased interest. • 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 1.08 L/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.

WHAT IS NEW?

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 graze lupin stubbles with care in high-risk environments.

WHAT VARIETY SHOULD I GROW?

Besides looking for stable high yields, growers generally choose to grow 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 (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	3.15	1.95	2.53	1.03	1.40
No. of trials	(2)	(1)	(3)	(2)	(1)
Coromup	94	98	92	101	98
Coyote	103	108	107	113	117
Danja	71	89	-	-	-
Jenabillup	89	93	96	-	-
Mandelup	105	100	-	99	99
PBA Barlock	116	98	-	93	95
PBA Bateman	95	-	101	106	108
PBA Gunyidi	100	104	-	108	109
PBA Jurien	125	105	-	103	108
PBA Leeman	93	-	93	97	94
Tanjil	94	93	-	-	-
Wonga	-	-	-	77	74

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.

TABLE 2. Grain yield of narrow-leaf lupin varieties in AGZONE 2 expressed as percentage of site mean yield for each trial year (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	2.56	1.88	1.97	1.67	2.06
No. of trials	(6)	(6)	(5)	(7)	(5)
Coromup	95	96	94	101	92
Coyote	107	113	106	110	123
Danja	78	79	-	-	-
Jenabillup	92	90	95	-	-
Mandelup	102	100	-	100	99
PBA Barlock	107	100	-	96	99
PBA Bateman	100	-	100	104	111
PBA Gunyidi	103	107	-	106	111
PBA Jurien	115	110	-	105	113
PBA Leeman	94	-	95	97	90
Tanjil	93	89	-	-	-
Wonga	-	-	-	82	72

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.

TABLE 3. Grain yield of narrow-leaf lupin varieties in AGZONE 4 expressed as percentage of site mean yield for each trial year (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	2.20	1.11	2.19	0.68	1.46
No. of trials	(2)	(2)	(3)	(3)	(3)
Coromup	99	103	94	100	95
Coyote	98	104	102	112	119
Danja	84	98	-	-	-
Jenabillup	89	92	93	-	-
Mandelup	105	99	-	101	100
PBA Barlock	112	95	-	100	99
PBA Bateman	93	-	97	102	108
PBA Gunyidi	98	103	-	107	110
PBA Jurien	118	100	-	114	113
PBA Leeman	97	-	94	95	92
Tanjil	98	97	-	-	-
Wonga	-	-	-	75	74

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.

TABLE 4. Grain yield of narrow-leaf lupin varieties in AGZONE 5 expressed as percentage of site mean yield for each trial year (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	1.00	3.02	1.68	1.22	1.58
No. of trials	(2)	(1)	(1)	(1)	(2)
Coromup	100	99	98	99	95
Coyote	106	101	107	105	114
Danja	78	99	-	-	-
Jenabillup	82	101	87	-	-
Mandelup	103	100	-	100	100
PBA Barlock	106	100	-	100	99
PBA Bateman	98	-	100	102	107
PBA Gunyidi	103	100	-	102	107
PBA Jurien	118	99	-	104	109
PBA Leeman	95	-	-	98	93
Tanjil	92	99	-	-	-
Wonga	-	-	-	93	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.

TABLE 5. Grain yield of narrow leaf lupin varieties in AGZONE 6 expressed as percentage of site mean yield for each trial year (2017-2020)

Year	2017	2018	2019	2020
Site mean yield (t/ha)	1.85	1.13	1.98	2.16
No. of trials	(1)	(1)	(1)	(1)
Coromup	88	72	98	93
Coyote	117	138	108	120
Danja	77	-	-	-
Jenabillup	104	92	-	-
Mandelup	98	-	103	101
PBA Barlock	101	-	105	103
PBA Bateman	-	117	99	107
PBA Gunyidi	107	-	104	110
PBA Jurien	106	-	118	119
PBA Leeman	-	-	94	90
Tanjil	87	-	-	-
Wonga	-	-	80	72

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.

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*p*	MRMS	MR
Coyote	MR*p*	MS*p*	MR*p*	MRMS*p*	S*p*
Jenabillup	MS	MRMS	MRMS*p*	MR	MS
Mandelup	MRMS	MS	MRMS*p*	MS	RMR
PBA Barlock	RMR	MS	MR*p*	MR	MR
PBA Bateman	MRMS*p*	MS	MR*p*	MS	RMR
PBA Gunyidi	MRMS	MS	MS*p*	MRMS	RMR
PBA Jurien	RMR	MS	MS*p*	MR	RMR
PBA Leeman	MRMS	MS	-	MR*p*	RMR*p*
Tanjil	RMR	MS	MR*p*	MR	MR

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 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/m^2.
- Yields can decline below 40 plants/m^2.

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 (e.g. Atradex® WG) at 280–560g/ha.
- Carbetamide 900g/kg (e.g. Ultro® 900 WG) at 1.1–2.3kg/ha.
- Dimethenamid-P 720g/L (e.g. Outlook®) at 1L/ha.
- Diuron 900g/kg (e.g. Diurex® WG) at 1.1kg/ha. Do not use on white or grey sands.
- Fomesafen 240g/L (e.g. Reflex®) at 0.5–1.5L/ha.
- Metribuzin 750g/kg (e.g. Titan Metribuzin, Stacato®) 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 (e.g. Stomp®) at 1.5–2.25L/ha.
- Propyzamide 900g/kg (e.g. Edge® 900 WG) at 0.56–1.11kg/ha.
- Prosulfocarb 800g/L + s-metolachlor 120g/L (e.g. Boxer Gold®) at 2.5L/ha.
- Pyroxasulfone 850g/kg (e.g. Sakura®) at 118g/ha.
- Simazine 900g/kg (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 (e.g. Terbyne® Xtreme®) at 0.86–1.2kg/ha.
- Terbuthylazine 600g/kg + Propyzamide 300g/kg (e.g. Effigy® 900 WG) at 1.25–1.75kg/ha.
- Tri-allate 500g/L (e.g. Avadex® Xtra) at 1.6L/ha.
- Trifluralin 480g/L (e.g. TriflurX®) at 1.2–1.7L/ha.
- Trifluralin 350g/L + Tri-allate 550g/L (e.g. Jetti Duo®) at 1.45–1.8L/ha.

Post-sowing pre-emergent (PSPE) herbicides

- Diuron 900g/kg (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 (e.g. Reflex®) at 0.5–1.25L/ha.
- Simazine 900g/kg (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 (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 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 on deep-white or grey sands.
- Due to a different sub-group within Group C (5) 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 may 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 (e.g. Brodal® Options, Bonanza® Elite) at 100-200mL/ha. Apply from 2nd-leaf stage to big bud stage (before start of main stem flowers).
- Metosulam 100g/L (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 (e.g. Eclipse®) at 50mL/ha + diflufenican 500g/L (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 (e.g. Stacato®, Mentor® WG) at 100–150g/ha plus 100mL/ha Brodal® (diflufenican 500g/L). Apply to actively growing lupins from 3-4 leaves until bud emergence stage.
- Picolinafen 750g/kg (e.g. Conquest Glocker® 750 WG Herbicide) at 33–50g/ha. Apply at 2–6 leaf stage.
- Simazine 900g/kg (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 (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 (e.g. Select®, 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 (e.g. Di-Grass, 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 (e.g. Fusilade® Forte) at 410–820mL/ha. Apply up until 17 weeks before crop harvest.
- Haloxyfop-R 520g/L (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) or simazine as crop yellowing may occur — separate applications are recommended. Apply from 2nd-leaf to pre-flowering crop growth stages.
- Propaquizafop 100g/L (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 (e.g. Elantra® Xtreme®, 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, diflufenican and picinolinafen when radish has 2–6 leaves.
- Target radish smaller than 250mm in diameter with metribuzin.
- Use metosulam (e.g. Eclipse®) for controlling radish around 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) 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®) 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 alone, or in combination with other herbicides, may 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 advised not to apply metribuzin in mixture with other herbicides if brown leaf spot or other leaf diseases are present.

- Metosulam (e.g. Eclipse®) 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 advised not to apply such products in a tank mix with broadleaf herbicides as 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 (e.g. Gramoxone®, 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 flowering to soft dough stage.
- If the target lupin and ryegrass windows are not going to match up but weed control is your highest priority, you may need to sacrifice some lupin yield (which could be more than 25%) and 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 (e.g. Reglone®) is registered at 2-3L/ha as a pre-harvest desiccant at full crop maturity. It helps overcome slow and uneven crop ripening and weed problems at harvest.
- Saflufenacil 700g/kg (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) of the spray volume. 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 (page157), 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, 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 are 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 what type you choose to grow, 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 harder to sell than desi chickpea – seek advice from potential buyers before growing Kabuli's in WA.

Genesis 090 is the most readily available variety of kabuli 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)

WHAT IS NEW?

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 yielded more than Genesis 836, a current variety with a similar erect plant type. CBA Captain has achieved similar yields to PBA Striker, but CBA Captain 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. They found 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 (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	**1.52**	**0.62**	**1.42**	**1.01**	**1.55**
No. of trials	**(2)**	**(3)**	**(4)**	**(2)**	**(1)**
Desi type					
Ambar	99	90	97	-	-
CBA Captain	-	116	104	108	115
Genesis 836	96	95	97	100	96
Neelam	103	102	98	101	112
PBA Striker	105	103	104	108	115
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 (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	0.99	1.00	0.59	0.39	0.79
No. of trials	(1)	(1)	(1)	(1)	(2)
Desi type					
Ambar	91	105	96	-	-
CBA Captain	-	107	107	101	113
Genesis 836	90	95	102	97	94
Neelam	106	100	104	113	94
PBA Striker	93	108	96	116	108
Kabuli type					
Genesis 090	92	92	88	107	79

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 (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	1.82	0.53	1.41	0.80	1.25
No. of trials	(1)	(2)	(2)	(2)	(2)
Desi type					
Ambar	90	107	98	-	-
CBA Captain	-	124	104	117	117
Genesis 836	89	102	98	98	95
Neelam	105	117	102	102	108
PBA Striker	101	111	98	114	111
Kabuli type					
Genesis 090	-	61	98	71	78

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
Site mean yield (t/ha)	1.20
No. of trials	(1)
Desi type	
CBA Captain	116
Genesis 836	88
Neelam	94
PBA Striker	113
Kabuli type	
Genesis 090	83

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*p*
Genesis 836	MS	S	MRMS*p*
Neelam	S	S	MRMS
PBA Striker	S	S	MRMS
Kabuli type			
Genesis 090	R	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 last 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. Can be applied with compounds containing N (MAP, DAP, Agras etc) or as single superphosphate.

Target density

- Desi: 40–45 plants/m²
- Kabuli: 30–35 plants/m²

Recommended plant density provides better competition with weeds than lower densities and aids efficient harvest.

Seeding rate

- Desi between 90–110kg/ha.
- Kabuli between 130–150kg/ha. Reduce seeding rate in early-sown high rainfall crops to reduce disease.

Calculate seeding rate as seed size and germination vary considerably. Stored chickpea seed can lose viability, so it is important to determine the germination rate of your chickpea seed.

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 (e.g. Ultro® 900 WG) at 1.1kg/ha.
- Cyanazine 900g/kg (e.g. Bladex®) at 1.1kg/ha.
- Dimethenamid-P 720g/L (e.g. Outlook®) at 1L/ha.
- Diuron 900g/kg (e.g. Diurex® WG, not all brands) at 0.83–1.1kg/ha. Use the lower rate on light sandy soils.
- Flumioxazin 500g/kg (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 (e.g. Reflex®) at 0.5–1.5L/ha.
- Pendimethalin 440g/L (e.g. Stomp®) at 1.5–2.25L/ha.
- Propyzamide 900g/kg (e.g. Edge® 900 WG) at 0.56–1.11kg/ha.
- Prosulfocarb 800g/L + s-metolachlor 120g/L (e.g. Boxer Gold®) at 2.5L/ha.
- Pyroxasulfone 850g/kg (e.g. Sakura®) at 118g/ha.
- Simazine 900g/kg WG at 0.55–1.1kg/ha.
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.86–1.2kg/ha.
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.86–1.2kg/ha + Imazethapyr 700g/kg (e.g. Skipper® 700 WG) at 20g/ha.
- Terbuthylazine 750g/kg + Isoxaflutole 75g/kg (e.g. Palmero® TX) at 1kg/ha.
- Terbuthylazine 600g/kg + Propyzamide 300g/kg (e.g. Effigy® 900 WG) at 1.25–1.75kg/ha.
- Tri-allate 500g/L (e.g. Avadex® Xtra) at 1.6L/ha.
- Trifluralin 480g/L (e.g. TriflurX®) at 1.25–1.7L/ha + 1.1kg/ha Simazine 900 DF.
- Trifluralin 350g/L + Tri-allate 550g/L (e.g. Jetti Duo®) at 1.45–1.8L/ha.

Post-sowing pre-emergent (PSPE) herbicides

- Carbetamide 900g/kg (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 (e.g. Diurex® WG, not all brands) at 550–830g/ha. Use the lower rate on light sandy soils.
- Fomesafen 240g/L (e.g. Reflex®) at 0.5–1.25L/ha.
- Isoxaflutole 750g/kg (e.g. Balance®, Palmero®) at 100g/ha.
- Metribuzin 750g/kg (e.g. Mentor® WG, Stacato®) at 180–380g/ha.
- Simazine 900g/kg (e.g. Simagranz®) at 0.55–1.1kg/ha.
- Terbuthylazine 875g/kg (e.g. Terbyne®, Xtreme®) at 0.6–0.86kg/ha. Apply within two days of sowing.
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.6–0.86kg/ha + Imazethapyr 700g/kg (e.g. Skipper® 700 WG) at 20g/ha.
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.86kg/ha + Isoxaflutole 750g/kg (e.g. Boundary® 750 WG) at 80g/ha.
- Terbuthylazine 750g/kg + isoxaflutole 75g/kg (e.g. Palmero® TX) at 0.7–1kg/ha.

Post-emergent herbicides for broadleaf weed control

- Flumetsulam 800g/kg (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 other chemicals with it.

Post-emergent herbicides for grass weed control

- Butroxydim 250g/kg (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 (e.g. Select®, 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 (e.g. Fusilade Forte®) at 500mL/ha. Apply up until seven weeks before crop harvest.
- Haloxyfop-R 520g/L (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 (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 (e.g. Elantra® Xtreme®, 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

- Can be used as a harvest aid.
- Diquat 200g/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 (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 (e.g. Sharpen® WG) 34g/ha in mixture with recommended label rate of glyphosate or paraquat plus 1% Hasten® or high-quality methylated seed oil (MSO) of the spray volume. Apply when 80 to 85% of chickpea pods within crop have turned yellow-brown. Applications earlier than the recommended growth stage may 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, beans can tolerate transient waterlogging and mild frosts, but they 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.

WHAT IS NEW?

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) plus other registered products has a minor use permit for use on imidazolinone-tolerant faba bean varieties such as PBA Bendoc (Permit 8684) until 30 April 2022.

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 slightly lower disease ratings than PBA Samira. PBA Amberley is a suggested variety for high rainfall zones with high disease pressure.

Although PBA Warda and PBA Nasma achieved high yields in 2018 trials they are quite susceptible to ascochyta and should not be grown in southern regions, as it is likely seed will be stained and downgraded.

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 (2016–2020)

	Agzone 3		Agzone 5				
Year	**2017**	**2020**	**2016**	**2017**	**2018**	**2019**	**2020**
Site mean yield (t/ha)	**0.70**	**1.65**	**3.82**	**2.69**	**3.09**	**1.28**	**1.94**
No. of trials	**(1)**	**(1)**	**(1)**	**(2)**	**(1)**	**(1)**	**(1)**
Farah	97	102	90	94	96	97	98
Nura	100	97	90	95	94	97	101
PBA Amberley	93	108	104	102	100	106	96
PBA Bendoc	100	86	99	102	96	105	99
PBA Marne	118	92	105	101	103	92	116
PBA Rana	83	-	82	87	93	94	-
PBA Samira	93	109	98	100	99	102	95
PBA Zahra	95	88	94	99	99	102	92

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 buff	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	Chocolate spot resistance	Ascochyta blight	Rust resistance	*Pratylenchus neglectus* resistance#
Farah	S	S	VS	MR
Nura	MS	RMR	S	MR
PBA Amberley	MRMS	RMR	VS	MR
PBA Bendoc	S	MR	S	RMR*p*
PBA Marne	S	MRMS	MRMS	MR
PBA Rana	MS	MRMS	S	MR
PBA Samira	MS	RMR	S	MR
PBA Zahra	MS	MRMS	VS	MR

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 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

- Carbetamide 900g/kg (e.g. Ultro® 900 WG) at 1.1–1.7kg/ha.
- Cyanazine 900g/kg (e.g. Bladex®) at 1.1kg/ha.
- Diuron 900g/kg (e.g. Diurex® WG) at 0.83–1.1kg/ha. Use the lower rate on light sandy soils.
- Flumioxazin 500g/kg (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 (e.g. Reflex®) at 0.5-1.5L/ha.
- Pendimethalin 440g/L (e.g. Stomp®) at 1.5–2.25L/ha.
- Propyzamide 900g/kg (e.g. Edge® 900 WG) at 0.56–1.11kg/ha.
- Prosulfocarb 800g/L + s-metolachlor 120g/L (e.g. Boxer Gold®) at 2.5L/ha.
- Simazine 900g/kg (Simagranz®) at 1.1–1.4kg/ha (use the lower rate on light soils).
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.86–1.2kg/ha.
- Terbuthylazine 600g/kg + Propyzamide 300g/kg (e.g. Effigy® 900 WG) at 1.25-1.75kg/ha.
- Tri-allate 500g/L (e.g. Avadex® Xtra) at 1.6L/ha.
- Trifluralin 480g/L (e.g. TriflurX®) at 800mL/ha + 1.1 kg/ha Simazine 900 DF.

Post-sowing pre-emergent (PSPE) herbicides

- Diuron 900g/kg (e.g. Diurex® WG) at 550–830g/ha. Use the lower rate on light, sandy soils.
- Fomesafen 240g/L (e.g. Reflex®) at 0.5-1.25L/ha.
- Imazethapyr 700g/kg (e.g. Spinnaker® WDG) at 70g/ha.
- Metribuzin 750g/kg (e.g. Stacato®, 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 (Simagranz®) at 1.1–1.4kg/ha. Use the lower rate on light soils.
- Terbuthylazine 875g/kg (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 (e.g. Ecopar®) at 800mL/ha + BS1000® 0.2% (v/v). Apply when crop is at 3–5 leaf stage.
- Imazamox 700g/kg (e.g. Crop Care Claw®, 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 B herbicides including some sulfonylureas. There is a permit (PER86849) for use of imazamox 33g/L + imazapyr 15g/L (e.g. Nufarm Intercept®) at 750mL/ha on IMI-tolerant faba bean varieties such as PBA Bendoc. The permit is valid until 30 April 2022. Intercept® has efficiency on both grass and broadleaf weeds.

Post-emergent herbicides for grass weed control

- Butroxydim 250g/kg (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 (e.g. Select®, 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 (e.g. Fusilade Forte®) at 410mL/ha. Apply up until five weeks before crop harvest.
- Haloxyfop-R 520g/L (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 (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 (e.g. Elantra® Xtreme®, 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 quality beans for human consumption are to be produced. Spray if one or more grubs per 10 sweeps.
- Crops also need to be monitored for red-legged 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® (asoxystrobin + cyproconazole). or tebuconazole (refer PER13752).

Crop-topping

- Paraquat 250g/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 the majority 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 may occur (more than 25%) especially if the crop is less advanced relative to the ryegrass; that is, 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 (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 (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 in excess of 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 (e.g. Sharpen® WG) 34g/ha in mixture with label rate of glyphosate or paraquat + 1% Hasten® or high-quality methylated seed oil (MSO) of the spray volume. 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. Leave sheep in the paddock no longer than is necessary to recover the spilt grain to minimise risk of wind erosion.
- 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. A feature of field pea is the excellent weed control options available, which combined with delayed sowing and crop-topping, results in 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.

WHAT IS NEW?

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. Both have limited testing in WA. 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. It produces similar or slightly lower yields than PBA Butler in WA. PBA Taylor is lower yielding in Agzone 5 where boron and sodicity reduce its performance.

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, in recent times, PBA Butler produce superior results on-farm.

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 (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	1.99	0.60	1.48	1.18	3.10
No. of trials	(2)	(2)	(2)	(1)	(1)
GIA Kastar	-	-	-	-	60
GIA Ourstar	-	-	-	-	80
Kaspa	62	99	105	106	93
Parafield	67	74	75	-	-
PBA Butler	103	97	109	98	108
PBA Gunyah	80	98	104	103	96
PBA Oura	90	91	102	102	93
PBA Pearl	96	76	116	98	102
PBA Percy	95	112	99	108	81
PBA Taylor	110	117	106	105	96
PBA Twilight	70	91	100	104	91
PBA Wharton	89	101	99	105	91

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 (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	1.93	1.52	1.37	0.86	1.92
No. of trials	(2)	(3)	(2)	(1)	(1)
GIA Kastar	-	-	-	-	94
GIA Ourstar	-	-	-	-	85
Kaspa	57	99	95	101	99
Parafield	51	79	79	-	-
PBA Butler	111	103	125	108	107
PBA Gunyah	81	100	97	99	104
PBA Oura	90	93	79	86	103
PBA Pearl	106	90	99	84	114
PBA Percy	55	94	34	93	86
PBA Taylor	109	109	97	111	111
PBA Twilight	76	95	89	88	104
PBA Wharton	101	102	91	93	111

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 (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	0.46	1.65	1.1	2.14	2.04
No. of trials	(1)	(1)	(1)	(1)	(1)
GIA Kastar	-	-	-	-	70
GIA Ourstar	-	-	-	-	72
Kaspa	48	98	71	97	96
Parafield	33	69	81	82	-
PBA Butler	116	130	95	103	108
PBA Gunyah	79	96	85	99	98
PBA Oura	95	72	102	99	89
PBA Pearl	126	96	105	103	89
PBA Percy	42	60	122	108	74
PBA Taylor	110	103	107	107	105
PBA Twilight	77	73	80	93	95
PBA Wharton	106	71	92	96	101

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 (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	1.91	1.07	1.92	0.63	1.53
No. of trials	(1)	(1)	(1)	(1)	(1)
GIA Kastar	-	-	-	-	108
GIA Ourstar	-	-	-	-	80
Kaspa	57	101	114	96	109
Parafield	59	64	67	-	-
PBA Butler	99	101	106	123	110
PBA Gunyah	79	101	111	101	109
PBA Oura	93	91	103	80	102
PBA Pearl	94	80	109	95	114
PBA Percy	88	102	95	27	84
PBA Taylor	113	119	112	111	114
PBA Twilight	74	94	110	96	108
PBA Wharton	101	106	111	109	113

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 (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	1.70	1.58	1.28	0.71	1.22
No. of trials	(3)	(7)	(5)	(7)	(1)
GIA Kastar	-	-	-	-	86
GIA Ourstar	-	-	-	-	87
Kaspa	102	93	90	94	98
Parafield	83	84	75	89	-
PBA Butler	110	106	92	103	107
PBA Gunyah	100	95	96	98	101
PBA Oura	92	91	96	103	101
PBA Pearl	102	94	79	112	113
PBA Percy	94	92	103	98	90
PBA Taylor	104	105	115	101	104
PBA Twilight	91	89	96	98	99
PBA Wharton	90	94	113	100	101

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 may 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 this 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 may 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 as well as to partially bury any cereal stubble, rocks and/or sticks present after sowing.
- Rolling can occur 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, such as doublegee, wild mustard and wild radish, as possible. For these reasons field pea should be sown into paddocks with cereal stubbles and the weeds primarily controlled pre-sowing.

Numerous herbicides are registered on field pea 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, etc.

Pre-seeding and incorporated by sowing (IBS) herbicides

- Carbetamide 900g/kg (e.g. Ultro® 900 WG) at 1.1–1.7kg/ha.
- Cyanazine 900g/kg (e.g. Bladex®) at 1.1kg/ha.
- Dimethenamid-P 720g/L (e.g. Outlook®) at 1L/ha.
- Diuron 900g/kg (e.g. Diurex® WG) at 0.83–1.1kg/ha. Use the lower rate on light sandy soils.
- Flumioxazin 500g/kg (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 (e.g. Reflex®) at 0.5–1.5L/ha.
- Metribuzin 750g/kg (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 (e.g. Stomp®) at 1.5–2.25L/ha.
- Propyzamide 900g/kg (e.g. Edge® 900 WG) at 0.56–1.11kg/ha.
- Prosulfocarb 800g/L + s-metolachlor 120g/L (e.g. Boxer Gold®) at 2.5L/ha.
- Pyroxasulfone 850g/kg (e.g. Sakura®) at 118g/ha.
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.86–1.2kg/ha.
- Terbuthylazine 600g/kg + Propyzamide 300g/kg (e.g. Effigy® 900 WG) at 1.25–1.75kg/ha.
- Tri-allate 500g/L (e.g. Avadex® Xtra) at 1.6L/ha.
- Trifluralin 480g/L (e.g. TriflurX®) at 1.2–1.7L/ha.
- Trifluralin 350g/L + Tri-allate 550g/L (e.g. Jetti Duo®) at 1.45–1.8L/ha.

Post-sowing pre-emergent (PSPE) herbicides

- Diuron 900g/kg (e.g. Diurex® WG) at 550–830g/ha. Use the lower rate on light sandy soils.
- Fomesafen 240g/L (e.g. Reflex®) at 0.5–1.25L/ha.
- Imazethapyr 700g/kg (e.g. Spinnaker® WDG) at 70g/ha.
- Metribuzin 750g/kg (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 (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 (e.g. Bladex®) at 0.55–1.1kg/ha. Apply at 3–5 crop nodes.
- Diflufenican 500g/L (e.g. Brodal® Options, Bonanza® Elite) at 100–200mL/ha. Apply from third node to pre-flowering of crop growth stages.
- Flumetsulam 800g/kg (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 (e.g. Raptor®) at 45g/ha + BS1000® at 0.2% (v/v). Do not apply after four-node stage of crop.
- Metribuzin 750g/kg (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 (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 (e.g. Glocker® 750 WG,) at 33–50g/ha. Apply from third-node to pre-flowering crop growth stages.
- Pyraflufen-ethyl 20g/L (e.g. Ecopar®) at 400mL/ha + 200mL/ha Aspect® Options (diflufenican 500g/L) or Ecopar® at 400mL/ha + 200g/ha Stacato® 750 (metribuzin 750g/kg) 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 (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 (e.g. Select®, 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 (e.g. Di-Grass, 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 (e.g. Fusilade Forte®) at 500mL/ha. Apply up until seven weeks before crop harvest.
- Haloxyfop-R 520g/L (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 (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 (e.g. Elantra® Xtreme®, 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 (e.g. Gramoxone®, 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 the majority 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 may occur (more than 25%) especially if the crop is less advanced relative to the ryegrass; that is, 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 (e.g Reglone®) at 2 to 3 L/ha. Spray as soon as the crop has reached full maturity.
- Glyphosate 690g/kg (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 (e.g. Sharpen® WG) 34g/ha in mixture with recommended label rate of glyphosate or paraquat plus 1% Hasten® or high-quality methylated seed oil (MSO) of the spray volume. 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 9. 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.

WHAT IS NEW?

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 – it has had limited testing in WA. GIA Leader has the best disease resistance package of the IMI lentils. GIA Leader is available from PB Seeds and has an EPR of $5.94/t.

PBA Kelpie XT was released in 2020. It is a large red lentil, with grain size slightly smaller than PBA Jumbo2. It has 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 Leader 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 and AGZONE 2 expressed as percentage of site mean yield for each trial year (2017–2020)

Agzone	Agzone 1			Agzone 2	
Year	**2017**	**2019**	**2020**	**2019**	**2020**
Site mean yield (t/ha)	**0.97**	**0.51**	**1.65**	**0.75**	**1.45**
No. of trials	**(1)**	**(1)**	**(1)**	**(1)**	**(1)**
GIA Leader	-	-	-	-	115
PBA Bolt	100	107	105	108	106
PBA Hallmark XT	102	111	110	113	123
PBA Highland XT	98	113	123	120	118
PBA Hurricane XT	103	104	109	105	119
PBA Jumbo2	99	104	115	99	100
PBA Kelpie XT	101	93	129	95	114

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

TABLE 2. Grain yield of lentil varieties in AGZONE 5 expressed as percentage of site mean yield for each trial year (2016–2020)

Year	2016	2017	2018	2019	2020
Site mean yield (t/ha)	**1.74**	**1.26**	**1.29**	**0.64**	**0.50**
No. of trials	**(3)**	**(4)**	**(3)**	**(1)**	**(1)**
GIA Leader	-	-	-	-	106
PBA Bolt	104	105	108	100	106
PBA Hallmark XT	103	108	118	90	119
PBA Highland XT	110	111	120	99	118
PBA Hurricane XT	101	103	110	88	114
PBA Jumbo2	107	101	95	98	93
PBA Kelpie XT	-	96	98	86	109

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

LENTIL VARIETY CHARACTERISTICS

TABLE 3. Agronomic characteristics of lentil varieties suited to WA

Variety	Grade	Seed coat colour	Flowering time	Days to flowering*	Maturity	Lodging	Canopy height (cm)#
GIA Leader	Medium red	Grey	Mid-late	-	Mid-late	MR	-
PBA Bolt	Medium red	Grey	Early-mid	125	Early-mid	R	29
PBA Hallmark XT	Medium red	Grey	Mid	126	Mid	MR	30
PBA Highland XT	Medium red	Grey	Early	116	Early-mid	MR	32
PBA Hurricane XT	Small red	Grey	Mid	124	Mid	MR	25
PBA Jumbo2	Large red	Grey	Mid-late	125	Mid	MRMS	27
PBA Kelpie XT	Large red	Grey	Early-mid	-	Mid	MRMS	31

*NVT sown April 30 at Merredin in 2018
#Dalwallinu Stage 4 assessed 10 September 2019

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

TABLE 4. Disease ratings for selected lentil varieties

Variety	Botrytis grey mould	Ascochyta blight	Nematode resistance # (*Pratylenchus neglectus*)
GIA Leader	MR*p*	RMR	MSS*p*
PBA Bolt	S	MRMS	MR
PBA Hallmark XT	MR	MRMS	MR
PBA Highland XT	MS	MR	MR
PBA Hurricane XT	MS	MRMS	MRMS
PBA Jumbo2	RMR	R	MR
PBA Kelpie XT	MRMS*p*	MRMS	MRMS*p*

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 5. Lentil tolerance to soil conditions

Variety	Boron	Salinity
GIA Leader	I*p*	I*p*
PBA Bolt	MI	MI
PBA Hallmark XT	I	MI
PBA Highland XT	I	MI
PBA Hurricane XT	I	I
PBA Jumbo2	MI	I
PBA Kelpie XT	I	MI

I = intolerant, MI = moderately intolerant
p = provisional 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 500 metres away from last 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 may 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. May be applied with compounds containing nitrogen (MAP, DAP, Agras, etc) or as single superphosphate.

Target density

- 100–110plants/m². Recommended plant density provides better competition with weeds than lower densities and aids efficient harvest.

Seeding rate

- Small-seeded varieties (PBA Hurricane XT) 35 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 last 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 damage to harvesters.
- Lentils can be rolled either 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 (e.g. Ultro® 900 WG) at 1.1–1.7kg/ha.
- Cyanazine 900g/kg (Bladex®) 1.1kg/ha.
- Diuron 900g/kg (e.g. Diurex®) at 0.83–1.1kg/ha. Use lowest rate or consider alternatives to avoid damage on lighter soil types.
- Fomesafen 240g/L (e.g. Reflex®) at 0.5–1.5L/ha.
- Pendimethalin 440g/L (e.g. Stomp®) at 1.5–2.25L/ha.
- Prosulfocarb 800g/L + s-metolachlor 120g/L (e.g. Boxer Gold®) at 2.5L/ha.
- Propyzamide 900g/kg (e.g. Edge® 900 WG) 0.56–1.1kg/ha.
- Pyroxasulfone 850g/kg (e.g. Sakura®) at 118g/ha.
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.86–1.2kg/ha.
- Terbuthylazine 600g/kg + Propyzamide 300g/kg (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 (e.g. Diurex®) at 0.55–0.83kg/ha. Rolling prior to spraying can improve crop safety. Use lowest rate or consider alternatives to avoid damage on lighter soil types.
- Imazethapyr 700g/kg (eg. 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.
- Metribuzin 750g/kg (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 (e.g. Brodal® Options) at 100–200mL/ha. Application window is between 3rd leaf and start of crop flowering.
- Flumetsulam 800g/kg (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 and imazapyr 15g/L (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 (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 (e.g. Select®, 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 (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 to pre-flowering crop growth stages.
- Propaquizafob 100g/L (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 (e.g. Elantra Xtreme®, 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 – for example, 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 around 12 weeks after sowing. Follow-up applications may be required during early to mid-flowering to maintain protection, depending on the varietal susceptibility (R and MR varieties may not require follow up sprays in low-risk situations), growth and seasonal conditions. Depending on seasonal conditions, further sprays may 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 may not be required. Monitor crops. Spraying may 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 (e.g. Gramoxone®, 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; that is, when the last annual ryegrass seed heads at the bottom of the plant have emerged and the majority 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 may occur (more than 25%) especially if the crop is less advanced relative to the ryegrass; that is, if crops have mostly green immature pods. The higher label rate may also increase any yield reduction. DO NOT harvest within seven days of application.

Desiccation

- Diquat 200g/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 (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 (e.g. Sharpen® WG) 34g/ha in mixture with recommended label rate of glyphosate or paraquat plus 1% Hasten® or high-quality methylated seed oil (MSO) of the spray volume. Apply just after crop starts to yellow (or senesce). Sharpen® WG may 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 lower 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 can be 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 the 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 may 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 results 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 Table 3 for suggested grain varieties and Table 4 for suggested hay, silage, grazing and green manure varieties 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 yields (t/ha) of current vetch varieties for 5 sites x 5 years in South Australia (2016-20)

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 3. 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 4. 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 5. 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 6. 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 7. 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 8. 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 (e.g. Ultro® 900 WG) at 1.1–1.7kg/ha.
- Diuron 900g/kg (e.g. Diurex WG) at 0.83–1.1kg/ha (Common vetch only).
- Fomesafen 240g/L (e.g. Reflex®) at 0.5–1.5L/ha.
- Trifluralin 480g/L (e.g. TriflurX®) at 1.7L/ha.

Post-sowing pre-emergent (PSPE) herbicides

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

Post-emergent herbicides for broadleaf weed control

- Flumetsulam 800g/kg (e.g. Broadstrike®) at 25g/ha at three fully expanded leaves onwards (Purple or Popany vetch only).
- Pyraflufen-ethyl 20g/L (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 (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 (e.g. Fusilade® Forte®) at 820mL/ha.
- Haloxyfop-R 520g/L (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 (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 (e.g. Elantra® Xtreme®) 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 (e.g. Gramoxone®, 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; that is, when the last annual ryegrass seed heads at the bottom of the plant have emerged and the majority 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 may occur (more than 25%) especially if the crop is less advanced relative to the ryegrass; that is, if crops have mostly green immature pods. The higher label rate may 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.

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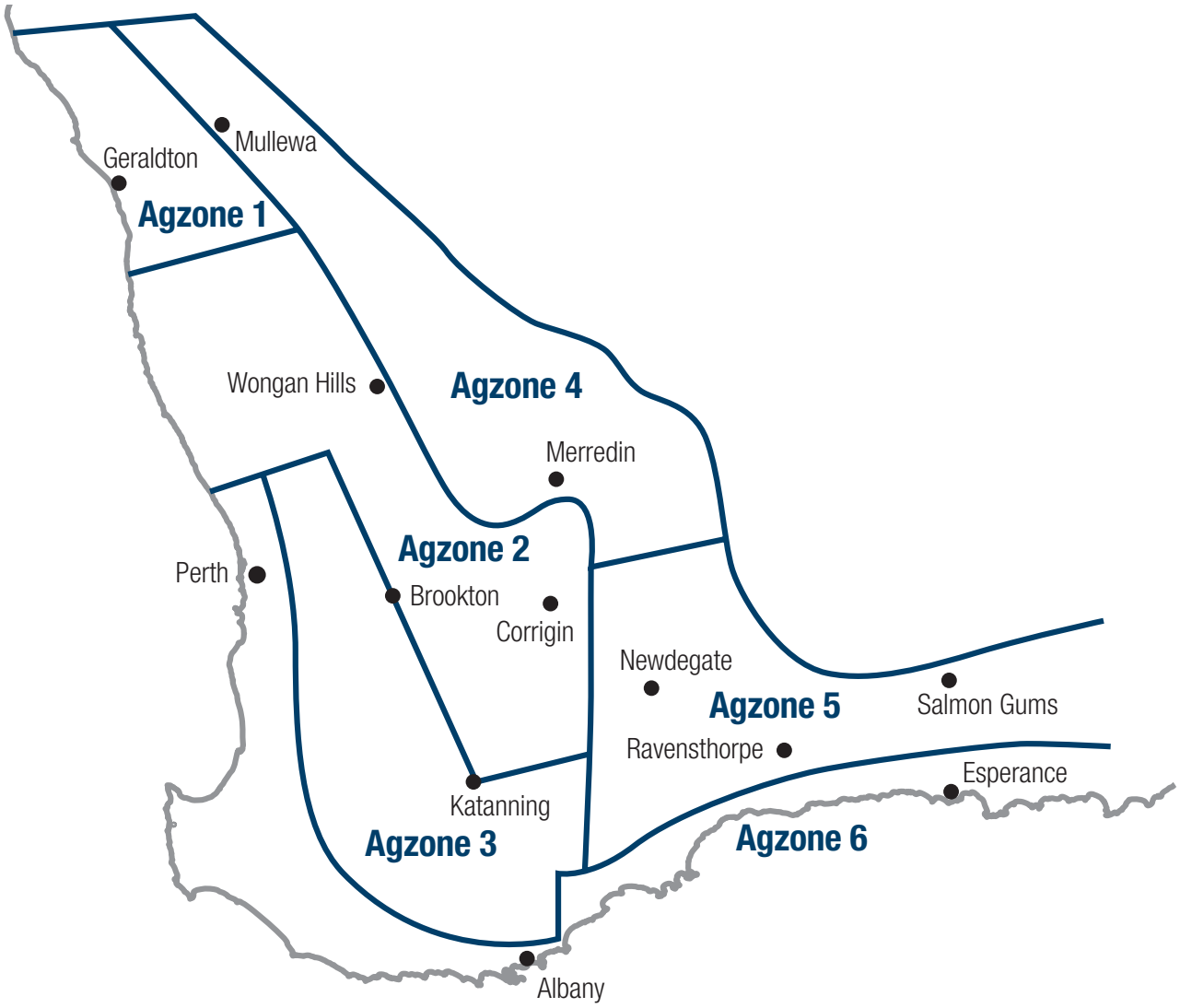

Agzones in Western Australia

Refer to page 104 for the distribution of Mid and Early Canola NVT's across Agzones.