Department of
Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

We're working for Western Australia.

2021 Western Australian Crop Sowing Guide

Bulletin 4917
Replaces Bulletin 4910
October 2020
ISSN: 1833 7236

GRDC NATIONAL VARIETY TRIALS™

Department of
Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

GRDC NATIONAL VARIETY TRIALS™

Title:
2021 Western Australian Crop Sowing Guide

Authors:
B Shackley, B Paynter, J Bucat, G Troup, M Seymour and A Blake (DPIRD)

ISSN: 1833 7236

Published: October 2020

Tel: +61 (0)8 9368 3333

Email: enquiries@dpird.wa.gov.au

Website: agric.wa.gov.au

DPIRD contact details:
Ms Brenda Shackley
Research Scientist
10 Dore St
KATANNING WA 6317

Phone:
(08) 9821 3243

Email:
brenda.shackley@dpird.wa.gov.au

Cover: Lupins sown into wheat stubble at Eradu
Photo: Peter Maloney (DPIRD)

Acknowledgements

The information contained in this bulletin is based on work conducted by many research scientists and technical officers at the Department of Primary Industries and Regional Development (DPIRD), with contributions from breeding and seed companies. These groups of people are acknowledged by the authors in each crop section.

The authors gratefully acknowledge the Grains Research and Development Corporation (GRDC) for the investment and support of the many research projects from which information has been developed for this bulletin. Most of the yield and disease data for this bulletin is sourced from the National Variety Trials (NVT) program, which is a GRDC initiative.

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

TABLE OF CONTENTS

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 (D), 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, 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: resistance ratings for the pulses, such as root lesion nematodes *P. neglectus* and *P. thornei* have been tested in the eastern states and, as such, should be used as a guide only 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 2021 edition of the Crop Sowing Guide for WA, which introduces 16 new variety releases: three wheat, one barley (plus four previous releases that are currently under malt evaluation), ten canola, a chickpea and a vetch.

This edition of 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. The pulse section also includes an 'Agronomy guide' to support the management of these high-value crops.

Not sure whether pulses are for your system? Yields and break-even yields for pulses are outlined in the 'Picking a Pulse' section (page 135) along with first-hand experiences with a range of pulse varieties. Please also consult your agronomist for more specific pulse information for your local area.

With the introduction of tariffs on barley imports into China in 2020 it is likely that, in the short-term, pricing will change for feed and malt grades and that this will influence the type and area of barley varieties sown. To help with barley decisions, market feedback from GIWA can be found on page 52 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 variety choice and sowing time remain the most reliable way of reducing yield losses. The relative maturity of wheat varieties are provided in the wheat section of this guide to help match sowing opportunities with the best variety. While all wheat and barley varieties are susceptible to frost, their risk profiles can differ during flowering. Frost performance values for individual varieties can be found on the NVT website. 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 2021 to confirm variety resistance ratings. The latest NVT data will be available early in 2021 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 approximately 4.5M hectares sown each year. Western Australia's wheat industry is supported with significant investment in variety improvement through pre-breeding, breeding and research through both 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 provides a summary on the yield performance of varieties in the GRDC National Variety Trials (NVT), disease resistance ratings and agronomic information. There is also a series of variety snapshots for 21 of the most common and recently released varieties at the back of this wheat section.

In this edition, Scepter is represented in all five years used in the NVT Long Term Multi Environment Trial (MET) analysis for the first time (Tables 6 to 11). With this milestone and in recognition of its popularity with growers (Scepter comprised over 50% of the area sown to wheat in WA in 2019), Scepter has replaced Mace as the comparison variety for yield (in the variety snapshots) and days to flowering (Table 18).

When deciding whether to implement a new variety into your farming system, it is important to determine whether the change will provide an advantage. A new variety should provide:

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

Given that environmental conditions are a major driver of crop performance, growers are encouraged to review available trial information and variety performance over multiple years to understand how a variety will perform in their environment across variable seasons. Additionally, growers are encouraged to consider how they may use varietal differences to their advantage through appropriate management, such as matching variety maturity with appropriate timing of sowing (and likely germination) to provide diversity or mitigate risk of frost. Finally, growers should be aware of the suitability of their variety for access into quality segregations. For example, growers of Calingiri should be aware that this variety will only be received as a feed grade wheat in WA from the 2022 harvest and beyond (see Variety Classification section).

WHAT IS NEW?

Denison is an APW wheat released by Australian Grain Technologies (AGT) in 2020. AGT data indicates that Denison is longer in maturity than Cutlass or Yitpi. Denison was tested in a limited number of NVT in 2019, with wider testing being carried out in 2020. Provisional disease ratings for Denison are MRMS for yellow spot, MR for stem and stripe rust and S for leaf rust. Further disease ratings will be generated in the 2020 season.

Hammer CL Plus is an imidazolinone herbicide tolerant AH wheat released by AGT in 2020. Hammer CL Plus was included in the WA NVT for the first time in 2020. Hammer CL Plus is closely related to Mace with a similar maturity and has provisional ratings of R for stripe rust, MR for stem rust and MSS for leaf rust.

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

Sting is an AH wheat variety with a short-mid season maturity released by AGT in 2020. AGT suggest that Sting offers a maturity similar to Corack. Sting was tested in the NVT for the first time in 2019, where it yielded higher than Corack, slightly above Scepter and slightly below Vixen. Provisional disease ratings for Sting are MS for yellow spot, MRMS for stem rust, MR for stripe rust and MSS for leaf rust. Other disease ratings will be generated in the 2020 season.

VARIETY CLASSIFICATION

Source: Wheat Quality Australia (WQA)

Removal of varieties: Wheat Quality Australia rationalise the Wheat Variety Master List with annual reviews of varieties that are more than 10 years old and which comprise 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 2020 and 2021 harvests 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), 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, LRPB Envoy, King Rock, LRPB Havoc, LRPB Trojan, LRPB Scout, Mace, RockStar, Sheriff CL Plus, Vixen, Westonia and Wyalkatchem. RockStar, Sheriff CL Plus and Vixen were additions to this list in 2020.

WHAT VARIETY SHOULD I GROW?

Despite the dominance in planting area of Scepter (Table 1), there are still about one million hectares of wheat 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 comprise a significant area of Western Australia's wheat acreage. In some cases, these long-retained varieties are longer maturity types that are retained to take advantage of earlier sowing opportunities. In recent years, there has been a significant yield improvement of varieties within the mid-long maturity class. This has been particularly evident in seasons with later breaks and/or dry finishes (like 2019), when the adaptability of these new varieties to WA environments has been apparent.

While many farming operations seek to limit the number of varieties present on their farm, it is important to consider the opportunities that a diverse range of varieties can provide, particularly when matched with appropriate management.

TABLE 1. Percentage of planned area sown to wheat varieties* for the 2015 to 2019 seasons

Variety	2015	2016	2017	2018	2019
Scepter	-	0.1	14.6	37.8	52.4
Mace	66.7	66.5	54.5	30.5	16.9
Ninja	-	-	0.2	3.4	5.1
Chief CL Plus	-	-	0.0	1.0	4.9
Zen	0.0	1.3	4.3	6.3	4.2
Calingiri	8.1	8.2	7.3	5.7	3.1
Corack	4.0	2.4	1.8	1.8	1.7
Magenta	3.5	4.1	4.0	2.7	1.6
LRPB Havoc	-	-	-	0.1	1.5
Yitpi	3.4	3.0	2.5	1.5	1.1
LRPB Cobra	1.8	1.9	1.7	1.3	0.9
Cutlass	-	0.0	0.2	0.4	0.8
Wyalkatchem	3.3	2.9	1.2	1.3	0.7
DS Pascal	-	-	0.0	0.1	0.5
Machete	0.2	0.3	0.1	0.1	0.5
LRPB Trojan	0.1	0.9	1.8	0.9	0.4
EGA Bonnie Rock	0.9	0.7	0.4	0.3	0.3
Westonia	0.8	0.5	0.3	0.4	0.3
Devil	-	-	-	-	0.3
Arrino	0.4	0.5	0.3	0.3	0.2
Emu Rock	0.6	0.6	0.4	0.6	0.2

Source: Data from CBH Group

*Varieties with less than 0.2% of total crop area in 2019/20 season are not included.

There are several traits which differ between well-adapted varieties that when used correctly, can increase production and/or reduce risk. Examples include selecting varieties of longer or shorter 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 risk and 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 your environment over multiple seasons
- maturity so that a variety's life cycle fits your targeted sowing time
- the herbicide tolerance and weed control options
- disease resistance ratings, particularly for prevalent diseases in your area and farming system. 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
- other quality requirements such as susceptibility to pre-harvest sprouting (presented as Falling Number Index ratings), black point and other quality defects

Tables 2 to 5 compare notable 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 state-wide 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 looking at the weighted average as it may mask important variety by environment interactions (i.e. how a variety's performance changes under different environmental conditions). Refer to Tables 6 to 11 for a more precise estimate of variety performance in a region.

AH and APW short-mid season varieties

Scepter remains a strong overall package with consistently high yields coupled with relatively good disease resistance and pre-harvest sprouting resistance (presented as Falling Number Index, Table 19).

Within the main season NVT, Devil performed very similarly to Scepter for yield. Devil has an AH and APWN classification but has a lower Falling Number Index rating than Scepter. If wanting to limit the number of varieties grown on farm, it may be prudent not to grow both Scepter and Devil due to their similarity, as other varieties provide greater diversity (through different maturities and/or herbicide tolerances).

Short maturity wheats have often been seen as a silver bullet for drought stress, yet they make up a small component of the WA crop. This is primarily due to the similar yield performance in later emergence situations achieved by varieties such as Mace or Scepter, as well as the reduced performance of the short maturity wheats in conditions with late season rainfall or earlier germination. Vixen has shown to be more yield competitive over several seasons than predecessors in the short maturity group such as Emu Rock and should be the preferred option when choosing a short season wheat. Vixen should be targeted to later sowing situations and scenarios with higher risk of terminal drought (e.g. shallow soils).

Table 2 shows that apart from Sting, which is MS (provisional) for yellow spot, all varieties competing in the short to short-mid maturity classes are MRMS for yellow spot and most are susceptible to powdery mildew and the new strain of leaf rust. There are no significant improvements in powdery mildew resistance over Scepter following LRPB Havoc's rating being lowered to MSS*p*. Although there are varieties that yield similarly or slightly higher than Scepter in some environments, Scepter has more robust rust resistance ratings and a higher Falling Number Index rating than Vixen, Devil, LRPB Havoc and Corack.

TABLE 2. Summary of wheat variety traits comparing Scepter with top yielding AH and APW short and short-mid maturity wheat varieties

	Scepter	Vixen	Devil	Sting	LRPB Havoc	Corack	Mace	Emu Rock
State-wide MET yield (% site mean)[1]	110%	111%	110%	109%^	107%	104%	103%	96%
Maturity	Short-mid	Short	Short-mid	Short-mid	Short-mid	Short-mid	Short-mid	Short
Classification	AH	AH(N)	AH(N)	AH	AH(N)	APW	AH(N)	AH
Falling no. index	5	3	3	-	3	4	5	2
Stem rust	MRMS	MRMS	MS	MRMS*p*	S	MR	MRMS	MS
Stripe rust	MR*	MRMS	MR	MR*p*	MR	MS	RMR*	MRMS
Leaf rust	MSS	SVS	SVS	MSS*p*	S	SVS	MSS	SVS
Powdery mildew	S	S	SVS	-	MSS*p*	SVS	MSS	S
Yellow spot	MRMS	MRMS	MRMS	MS*p*	MRMS	MRMS	MRMS	MRMS

[1]Regional differences in yield are masked when using a state-wide average of the WA wheat NVT MET data (2015-2019). 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 pathotypes present in eastern Australia can attack these varieties. *p* = provisional rating. ^ = single year of NVT data in 2019. Falling no. index please refer to pages 28 and 29.

CL Plus wheats

Wheat varieties denoted with 'CL Plus' are varieties with two resistance genes for imidazolinone herbicides and as such are registered for spraying with label rates of Intervix®.

The yields of Chief CL Plus, Sheriff CL Plus and Razor CL Plus are competitive with Mace in the NVT and also far out-yield previous CL Plus varieties, however they are inferior in yield to some non-imidazolinone resistant varieties such as Scepter, Devil and Vixen (Table 3). Chief CL Plus and Sheriff CL Plus are both classified as APW and APWN and Razor CL Plus is classified as ASW. Yield results of 2019 NVT showed the shorter maturity Razor CL Plus performed better than Chief CL Plus in a dry finish to the season, but its ASW quality and MSS rating for yellow spot will limit its competitiveness with Chief CL Plus for many. Hammer CL Plus is an AH variety released by AGT in 2020. The 2020 season is the first time Hammer CL Plus has been entered into the WA NVT.

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

TABLE 3. Summary of wheat variety traits comparing Scepter with CL Plus wheat varieties

	Scepter	Razor CL Plus	Chief CL Plus	Sheriff CL Plus	Grenade CL Plus	Hammer CL Plus
State-wide MET yield (% site mean)[1]	110%	103%	102%	101%	92%	-
Maturity	Short-mid	Short-mid	Mid	Mid	Short-mid	Short-mid
Classification	AH	ASW	APW(N)	APW(N)	APW	AH
Falling no. index	5	4*p*	4	4*p*	5	-
Stem rust	MRMS	MRMS	MR	MS	MR	MR*p*
Stripe rust	MR*	RMR	S	MS	RMR	R
Leaf rust	MSS	S	MR*	SVS	S	MSS*p*
Powdery mildew	S	MSS	S	SVS	MSS	–
Yellow spot	MRMS	MSS	MRMS	MRMS	S	MRMS*p*

[1]Regional differences in yield are masked when using a state-wide average of the WA wheat NVT MET data (2015-2019). 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 pathotypes present in eastern Australia can attack these varieties. *p* = provisional rating. Falling no. index please refer to pages 28 and 29.

Mid-long maturity varieties

Mid-long maturity wheats, as their name suggests, show a delayed rate of development compared to the widely grown short-mid types. They provide an option to maintain flowering at an optimum date as sowing date is moved earlier (with early sowing opportunities) or delayed compared to mainstream sowing dates enabling avoidance of periods of high frost prevalence.

The 2019 releases, RockStar and Catapult, performed very well in the 2018 and 2019 NVT, with RockStar yielding as well as Scepter despite its slightly longer maturity. Catapult and Kinsei have shown superior yields to other mid-long varieties such as Cutlass, Magenta and LRPB Trojan since their entry into the NVT in 2018 and 2017 respectively.

Provisional Falling Number Index ratings suggest RockStar to be a higher risk of low falling number than Catapult. It should be noted that the yield advantage of these varieties with earlier sowing opportunities (late April to early May) can be significant and this is not always represented by their yield in main season NVT, which are commonly sown at a date best suited to short-mid maturity varieties. Despite this, these newer mid-long varieties have a much lower risk of poor yields from delayed sowing/emergence than the superseded mid-long maturity varieties (as seen in their NVT performance).

Denison is an APW variety that was released by AGT in 2020 and is suggested to be longer in maturity than Cutlass. Denison was tested at a few NVT sites in 2019 and yielded similar to Cutlass in Agzone 2 and slightly higher than Cutlass but similar to Catapult in Agzones 3 and 6 (Tables 7, 8 and 11).

Denison has lower rust ratings (provisional) than Cutlass, being roughly equivalent to Catapult and RockStar.

Compared to Catapult and RockStar, Kinsei has inferior ratings to stem and stripe rust, with Catapult and RockStar both rated as MR to stem rust and RMR to stripe rust. Catapult, Kinsei and RockStar are S to the new pathotype of leaf rust, which is inferior to Cutlass, Magenta and LRPB Trojan. Denison, RockStar and Catapult are rated as MRMS to yellow spot and Kinsei is rated MS. RockStar has the highest powdery mildew rating (MS*p*) for this group of new releases.

With Catapult and RockStar classified as AH or AH and APWN, respectively, Yitpi now has an inferior yield and disease package among these AH, mid-long maturity wheats.

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

TABLE 4. Summary of wheat variety traits comparing Scepter with mid-long maturity wheat varieties

	Scepter	RockStar	Kinsei	Catapult	Cutlass	Denison	Magenta	Yitpi
State-wide MET yield (% site mean)[1]	110%	111%	104%	103%	99%	95%^	97%	94%
Maturity	Short-mid	Mid-long	Mid-long	Mid-long	Mid-long	Long(*p*)	Mid-long	Mid-long
Classification	AH	AH(N)	ANW	AH	APW(N)	APW	APW	AH
Falling no. index	5	3*p*	4	6*p*	4	-	3	5
Stem rust	MRMS	MR	MSS	MR	R	MR*p*	RMR	S
Stripe rust	MR*	RMR	MRMS	RMR	RMR*	MR*p*	MSS	MRMS
Leaf rust	MSS	S	S	S	R*	S*p*	RMR*	S
Powdery mildew	S	MS*p*	S	S*p*	S	–	MRMS	MS
Yellow spot	MRMS	MRMS	MS	MRMS	MSS	MRMS*p*	MR	SVS

[1]Regional differences in yield are masked when using a state-wide average of the WA wheat NVT MET data (2015-2019). 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 pathotypes present in eastern Australia can attack these varieties. *p* = provisional rating. ^ = single year of NVT data in 2019. Falling no. index please refer to pages 28 and 29.

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 longer maturing Kinsei has also performed well, with both varieties having improved yields over all other ANW varieties. Ninja is marginally shorter in maturity than Zen and Calingiri, while Kinsei is slightly longer in maturity. As Ninja is S to powdery mildew and leaf rust and SVS to stem 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.

GRAIN YIELD

GRDC's 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 to11 are outputs extracted from nvtonline.com.au. They provide the MET data for the six Agzones in WA between 2015 and 2019. Where there is either 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 where a variety was absent at a site or season.

Agzones were developed by the Department of Primary Industries and Regional Development (DPIRD) through statistical analysis to group together environmental regions that give similar crop performance in WA. 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, the germination time, 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 5. Summary of wheat variety traits comparing Scepter with noodle wheat varieties

	Scepter	Ninja	Kinsei	Zen	Supreme	Calingiri
State-wide MET yield (% site mean)[1]	110%	106%	104%	103%	96%	94%
Maturity	Short-mid	Mid	Mid-long	Mid-long	Short-mid	Mid-long
Classification	AH	ANW	ANW	ANW	ANW	ANW
Falling no. index	5	4	4	3	4	4
Stem rust	MRMS	SVS	MSS	S	MRMS	S
Stripe rust	MR*	MS	MRMS	MRMS	MR*	SVS
Leaf rust	MSS	S	S	S	RMR*	S
Powdery mildew	S	S	S	S	MS	S
Yellow spot	MRMS	MRMS	MS	MRMS	MS	MSS

[1]Regional differences in yield are masked when using a state-wide average of the WA wheat NVT MET data (2015-2019). 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 pathotypes present in eastern Australia can attack these varieties. Falling no. index please refer to pages 28 and 29.

TABLE 6. Grain yield of wheat varieties in AGZONE 1 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there is either more than one year of data or four or more observations)

Year			2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)			2.40	4.09	2.80	3.61	1.23	
Variety	Maturity	(No. trials)	(6)	(5)	(4)	(6)	(5)	(26)
Australian Hard								
Catapult	Mid-long	(11)	-	-	-	101	105	**103**
Devil (N)	Short-mid	(15)	-	-	104	110	113	**108**
Emu Rock	Short	(26)	84	97	86	101	96	**93**
LRPB Havoc (N)	Short-mid	(20)	-	105	96	112	108	**104**
Mace (N)	Short-mid	(26)	97	101	97	105	108	**102**
RockStar (N)	Mid-long	(11)	-	-	-	109	111	**111**
Scepter	Short-mid	(26)	107	107	105	110	112	**108**
Sting	Short-mid	(5)	-	-	-	-	114	**-**
Vixen (N)	Short	(15)	-	-	91	116	114	**104**
Yitpi	Mid-long	(26)	98	92	102	91	92	**95**
Australian Premium White								
Chief CL Plus (N)	Mid	(20)	-	101	105	104	102	**104**
Corack	Short-mid	(26)	92	100	94	109	108	**101**
Cutlass (N)	Mid-long	(26)	107	97	108	96	94	**100**
Denison	Long(*p*)	(0)	-	-	-	-	-	**-**
LRPB Trojan (N)	Mid-long	(26)	97	99	99	96	91	**96**
Magenta	Mid-long	(26)	109	99	107	93	89	**99**
Sheriff CL Plus (N)	Mid	(14)	-	102	103	-	100	**102**
Australian Noodle Wheat								
Calingiri	Mid-long	(26)	101	95	104	91	94	**97**
Kinsei	Mid-long	(15)	-	-	108	102	105	**106**
Ninja	Mid	(26)	110	106	107	104	105	**106**
Zen	Mid-long	(26)	103	103	102	104	104	**103**
Australian Standard White								
Razor CL Plus	Short-mid	(15)	-	-	91	105	109	**100**

(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 (2015-2019) and the weighted average over the five-year period (where there is either more than one year of data or four or more observations)

Year			2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)			2.39	3.53	3.48	4.02	2.24	
Variety	Maturity	(No. trials)	(14)	(7)	(16)	(14)	(16)	(67)
Australian Hard								
Catapult	Mid-long	(30)	-	-	-	104	104	**103**
Devil (N)	Short-mid	(46)	-	-	109	112	112	**110**
Emu Rock	Short	(67)	93	95	97	94	101	**96**
LRPB Havoc (N)	Short-mid	(53)	-	98	109	106	110	**107**
Mace (N)	Short-mid	(67)	101	100	105	104	108	**104**
RockStar (N)	Mid-long	(30)	-	-	-	112	108	**110**
Scepter	Short-mid	(67)	110	110	109	110	111	**110**
Sting	Short-mid	(16)	-	-	-	-	115	**-**
Vixen (N)	Short	(46)	-	-	111	109	118	**111**
Yitpi	Mid-long	(67)	93	96	92	95	94	**94**
Australian Premium White								
Chief CL Plus (N)	Mid	(53)	-	95	103	103	102	**102**
Corack	short-mid	(67)	98	98	105	107	111	**105**
Cutlass (N)	Mid-long	(67)	102	103	96	100	96	**99**
Denison	Long(*p*)	(16)	-	-	-	-	96	**-**
LRPB Trojan (N)	Mid-long	(67)	98	102	94	98	93	**96**
Magenta	Mid-long	(67)	103	102	94	95	90	**96**
Sheriff CL Plus (N)	Mid	(39)	-	100	102	-	100	**102**
Australian Noodle Wheat								
Calingiri	Mid-long	(67)	94	96	94	96	92	**94**
Kinsei	Mid-long	(46)	-	-	104	107	101	**104**
Ninja	Mid	(67)	108	108	104	105	102	**105**
Zen	Mid-long	(67)	102	100	103	105	103	**103**
Australian Standard White								
Razor CL Plus	Short-mid	(46)	-	-	105	102	108	**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 (2015-2019) and the weighted average over the five-year period (where there is either more than one year of data or four or more observations)

Year			2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)			3.67	3.15	4.24	2.98	3.32	
Variety	Maturity	(No. trials)	(6)	(3)	(4)	(3)	(4)	(20)
Australian Hard								
Catapult	Mid-long	(7)	-	-	-	102	104	**103**
Devil (N)	Short-mid	(11)	-	-	112	112	112	**111**
Emu Rock	Short	(20)	100	94	92	96	98	**97**
LRPB Havoc (N)	Short-mid	(14)	-	95	104	111	111	**107**
Mace (N)	Short-mid	(20)	106	100	102	105	107	**104**
RockStar (N)	Mid-long	(7)	-	-	-	111	109	**111**
Scepter	Short-mid	(20)	109	109	112	110	110	**110**
Sting	Short-mid	(4)	-	-	-	-	112	**-**
Vixen (N)	Short	(7)	-	-	-	112	115	**111**
Yitpi	Mid-long	(20)	88	98	92	93	95	**92**
Australian Premium White								
Chief CL Plus (N)	Mid	(14)	-	95	101	105	105	**102**
Corack	Short-mid	(20)	106	97	101	109	111	**105**
Cutlass (N)	Mid-long	(20)	92	103	100	98	97	**97**
Denison	Long(*p*)	(4)	-	-	-	-	102	**-**
DS Pascal	Mid-long	(14)	-	91	86	83	81	**85**
LRPB Trojan (N)	Mid-long	(20)	94	101	99	97	94	**97**
Magenta	Mid-long	(20)	91	103	100	93	91	**95**
Sheriff CL Plus (N)	Mid	(11)	-	99	103	-	102	**102**
Australian Noodle Wheat								
Calingiri	Mid-long	(20)	92	98	95	94	94	**94**
Kinsei	Mid-long	(11)	-	-	109	105	103	**105**
Ninja	Mid	(20)	104	108	109	104	102	**105**
Zen	Mid-long	(20)	104	100	104	106	105	**104**
Australian Standard White								
Razor CL Plus	Short-mid	(11)	-	-	102	102	104	**104**

(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 (2015-2019) and the weighted average over the five-year period (where there is either more than one year of data or four or more observations)

Year			2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)			2.13	3.05	2.15	3.25	1.20	
Variety	Maturity	(No. trials)	(8)	(4)	(9)	(9)	(9)	(39)
Australian Hard								
Catapult	Mid-long	(18)	-	-	-	103	106	**104**
Devil (N)	Short-mid	(27)	-	-	110	110	115	**110**
Emu Rock	Short	(39)	95	99	96	97	103	**98**
LRPB Havoc (N)	Short-mid	(31)	-	106	104	108	109	**106**
Mace (N)	Short-mid	(39)	99	104	104	105	110	**105**
RockStar (N)	Mid-long	(18)	-	-	-	111	108	**110**
Scepter	Short-mid	(39)	107	110	109	110	115	**110**
Sting	Short-mid	(9)	-	-	-	-	121	**-**
Vixen (N)	Short	(27)	-	-	109	112	124	**112**
Yitpi	Mid-long	(39)	96	89	100	93	96	**96**
Australian Premium White								
Chief CL Plus (N)	Mid	(31)	-	99	102	103	99	**101**
Corack	Short-mid	(39)	95	101	106	105	111	**104**
Cutlass (N)	Mid-long	(39)	103	95	103	98	98	**100**
Denison	Long(*p*)	(0)	-	-	-	-	-	**-**
LRPB Trojan (N)	Mid-long	(39)	100	95	97	95	93	**96**
Magenta	Mid-long	(39)	106	96	97	95	90	**97**
Sheriff CL Plus (N)	Mid	(13)	-	100	-	-	98	**100**
Australian Noodle Wheat								
Calingiri	Mid-long	(39)	96	92	97	93	89	**94**
Kinsei	Mid-long	(27)	-	-	103	104	99	**102**
Ninja	Mid	(39)	107	107	104	105	103	**105**
Zen	Mid-long	(39)	100	101	102	103	100	**101**
Australian Standard White								
Razor CL Plus	Short-mid	(27)	-	-	102	104	113	**105**

(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 (2015-2019) and the weighted average over the five-year period (where there is either more than one year of data or four or more observations)

Year			2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)			3.09	2.99	3.20	2.44	2.08	
Variety	Maturity	(No. trials)	(6)	(3)	(5)	(4)	(4)	(22)
Australian Hard								
Catapult	Mid-long	(8)	-	-	-	107	106	**105**
Devil (N)	Short-mid	(13)	-	-	114	114	114	**113**
Emu Rock	Short	(22)	102	95	97	99	100	**99**
LRPB Havoc (N)	Short-mid	(16)	-	96	106	109	110	**108**
Mace (N)	Short-mid	(22)	106	99	102	106	108	**105**
RockStar (N)	Mid-long	(8)	-	-	-	113	111	**113**
Scepter	Short-mid	(22)	114	110	115	116	115	**114**
Sting	Short-mid	(4)	-	-	-	-	118	**-**
Vixen (N)	Short	(13)	-	-	116	120	122	**118**
Yitpi	Mid-long	(22)	88	99	98	98	97	**95**
Australian Premium White								
Chief CL Plus (N)	Mid	(16)	-	95	100	102	103	**101**
Corack	Short-mid	(22)	109	98	104	106	110	**106**
Cutlass (N)	Mid-long	(22)	94	106	107	104	100	**102**
Denison	Long(*p*)	(4)	-	-	-	-	89	**-**
LRPB Trojan (N)	Mid-long	(22)	96	104	101	95	93	**98**
Magenta	Mid-long	(22)	92	105	102	98	93	**97**
Sheriff CL Plus (N)	Mid	(12)	-	100	101	-	100	**101**
Australian Noodle Wheat								
Calingiri	Mid-long	(22)	87	97	91	89	90	**90**
Kinsei	Mid-long	(13)	-	-	103	99	99	**102**
Ninja	Mid	(22)	106	108	108	106	104	**106**
Zen	Mid-long	(22)	104	99	100	99	100	**101**
Australian Standard White								
Razor CL Plus	Short-mid	(13)	-	-	101	105	108	**105**

(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 (2015-2019) and the weighted average over the five-year period (where there is either more than one year of data or four or more observations)

Year			2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)			4.20	4.04	4.16	3.74	4.28	
Variety	Maturity	(No. trials)	(3)	(2)	(1)	(2)	(1)	(9)
Australian Hard								
Catapult	Mid-long	(3)	-	-	-	103	105	**-**
Devil (N)	Short-mid	(4)	-	-	110	109	111	**110**
Emu Rock	Short	(9)	94	94	95	94	87	**93**
LRPB Havoc (N)	Short-mid	(6)	-	93	101	104	107	**103**
Mace (N)	Short-mid	(9)	102	100	100	101	104	**101**
RockStar (N)	Mid-long	(3)	-	-	-	112	117	**-**
Scepter	Short-mid	(9)	113	108	111	109	111	**111**
Sting	Short-mid	(1)	-	-	-	-	105	**-**
Vixen (N)	Short	(3)	-	-	-	106	103	**-**
Yitpi	Mid-long	(9)	88	103	99	96	92	**95**
Australian Premium White								
Chief CL Plus (N)	Mid	(6)	-	95	99	102	108	**101**
Corack	Short-mid	(9)	100	95	100	101	101	**99**
Cutlass (N)	Mid-long	(9)	99	107	106	103	99	**102**
Denison	Long(*p*)	(1)	-	-	-	-	105	**-**
DS Pascal	Mid-long	(6)	-	95	91	91	85	**90**
LRPB Trojan (N)	Mid-long	(9)	97	101	102	100	91	**98**
Magenta	Mid-long	(9)	100	106	104	102	97	**102**
Sheriff CL Plus (N)	Mid	(4)	-	98	101	-	104	**102**
Australian Noodle Wheat								
Calingiri	Mid-long	(9)	91	99	95	95	98	**95**
Kinsei	Mid-long	(4)	-	-	104	105	110	**106**
Ninja	Mid	(6)	-	107	107	107	108	**108**
Zen	Mid-long	(9)	104	97	100	102	106	**102**
Australian Standard White								
Razor CL Plus	Short-mid	(4)	-	-	100	99	99	**100**

(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 have been developed (Table 12) 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 20). 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 have a higher risk of yield loss if sown before late April in WA.

Knowing the relative flowering time to Scepter can help with decisions on planting order of wheat varieties. The number of days to flowering of a variety relative to Scepter are provided in the variety snapshots at the end of this section.

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 locations. Key management strategies are available on the GRDC and DPIRD websites. Relative maturities of varieties are given in Table 13 to help decide the best variety choice for sowing opportunities. All wheat varieties are susceptible to frost, however their risk profile during flowering can differ.

MATURITY

Spring wheat varieties are broadly classified based on their duration to flowering into maturity categories of short, short-mid, mid and mid-long in WA. While there are longer maturing spring wheats and winter wheats, these are not commonly grown in WA. The majority of spring wheat varieties grown in WA have a minor vernalisation requirement (response 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 such as 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-long maturity class. In recent years, very long spring (such as LRPB Nighthawk) and winter wheats (such as Longsword and Illabo) with greater adaptation to the WA environment have been released, offering unique maturity characteristics for very early sowing.

Sowing spring wheats into early 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 early April sowing in WA, primarily due to their vernalisation requirement.

Table 13 is a summary of DPIRD experiments in 2018 and 2019 with sowing times ranging from early April to mid-June. The results show the large spread in days to flowering (relative to Scepter) provided by the mid-long to mid-winter wheats, particularly when sown in April and early May. A more detailed flowering comparison between Scepter and other varieties can be found in the variety snapshots (pages 31 to 41).

Flowering dates change with sowing date, location and from season to season due to differences in temperatures experienced. It is important to consider data from various experiments over several seasons because the genetic control of flowering is complex.

TABLE 12. Suggested sowing times of wheat varieties in WA where risk of frost damage is low

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-long: Calingiri, Catapult, Cutlass, Kinsei, LRPB Trojan, Magenta, Rockstar, Yitpi, Zen												
Short-mid to mid: Chief CL Plus, Corack, Devil, LRPB Cobra, LRPB Havoc, Mace, Ninja, Scepter												
Short: Emu Rock, Vixen												

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

TABLE 13. Number of days to flowering compared with Scepter for selected varieties over five sowing dates, averaged from four DPIRD sites in 2018 and 2019

Variety	Maturity	Time of sowing				
		10-Apr	24-Apr	8-May	22-May	20-Jun
Emu Rock	Short	-16	-14	-11	-8	-6
Vixen	Short	-16	-11	-10	-7	-4
Devil	Short-mid	-8	-5	-4	-3	-3
LRBP Havoc	Short-mid	-7	-7	-5	-5	-4
Razor CL Plus	Short-mid	-	-	-2	-3	-4
Mace	Short-mid	-2	-1	-2	-2	-2
Scepter	Short-mid	0	0	0	0	0
Chief CL Plus	Mid	5	2	1	1	1
Sheriff CL Plus^	Mid	1^	4^	3^	0^	0^
Ninja	Mid	7	5	3	2	1
RockStar^	Mid-long	6^	4^	3^	3^	0^
Zen	Mid-long	6	5	3	2	1
Magenta	Mid-long	6	6	6	5	6
LRPB Trojan	Mid-long	10	9	3	3	3
Catapult^	Mid-long	11^	10^	7^	5^	2^
Kinsei	Mid-long	11	10	6	5	3
DS Pascal	Mid-long	17	15	9	7	6
Yitpi	Mid-long	18	17	11	7	6
Cutlass	Mid-long	21	19	12	9	6
LRPB Nighthawk	Very long	42	29	21	18	13
Longsword	Fast winter	48	32	20	14	9
Forrest	Very long	49	34	26	19	11
Wedgetail	Mid-winter	54	37	26	19	15
DS Bennett	Mid-long winter	73	58	43	19	14

^ = single year of data in 2019. Refer to variety snapshots (pages 31 to 41) for a more detailed comparison across locations.

SOWING TIME RESPONSE OF WHEAT VARIETIES IN WA

Matching an appropriate choice of sowing date to your chosen variety or varieties is the key to maximising wheat yield potential in WA. Given every season is different and the key environmental constraints will differ in significance, prevalence and timing, the perfect match of variety development to any given season is difficult to achieve. For example, many wheat growing areas in WA have observed both tight, dry finishes and cool, long finishes over the last few years, which changes the optimum development 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 a number of seasons that can guide appropriate variety choice for any sowing opportunity.

The majority of 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 2018, GRDC and DPIRD funded agronomy research that 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 1). However, the variety combinations to maximise yield from each sowing date at each site varied significantly especially when comparing Katanning with the other three sites.

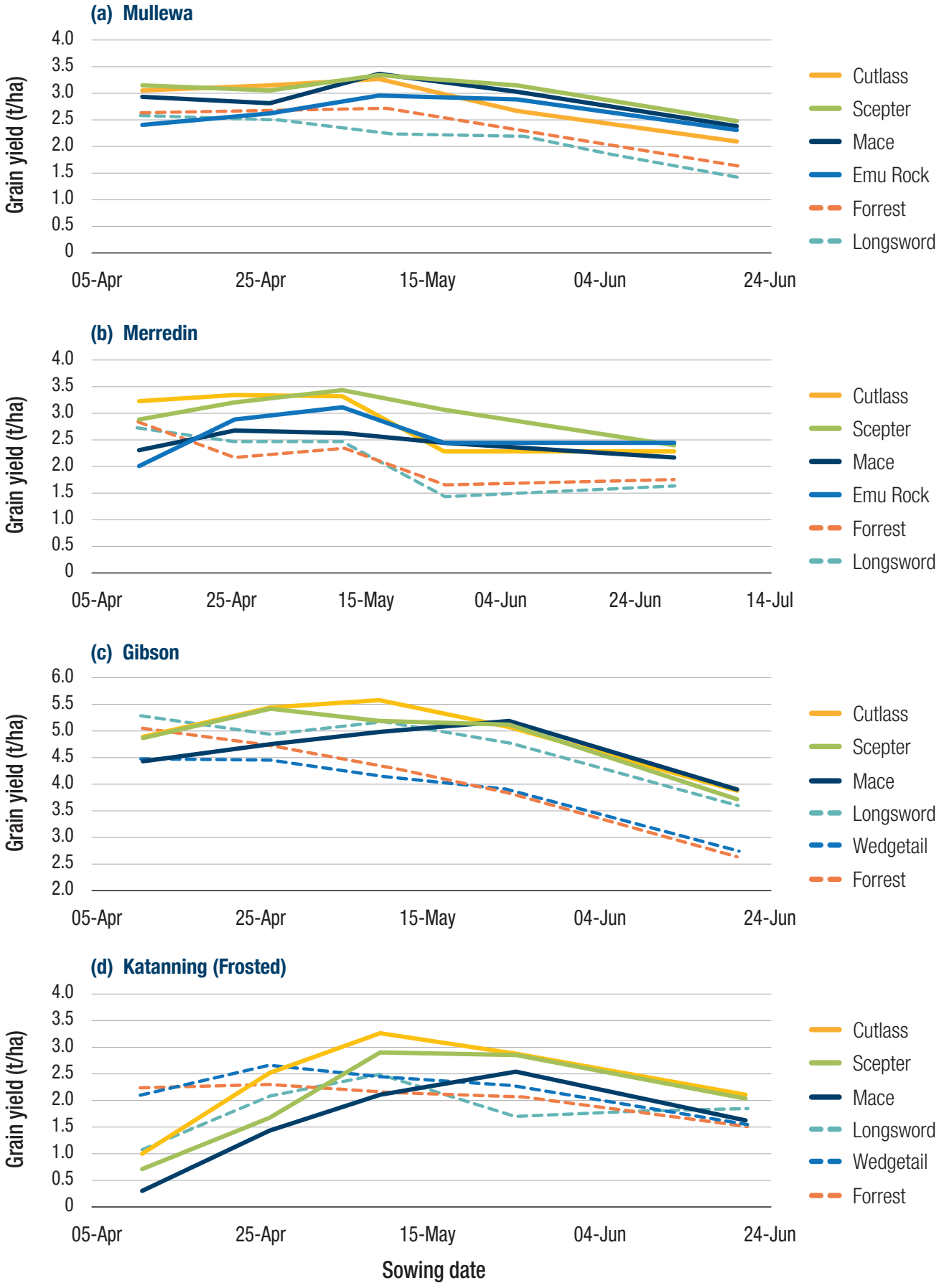


FIGURE 1. Grain yield (t/ha) response for a set of varieties sown at five sowing dates at a) Mullewa (2016 and 2018), b) Merredin (2016-2018), c) Gibson (2015-2018) and d) Katanning (frosted 2017-2018).

LSD = 0.5t/ha. Irrigation was used at the early sowing dates to ensure timely germination. Source: GRDC/DPIRD Tactical Wheat Agronomy for the West Project.

At all sites except Katanning, yield potential was generally stable across the April and May sowing dates.

At the northern Mullewa site, the highest yields were achieved by Scepter and Cutlass, short-mid and mid-long maturity types that are well adapted to WA growing conditions. Even at early sowing dates, the longer maturity varieties, Forrest and Longsword, 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 short-mid and mid-long spring wheats that once again maximised yield potential across the sowing window. By sowing a mid-long variety (like Cutlass) in April before switching to short-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 sowing dates, typically from short-mid and mid-long 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, longer maturing varieties like Forrest and Longsword generated higher yields when sown in early April.

At Katanning, a frost prone site in the south-west, short-mid and mid-long 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 longer maturing varieties such as winter wheats.

Results of the trials across the WA wheatbelt show that the optimum combination of variety (and in particular, 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 for 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 short-mid maturity, appears to be more adaptable across a range of sowing times than some other short-mid varieties, however it is still at risk of frost or increased disease when sown too early. Similarly, not all mid-long varieties will perform the same at any given environment, with Catapult, Cutlass and RockStar generally having higher yields than DS Pascal, Magenta and Yitpi.

EARLY SEASON NVT

Since 2017, an ‘early-season’ wheat NVT series has been carried out in WA to evaluate the performance of longer maturing varieties when sown at an earlier sowing date.

Between 2017 and 2019 the ‘early-season’ series was generally sown in late April, a timing favorable to varieties with a mid-long maturity but potentially not early enough for the long spring or winter varieties.

The ‘early-season’ trial series demonstrated that Yitpi, Magenta, LRPB Trojan and DS Pascal yields are inferior to the more recent mid-long maturing varieties such as Cutlass, Kinsei, Catapult and RockStar (Tables 14 and 15). While Yitpi, Magenta, LRPB Trojan and DS Pascal have offered unique agronomic characteristics such as improved pre-harvest sprouting resistance and/or improved powdery mildew resistance, they also have big weaknesses. Some of the new mid-long varieties also have these strengths, plus a greater yield potential.

Cutlass and Kinsei have consistently been amongst the highest yielding varieties across all the early-season sites in the past three years. Catapult has only been included in the early-season series since 2018 and has yielded similarly to Kinsei and Cutlass. The single year of data for RockStar in 2019 indicates that it is similar in yield to Catapult, Kinsei and Cutlass but more data is required to confirm its performance 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, there is more risk involved with earlier sowing of quicker maturing varieties in areas that are prone to frost, higher disease burden or low biomass.

The suitability of winter wheats and longer spring varieties is still being assessed, however, they appear to be more competitive when sown at more southern and/or frost-prone locations (Figure 1).

TABLE 14. Early season NVT for AGZONES 1 and 4 (2017-2019), expressed as a percentage of site mean yield

Agzone			1			4		
Year			2017	2018	2019	2017	2018	2019
Site			Ogilvie	Ogilvie	Ogilvie	Bencubbin	Bencubbin	Moorine Rock
Sowing date			20-Apr	20-Apr	17-Apr	24-Apr	30-Apr	11-Apr
Site mean yield (t/ha)			3.47	4.02	1.91	1.24	2.91	2.15
Variety (order of maturity)	Classification	Maturity						
Scepter	AH	Short-mid	-	93	105	-	114	95
RockStar	AH (N)	Mid-long	-	-	114	-	-	-
LRPB Trojan	APW (N)	Mid-long	97	102	105	105	111	104
Magenta	APW	Mid-long	97	99	102	103	105	100
Catapult	AH	Mid-long	-	106	115	-	120	109
Kinsei	ANW	Mid-long	112	104	113	119	113	105
DS Pascal	APW	Mid-long	107	107	102	98	99	107
Yitpi	AH	Mid-long	93	99	99	101	105	101
Cutlass	APW (N)	Mid-long	109	110	112	112	114	112
LRPB Nighthawk	APW	Very long	-	103	97	-	93	102
Longsword	Feed	Fast winter	118	99	105	103	89	90
Illabo	AH	Fast winter	98	100	96	80	86	96
Forrest	ASW	Very long	-	105	100	-	96	104
EGA Wedgetail	APW	Mid-winter	84	92	82	61	72	86
DS Bennett	Feed	Mid-long winter	-	-	86	-	-	-

TABLE 15. Early season NVT for AGZONES 2, 3, 5 and 6 (2017-2019), expressed as a percentage of site mean yield

Agzone			2		3		5	6
Year			2017	2019	2017	2019	2019	2018
Site			Eneabba	Wickepin	York	Narrogin	Hyden	Gibson
Sowing date			20-Apr	18-Apr	24-Apr	18-Apr	16-Apr	2-May
Site mean yield (t/ha)			2.84	3.18	4.07	3.50	2.44	3.10
Variety (order of maturity)	Classification	Maturity						
Scepter	AH	Short-mid	-	119	-	100	130	107
RockStar	AH (N)	Mid-long	-	117	-	109	132	-
LRPB Trojan	APW (N)	Mid-long	107	108	111	101	119	103
Magenta	APW	Mid-long	103	105	107	100	109	101
Catapult	AH	Mid-long	-	120	-	106	125	114
Kinsei	ANW	Mid-long	120	118	114	106	117	117
DS Pascal	APW	Mid-long	101	96	92	103	98	105
Yitpi	AH	Mid-long	99	99	106	97	106	91
Cutlass	APW (N)	Mid-long	117	112	108	107	120	116
LRPB Nighthawk	APW	Very long	-	92	-	101	90	-
Longsword	Feed	Fast winter	107	108	93	106	84	123
Illabo	AH	Fast winter	90	98	86	105	95	119
Forrest	ASW	Very long	-	88	-	98	75	87
EGA Wedgetail	APW	Mid-winter	68	80	75	97	77	99
DS Bennett	Feed	Mid-long winter	-	86	-	101	82	-

DISEASE RESISTANCE

Key points:

- Be aware of your variety's disease package so you can plan any in-season disease management that may be needed.
- Choose your variety wisely. Don't plant a susceptible variety into a high disease risk paddock.
- Diversify your wheat varieties as well as your crop types.

When selecting a wheat variety, it is important to consider not only the yield or potential quality grade but also the disease resistance of each variety (Table 18).

Higher resistance ratings reduce disease severity and subsequent 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, and
- a susceptible host crop to become infected.

Depending on the disease in question, inoculum can be carried on infested stubble or trash, on a green bridge, in seed or in the soil (Table 16).

TABLE 16. 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, rhizoctonia root rot, flag smut and common bunt.

Choose your variety for each paddock based on its 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 susceptible to very susceptible to yellow spot, onto wheat stubble.

Table 17 provides suggested minimum resistance for wheat varieties in different disease risk profiles to five of the common leaf diseases. This table is a useful guide when selecting a suitable variety in problem paddocks.

Planning ahead and understanding the disease strengths and weaknesses of your variety will allow more effective disease management during the season. For example, Scepter is susceptible for powdery mildew. In a season or environment conducive to powdery mildew it may be prudent to use seed dressing or in-furrow fungicide and to 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 infection 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 the majority of 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 the disease table (Table 18) are for the pathotype that entered WA in 2015 (104-1,3,4,6,7,8,10,12 +Lr37).

For powdery mildew, the ratings reflect expected resistance to the general mildew population, but a variety's response (such as LRPB Havoc) may differ on rare occasions when a more virulent isolate occurs.

Nodorum blotch causes characteristic necrotic lesions on leaves and can also cause glume blotch, dark brown to black lesions or staining on the heads associated with infection. Varieties can differ in expression of disease on foliage and heads and in this 2021 guide variety rankings have been included for both characteristics (Table 18). 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.

For more information:

- Crop diseases – forecasts and management at www.agric.wa.gov.au
- Search wheat disease ratings at www.agric.wa.gov.au
- Download the 'Australian Field Crop Disease Guide App' which is available for both Apple and Android.

TABLE 17. Suggested minimum resistance for wheat varieties in different disease risk areas to common leaf diseases

Disease risk*	Stem rust	Stripe rust	Leaf rust	Yellow spot	Nodorum blotch
Low risk	MSS	MS	MS	MSS	MSS
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).

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

Variety	Grade	Nodorum blotch (leaf)	Nodorum blotch (glume)	Septoria tritici blotch	Yellow spot	Rust		
						Stem	Stripe	Leaf
Arrino	ANW	MS	MS*p*	S	MS	SVS	S	VS
Bremer	AH	MS	MRMS*p*	S	MSS	MR	MR*	MR*
Calingiri	ANW	MSS	MRMS*p*	MSS	MSS	S	SVS	S
Catapult	AH	MS*p*	MRMS*p*	Sp	MRMS	MR	RMR	S
Chief CL Plus	APW (N)	MS	MRMS*p*	S	MRMS	MR	S	MR*
Corack	APW	MSS	MS*p*	S	MRMS	MR	MS	SVS
Cutlass	APW (N)	MRMS	MR*p*	MSS	MSS	R	RMR*	R*
Devil	AH (N)	MS	MRMS*p*	S	MRMS	MS	MR	SVS
Denison	APW	–	–	–	MRMS*p*	MR*p*	MR*p*	S*p*
DS Bennett	Feed	MRMS	MR*p*	MR	MRMS	MRMS	R	S
DS Pascal	APW	MS	RMR*p*	MS	MRMS	MSS	RMR	MS
EGA Bonnie Rock	AH (N)	MSS	MS*p*	S	MRMS	MSS	VS	SVS
EGA Wedgetail	APW	MRMS	–	MSS	MSS	MRMS	MS	MSS
Emu Rock	AH	SVS	MR*p*	S	MRMS	MS	MRMS	SVS
Grenade CL Plus	APW	MSS	MRMS*p*	S	S	MR	RMR	S
Hammer CL Plus	AH	–	–	–	MRMS*p*	MR*p*	Rp	MSS*p*
Harper	APW	MS	–	MSS	MSS	MS	RMR	S
Illabo	AH	MRMS	MR*p*	MR	MS	MRMS	RMR	S
Kinsei	ANW	MS	MR*p*	S	MS	MSS	MRMS	S
Longsword	Feed	MRMS	MR*p*	MRMS	MRMS	MR	RMR	MSS
LRPB Cobra	AH	MS	MR*p*	MSS	MRMS	MR	MSS	MR
LRPB Havoc	AH (N)	MS	MS*p*	MRMS	MRMS	S	MR	S
LRPB Trojan	APW (N)	MS	MR*p*	MSS	MSS	MRMS	MR	MR
LRPB Nighthawk	APW	MS	MR*p*	MRMS*p*	MS	RMR	R	MSS
Mace	AH (N)	MS	MSS*p*	S	MRMS	MRMS	RMR*	MSS
Magenta	APW	MRMS	MRMS*p*	MRMS	MR	RMR	MSS	RMR*
Ninja	ANW	MS	MR*p*	MS	MRMS	SVS	MS	S
Razor CL Plus	ASW	MS	MRMS*p*	SVS	MSS	MRMS	RMR	S
RockStar	AH (N)	MRMS*p*	MR*p*	MSS*p*	MRMS	MR	RMR	S
Scepter	AH	MS	MSS*p*	S	MRMS	MRMS	MR*	MSS
Sheriff CL Plus	APW (N)	MS	MR*p*	S	MRMS	MS	MS	SVS
Sting	AH	–	–	–	MS*p*	MRMS*p*	MR*p*	MSS*p*
Supreme	ANW	S	MS*p*	MSS	MS	MRMS	MR*	RMR*
Tungsten	AH	MRMS	MR*p*	MSS	MSS	MS	RMR	MS
Vixen	AH (N)	S	MS*p*	MSS	MRMS	MRMS	MRMS	SVS
Westonia	APW (N)	MSS	MRMS*p*	SVS	MS	SVS	VS	MS
Wyalkatchem	APW (N)	MSS	MR*p*	S	MR	MSS	S	S
Yitpi	AH	MS	RMR*p*	MRMS	SVS	S	MRMS	S
Zen	ANW	MS	MR*p*	S	MRMS	S	MRMS	S

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

Variety	Grade	Powdery mildew	Flag smut	Common bunt	Root lesion nematode		Cereal cyst nematode	Crown rot
					P. quasitereoides	*P. neglectus*		
Arrino	ANW	MRMS	MSS	MS	S	S	–	–
Bremer	AH	S	MSS	RMR	MS*p*	SVS	MRMS	S
Calingiri	ANW	S	RMR	MRMS	S	SVS	–	S
Catapult	AH	S*p*	RMR*p*	MR*p*	–	S	R	S*p*
Chief CL Plus	APW (N)	S	SVS	MR	–	MRMS	MS	MSS
Corack	APW	SVS	MRMS	MSS	MSS	MSS	RMR	S
Cutlass	APW (N)	S	MSS	S	–	MSS	MR	S
Devil	AH (N)	SVS	SVS	MR	MS*p*	S	MSS	MSS
Denison	APW	–	–	–	–	–	–	–
DS Bennett	Feed	R	SVS	RMR	–	–	S	VS
DS Pascal	APW	RMR	S	SVS	–	S	S	S
EGA Bonnie Rock	AH (N)	S	S	MS	S	SVS	–	–
EGA Wedgetail	APW	–	–	–	–	SVS	S	S
Emu Rock	AH	S	R	SVS	MS	MSS	S	MSS
Grenade CL Plus	APW	MSS	MR	SVS	–	MSS	R	S
Hammer CL Plus	AH	–	–	–	–	–	–	–
Harper	APW	MS	RMR	MSS	–	S	MRMS	S
Illabo	AH	RMR	R	MS	MS*p*	S	MRMS	S*p*
Kinsei	ANW	S	RMR	RMR	S*p*	S	MSS	MSS
Longsword	Feed	MS	MRMS	RMR	–	MRMS	MRMS	MSS
LRPB Cobra	AH	MSS	MS	SVS	MS	MSS	MS	S
LRPB Havoc	AH (N)	MS*Sp*	MS	R	–	S	S	MSS
LRPB Trojan	APW (N)	S	SVS	SVS	MS*p*	MSS	MS	MS
LRPB Nighthawk	APW	MSS	MSS	RMR	–	S*p*	MS*p*	MS*Sp*
Mace	AH (N)	MSS	S	MR	MRMS	MSS	MRMS	S
Magenta	APW	MRMS	MSS	SVS	MSS	MSS	S	MSS
Ninja	ANW	S	MR	RMR	–	S	MS	S
Razor CL Plus	ASW	MSS	RMR	RMR	–	S	MR	S
RockStar	AH (N)	MS*p*	SVS	MR*p*	–	MRMS	MS*Sp*	S*p*
Scepter	AH	S	MSS	MSS	MS	S	MRMS	MSS
Sheriff CL Plus	APW (N)	SVS	S	RMR	MS*Sp*	MRMS	MS	S
Sting	AH	–	–	–	–	–	–	–
Supreme	ANW	MS	MSS	SVS	–	MSS	S	MSS
Tungsten	AH	MS	MR	S	–	MSS	MS	S
Vixen	AH (N)	S	SVS	RMR	MS*p*	MRMS	MSS	S
Westonia	APW (N)	S	SVS	S	S	SVS	S	S
Wyalkatchem	APW (N)	SVS	SVS	RMR	MSS	MRMS	S	S
Yitpi	AH	MS	MR	S	MS	MSS	MR	S
Zen	ANW	S	MS	MR	MS*p*	MRMS	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. Combined *P. neglectus* ratings from DPIRD, SARDI, AgVic and USQ data. Not all varieties have been tested in WA. *P. quasitereoides* ratings are from DPIRD glasshouse and field trials. Provisional ratings provided for varieties with fewer than three observations or where there has been no field trial verification of the glasshouse rating. CCN ratings from GRDC NVT data. R = resistant – nematode numbers will decrease when this variety is grown. MR = Moderately resistant – nematode numbers will slightly decrease when this variety is grown. MS = Moderately susceptible – nematode numbers will slightly increase when this variety is grown. S = Susceptible – nematode numbers will increase greatly when this variety is grown. Crown rot ratings from SARDI, USQ and DPI NSW data.

VARIETY TRAITS

Coleoptile length and seeding depth

The longer the coleoptile, the better the chance of establishment if seeding depth increases. The ability to establish wheat crops from seed placed deeper in the soil could be useful in situations where the soil surface is dry, but the subsoil is moist.

Varieties have inherently different coleoptile lengths, and there is some evidence that seed size may improve germination. An index value for coleoptile length (Table 19) replaces reporting of a variety coleoptile length as short, medium or long.

- The majority of current wheat varieties have a coleoptile index of 6-7cm. Sowing the seed into moist soil at 2-4cm is preferred.
- Varieties with longer coleoptile indexes include Cutlass (7.3), Harper (8.1), Magenta (7.5) and Yitpi (7.8).
- If dry seeding, increase the seed rate as staggered emergence is a risk with a false break.
- The impact of deep sowing on grain yield depends on growing season conditions and whether low plant density can be compensated through increases in other yield components such as tiller number, grains per ear and grain weight.
- Not all seeding systems are equal for deep-sowing, so ensure depth is monitored as conditions change.
- Sowing deeper than 5cm when an advantage of earlier emergence is not possible will generally reduce yield.

Grain quality

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

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

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 19). There are several causes of low falling number in wheat, and these are controlled by complex interactions between genotype and the environment.

Pre-harvest sprouting, a common cause of low falling number whereby mature grain begins to germinate in the paddock in response to rainfall, is an example of this. The wheat variety grown, the seasonal environmental conditions (e.g. rainfall, temperature, humidity) it is subjected to and the stage of maturity during which these occur will all influence the falling number of a variety upon receival.

Since 2013, DPIRD have conducted research trials to better understand the susceptibility of wheat varieties to low falling number, both in response to growing conditions and rainfall in the pre- and post-maturation period.

The FNI is designed to inform growers of the relative differences between wheat varieties in their risk of exhibiting a low falling number at harvest. Varieties with a higher FNI have less risk to pre-harvest sprouting.

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 the FNI of 5. DS Pascal is considered the variety of lowest risk, and this is reflected in its FNI of 7. New varieties that have received a provisional rating in this 2021 guide include Catapult (rated 6*p*), Illabo (6*p*), Razor CL Plus (4*p*), RockStar (3*p*) and Sheriff CL Plus (4*p*).

TABLE 19. 2021 blackpoint ratings, falling number index and coleoptile index for wheat

Variety	Black point	Falling number index	Coleoptile index (cm)
Arrino	MS	2	6.8
Bremer	MRMS	5	6.8
Calingiri	MS	4	6.4
Catapult	MSS	6*p*	-
Chief CL Plus	MS	4	-
Corack	S	4	6.8
Cutlass	MS	4	7.3
Devil	MSS	3	-
DS Pascal	MS	7	6
EGA Bonnie Rock	MR	4	6.6
EGA Wedgetail	MS	-	-
Emu Rock	MSS	2	6.5
Grenade CL Plus	MSS	5	6.6
Harper	MRMS	5	8.1
Illabo	MRMS	6*p*	-
Kinsei	S	4	-
LRPB Cobra	MSS	2	6.6
LRPB Havoc	MS	3	-
LRBP Nighthawk	MS	-	-
LRPB Trojan	MS	5	-
Mace	MRMS	5	6.9
Magenta	MSS	3	7.5
Ninja	MRMS	4	-
Razor CL Plus	MS	4*p*	-
RockStar	MS	3*p*	-
Scepter	MS	5	6.6
Sheriff CL Plus	MRMS	4*p*	-
Supreme	MSS	4	5.7
Tungsten	MRMS	3	6.3
Vixen	MSS	3	-
Westonia	MS	2	7
Wyalkatchem	MS	3	6.4
Yitpi	MS	5	7.8
Zen	MRMS	3	6.6

Note: Coleoptile lengths (cm) are based on predicted mean length of main-season sown wheats at 55 NVT during 2007-2015. Screening of varieties was undertaken as part of the NVT project.

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

p = provisional rating based upon a single year of data.

Variety snapshots

Variety snapshots are presented for 21 varieties in order of quality classification.

Each snapshot includes a general comment describing essential characteristics of the variety and highlighting key strengths and weaknesses. Grain yields relative to Scepter for each year between 2015 and 2019 for each Agzone are presented as extracted from **nvtonline.com.au**. Disease ratings are as per Table 17.

Flowering information is sourced from DPIRD experiments in 2018 and 2019 and 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** and the respective breeding company.

ACKNOWLEDGEMENTS

The information contained in this guide is based on the work carried out by many research scientists, technical officers, plant breeders and service providers. The authors would like to thank the following groups and staff:

- DPIRD wheat Agronomy: Rod Bowey, Helen Cooper, Bruce Haig, Anne Smith and Melanie Kupsch.
- DPIRD biometrics: Andrew van Burgel.
- DPIRD plant pathology: Donna Foster, Ryan Varischetti, Hossein Golzar, Dorthe Jorgensen, Jason Bradley.
- DPIRD fungal soilborne diseases and nematology: Sarah Collins, Carla Wilkinson and Daniel Huberli.
- DPIRD research support: Carnarvon, Manjimup, Shenton Park (UWA), Geraldton, Merredin, Katanning and Esperance.
- Breeding companies: Australian Grain Technologies, InterGrain and LongReach Plant Breeders
- GRDC: NVT trials (grain yield and plant pathology data) and their service providers.
- SARDI Researcher Hugh Wallwork, for the blackpoint data as part of a NVT project.
- DPI NSW researcher Peter Mtthews for the coleoptile data as part of an NVT project.

CATAPULT(Þ)

AH

Comments

Catapult is a mid-long 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 Cutlass, LRPB Trojan and Magenta, but lower than Scepter in the main season trials. In the 2018 and 2019 early season NVT trials, Catapult was one of the highest yielding varieties, highlighting its suitablity for plantings towards the end of April. 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 has no significant effect on yield. Contact AGT for more info.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	-	-	-	92	94
Agzone 2	-	-	-	95	94
Agzone 3	-	-	-	93	95
Agzone 4	-	-	-	94	92
Agzone 5	-	-	-	92	92
Agzone 6	-	-	-	94	95
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS*p*				
Nodorum blotch (glume)	MRMS*p*				
S. tritici blotch	S*p*				
Yellow spot	MRMS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	S*p*				
Flag smut	RMR*p*				
Common bunt	MR*p*				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	S				
CCN	R				
Crown rot	S*p*				
Flowering	**Days after/before Scepter**				
2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	+7	+10	+10	+15	+4
Northam	+17	+15	+12	+1	+1
Katanning	+8	+6	+2	+2	+2
Gibson	+12	+9	+5	+3	+3
Agronomic traits					
Coleoptile length (cm)	–				
Black point	MSS				
Falling number index	6*p*				
Maturity	Mid-long				
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(Þ)

AH (N)

Comments

Devil is a short-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. 2018 and 2019 DPIRD trials suggest that Devil has different maturity triggers to Scepter resulting in earlier flowering in the northern regions when sown in April and early May. A falling number rating of 3 so not recommended for areas prone to pre-harvest sprouting.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	-	-	99	100	101
Agzone 2	-	-	100	102	101
Agzone 3	-	-	100	102	102
Agzone 4	-	-	101	100	100
Agzone 5	-	-	99	98	99
Agzone 6	-	-	99	100	100
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS*p*				
S. tritici blotch	S				
Yellow spot	MRMS				
Stem rust	MS				
Stripe rust	MR				
Leaf rust	SVS				
Powdery mildew	SVS				
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**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	-13	-7	-8	-4	-4
Northam	-7	-4	-4	-1	-3
Katanning	-5	-3	-2	-3	-2
Gibson	-6	-7	-4	-4	-1
Agronomic traits					
Coleoptile length (cm)	–				
Black point	MSS				
Falling number index	3				
Maturity	Short-mid				
Variety information					
Pedigree	IGW3110/Mace				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$3.50				

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

EMU ROCK(Þ)

AH

Comments

Emu Rock is a short 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 short maturing AH (N) Vixen.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	79	91	82	92	86
Agzone 2	85	86	89	85	91
Agzone 3	92	86	82	87	89
Agzone 4	89	90	88	88	90
Agzone 5	89	86	84	85	87
Agzone 6	83	87	86	86	78
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	SVS				
Nodorum blotch (glume)	MR*p*				
S. tritici blotch	S				
Yellow spot	MRMS				
Stem rust	MS				
Stripe rust	MRMS				
Leaf rust	SVS				
Powdery mildew	S				
Flag smut	R				
Common bunt	SVS				
RLN (*P. quasitereoides*)	MS				
RLN (*P. neglectus*)	MSS				
CCN	S				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	-26	-19	-17	-11	-9
Northam	-19	-12	-9	-5	-4
Katanning	-	-8	-8	-5	-3
Gibson	-	-18	-12	-10	-7
Agronomic traits					
Coleoptile length (cm)	6.5				
Black point	MSS				
Falling number index	2				
Maturity	Short				
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

HAMMER CL PLUS(Þ)

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. Hammer CL Plus has a provisional rating of R*p* for stripe rust, MR*p* for stem rust and MSS*p* 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)	2015	2016	2017	2018	2019
Agzone 1	-	-	-	-	-
Agzone 2	-	-	-	-	-
Agzone 3	-	-	-	-	-
Agzone 4	-	-	-	-	-
Agzone 5	-	-	-	-	-
Agzone 6	-	-	-	-	-
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	-				
Nodorum blotch (glume)	-				
S. tritici blotch	-				
Yellow spot	MRMS*p*				
Stem rust	MR*p*				
Stripe rust	R*p*				
Leaf rust	MSS*p*				
Powdery mildew	-				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	-				
CCN	-				
Crown rot	-				
Flowering	**Days after/before Scepter**				
2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	-	-	-	-	-
Northam	-	-	-	-	-
Katanning	-	-	-	-	-
Gibson	-	-	-	-	-
Agronomic traits					
Coleoptile length (cm)	-				
Black point	-				
Falling number index	-				
Maturity	Short-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(Ф)

AH (N)

Comments

LRPB Havoc is a short-mid maturity AH (N) variety released by LongReach in 2017. Over the last four 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*p* to powdery mildew.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	-	98	91	102	96
Agzone 2	-	89	100	96	99
Agzone 3	-	87	93	101	101
Agzone 4	-	96	95	98	95
Agzone 5	-	87	92	94	96
Agzone 6	-	86	91	95	96
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MS*p*				
S. tritici blotch	MRMS				
Yellow spot	MRMS				
Stem rust	S				
Stripe rust	MR				
Leaf rust	S				
Powdery mildew	MS*p*				
Flag smut	MS				
Common bunt	R				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	S				
CCN	S				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	-9	-7	-9	-4	-5
Northam	-5	-6	-3	-4	-4
Katanning	-	-4	-3	-4	-3
Gibson	-	-12	-6	-6	-6
Agronomic traits					
Coleoptile length (cm)	-				
Black point	MS				
Falling number index	3				
Maturity	Short-mid				
Variety information					
Pedigree	Mace/LPB07-0980				
Breeder/Seed licensee	LongReach Plant Breeders				
Access to seed	Seed associate and farmer to farmer (WA)				
EPR ($/t, excl GST)	$4.00				

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

MACE(Ф)

AH (N)

Comments

Mace is a short-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 1-4 or 91% in Agzones 5 and 6. Mace is a relatively low risk for pre-harvest sprouting, as indicated by it's Falling Number Index of 5.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	91	94	92	95	96
Agzone 2	92	91	96	95	97
Agzone 3	97	92	91	95	97
Agzone 4	93	95	95	95	96
Agzone 5	93	90	89	91	94
Agzone 6	90	93	90	93	94
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MS*p*				
S. tritici blotch	S				
Yellow spot	MRMS				
Stem rust	MRMS				
Stripe rust	RMR*				
Leaf rust	MSS				
Powdery mildew	MSS				
Flag smut	S				
Common bunt	MR				
RLN (*P. quasitereoides*)	MRMS				
RLN (*P. neglectus*)	MSS				
CCN	MRMS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	-4	-2	-5	-1	-3
Northam	-2	-2	+0	-2	-3
Katanning	-3	+0	-1	-3	-2
Gibson	-1	-2	-2	-4	-2
Agronomic traits					
Coleoptile length (cm)	6.9				
Black point	MRMS				
Falling number index	5				
Maturity	Short-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				

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

ROCKSTAR

AH (N)

Comments

RockStar is a mid-long AH (N) released in 2019 by InterGrain. It was included in the NVT for the first time in 2018 & 2019, yielding similar to Scepter and higher than other mid-long alternatives such as Catapult, Cutlass, 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 in 2019. RockStar has different maturity triggers than other mid-long varieties such as Cutlass, hence caution is recommended if sown in April, where frost may be an issue. A provisional falling number rating of 3 so appears to be a higher risk to pre-harvest sprouting.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	-	-	-	99	99
Agzone 2	-	-	-	102	97
Agzone 3	-	-	-	101	99
Agzone 4	-	-	-	101	94
Agzone 5	-	-	-	97	97
Agzone 6	-	-	-	103	105
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MRMS*p*				
Nodorum blotch (glume)	MR*p*				
S. tritici blotch	MSS*p*				
Yellow spot	MRMS				
Stem rust	MR				
Stripe rust	RMR				
Leaf rust	S				
Powdery mildew	MS*p*				
Flag smut	SVS				
Common bunt	MR*p*				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	MRMS				
CCN	MSS*p*				
Crown rot	S*p*				
Flowering	**Days after/before Scepter**				
2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	+4	+2	+1	+9	-1
Northam	+11	+7	+9	+3	+1
Katanning	+5	+6	+0	+0	-1
Gibson	+2	+2	+1	+0	+0
Agronomic traits					
Coleoptile length (cm)	-				
Black point	MS				
Falling number index	3*p*				
Maturity	Mid-long				
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

AH

Comments

Scepter, released in 2015, remains the yield benchmark in WA NVT, although it is similiar in yield to Devil and Vixen (2017-2019). This variety is MSS to the latest strain of leaf rust, which is an advantage over 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)	2015	2016	2017	2018	2019
Agzone 1	110	106	108	105	104
Agzone 2	109	110	104	106	103
Agzone 3	103	109	110	105	103
Agzone 4	108	106	105	105	105
Agzone 5	108	111	113	109	106
Agzone 6	111	108	111	108	107
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MSS*p*				
S. tritici blotch	S				
Yellow spot	MRMS				
Stem rust	MRMS				
Stripe rust	MR*				
Leaf rust	MSS				
Powdery mildew	S				
Flag smut	MSS				
Common bunt	MSS				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	S				
CCN	MRMS				
Crown rot	MSS				
Flowering	**Days after/before Mace**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	+4	+2	+5	+1	+3
Northam	+2	+2	+0	+2	+3
Katanning	+3	+0	+1	+3	+2
Gibson	+1	+2	+2	+4	+2
Agronomic traits					
Coleoptile length (cm)	6.6				
Black point	MS				
Falling number index	5				
Maturity	Short-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				

p = provisional assessment
* = Some races in estern Australia can attack these varieties

STING(b)

AH

Comments

Sting is a short-mid maturity, AH released in 2020 by AGT. It was present in the NVT for the first time in 2019, in which Sting yielded slightly above Scepter and slightly below Vixen. AGT suggest that Sting's maturity is similar to Corack and slightly faster than Mace. Sting is MSp to yellow spot.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	-	-	-	-	102
Agzone 2	-	-	-	-	104
Agzone 3	-	-	-	-	102
Agzone 4	-	-	-	-	105
Agzone 5	-	-	-	-	105
Agzone 6	-	-	-	-	95
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	-				
Nodorum blotch (glume)	-				
S. tritici blotch	-				
Yellow spot	MS*p*				
Stem rust	MRMS*p*				
Stripe rust	MR*p*				
Leaf rust	MSS*p*				
Powdery mildew	-				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	-				
CCN	-				
Crown rot	-				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	-	-	-	-	-
Northam	-	-	-	-	-
Katanning	-	-	-	-	-
Gibson	-	-	-	-	-
Agronomic traits					
Coleoptile length (cm)	-				
Black point	-				
Falling number index	-				
Maturity	Short-mid				
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

VIXEN(b)

AH (N)

Comments

Vixen is a short maturity, AH (N) released in 2018 by InterGrain. It has been in the NVT for three years where its yields are comparable to Scepter. 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)	2015	2016	2017	2018	2019
Agzone 1	-	-	87	105	102
Agzone 2	-	-	102	99	106
Agzone 3	-	-	-	102	105
Agzone 4	-	-	100	102	108
Agzone 5	-	-	101	103	106
Agzone 6	-	-	-	97	93
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	S				
Nodorum blotch (glume)	MS*p*				
S. tritici blotch	MSS				
Yellow spot	MRMS				
Stem rust	MRMS				
Stripe rust	MRMS				
Leaf rust	SVS				
Powdery mildew	S				
Flag smut	SVS				
Common bunt	RMR				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	MRMS				
CCN	MSS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	-26	-12	-14	-8	-4
Northam	-20	-11	-9	-3	-3
Katanning	-	-	-10	-10	-7
Gibson	-	-	-7	-7	-4
Agronomic traits					
Coleoptile length (cm)	-				
Black point	MSS				
Falling number index	3				
Maturity	Short				
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

YITPI

AH

Comments

Yitpi has been the Western Australian industry standard for early sowing because of its longer maturity and maintenance of falling number after pre-harvest rain. Yitpi has a long coleoptile but is SVS to yellow spot and S to stem and leaf rust. This variety has been superceded by several new mid-long maturity releases in recent years such as Cutlass.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	92	86	97	83	82
Agzone 2	85	87	84	86	85
Agzone 3	81	90	82	85	86
Agzone 4	90	81	92	85	83
Agzone 5	77	90	85	84	84
Agzone 6	78	95	89	88	83
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	RMR*p*				
S. tritici blotch	MRMS				
Yellow spot	SVS				
Stem rust	S				
Stripe rust	MRMS				
Leaf rust	S				
Powdery mildew	MS				
Flag smut	MR				
Common bunt	S				
RLN (*P. quasitereoides*)	MS				
RLN (*P. neglectus*)	MSS				
CCN	MR				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Geraldton	+21	+22	+15	+13	+8
Northam	+18	+20	+13	+8	+9
Katanning	+12	+12	+4	+3	+3
Gibson	+22	+15	+11	+6	+4
Agronomic traits					
Coleoptile length (cm)	7.8				
Black point	MS				
Falling number index	5				
Maturity	Mid-long				
Variety information					
Pedigree	C8MMC8HMM/Frame				
Breeder/Seed licensee	SeedNet				
Access to seed	SeedNet				
EPR ($/t, excl GST)	$1.00				

p = provisional assessment

CHIEF CL PLUS(Þ)

APW (N)

Comments

Chief CL Plus is an APW (N) imidazolinone tolerant variety which was released in 2016. This variety was the highest yielding APW imidazolinone tolerant variety in its four years of NVT trial data with yields which were competitive with Mace. Chief CL Plus is resistant to both pathotypes of 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)	2015	2016	2017	2018	2019
Agzone 1	-	94	100	95	91
Agzone 2	-	86	94	94	92
Agzone 3	-	87	90	95	95
Agzone 4	-	90	94	94	86
Agzone 5	-	86	87	88	90
Agzone 6	-	88	89	94	97
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MRMS*p*				
S. tritici blotch	S				
Yellow spot	MRMS				
Stem rust	MR				
Stripe rust	S				
Leaf rust	MR*				
Powdery mildew	S				
Flag smut	SVS				
Common bunt	MR				
RLN (*P. quasitereoides*)	–				
RLN (*P. neglectus*)	MRMS				
CCN	MS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	+9	+2	+1	+5	+3
Eastern	+6	+3	+4	+0	-1
Katanning	+1	+1	-2	-0	+0
Gibson	+3	+2	+2	-1	+1
Agronomic traits					
Coleoptile length (cm)	-				
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				
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

CORACK(Þ)

APW

Comments

Corack is an APW variety with a Wyalkatchem background which is suitable for sowings from mid-May. Corack is useful for planting where resistance to CCN, stem rust and yellow spot is required. Corack is less suitable to higher rainfall zones because of its susceptibility to black point and powdery mildew. This variety is SVS to the latest pathotype of leaf rust. Similar yields to Mace, however has been surpassed for yield by other varieties such as Scepter.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	86	93	90	99	96
Agzone 2	89	89	96	97	100
Agzone 3	97	89	90	99	101
Agzone 4	89	92	97	95	97
Agzone 5	96	89	90	91	96
Agzone 6	88	88	90	93	91
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MSS				
Nodorum blotch (glume)	MS*p*				
S. tritici blotch	S				
Yellow spot	MRMS				
Stem rust	MR				
Stripe rust	MS				
Leaf rust	SVS				
Powdery mildew	SVS				
Flag smut	MRMS				
Common bunt	MSS				
RLN (*P. quasitereoides*)	MSS				
RLN (*P. neglectus*)	MSS				
CCN	RMR				
Crown rot	S				
Flowering					
Selected NVT trials	**Days after/before Scepter**				
2016 (ave sowing date May 8)	-6				
2017 (ave sowing date May 24)	-4				
2018 (ave sowing date May 28)	-2				
Average	-4				
Agronomic traits					
Coleoptile length (cm)	6.8				
Black point	S				
Falling number index	4				
Maturity	Short-mid				
Variety information					
Pedigree	Wyalkatchem/Silverstar//Wyalkatchem				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.00				

p = provisional assessment

CUTLASS(b)

APW (N)

Comments

Cutlass is a variety which provides growers with a later maturing APW (N) option. Over the last five years, Cutlass has outyielded Yitpi, another longer 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-long 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)	2015	2016	2017	2018	2019
Agzone 1	100	91	103	87	84
Agzone 2	93	94	88	91	86
Agzone 3	84	94	89	89	88
Agzone 4	96	86	94	89	85
Agzone 5	82	96	93	90	87
Agzone 6	88	99	95	94	89
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MR*p*				
S. tritici blotch	MSS				
Yellow spot	MSS				
Stem rust	R				
Stripe rust	RMR*				
Leaf rust	R*				
Powdery mildew	S				
Flag smut	MSS				
Common bunt	S				
RLN (*P. quasitereoides*)	–				
RLN (*P. neglectus*)	MSS				
CCN	MR				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	+24	+23	+16	+12	+9
Eastern	+19	+21	+15	+8	+6
Katanning	+13	+13	+4	+5	+3
Gibson	+27	+18	+13	+10	+6
Agronomic traits					
Coleoptile length (cm)	7.3				
Black point	MS				
Falling number index	4				
Maturity	Mid-long				
Variety information					
Pedigree	RAC1316//Fang				
Breeder/Seed licensee	AGT				
Access to seed	AGT Affiliates, retailers, or Seed Sharing				
EPR ($/t, excl GST)	$3.00				

p = provisional assessment

* = Some races in estern Australia can attack these varieties

(N) denotes the supplementary classification of APWN

DENISON(b)

APW

Comments

Denison is an APW variety released by AGT in 2020. Denison was tested in a limited number of NVT sites in 2019, yielding similiar to Cutlass in Agzone 2 and slightly higher than Cutlass in Agzones 3 & 6 and lower than Cutlass in Agzone 5. AGT suggest that Denision's maturity is longer than Cutlass or Yitpi. Denison is S to the latest leaf rust strain.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	-	-	-	-	-
Agzone 2	-	-	-	-	86
Agzone 3	-	-	-	-	93
Agzone 4	-	-	-	-	-
Agzone 5	-	-	-	-	77
Agzone 6	-	-	-	-	95
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	-				
Nodorum blotch (glume)	-				
S. tritici blotch	-				
Yellow spot	MRMS*p*				
Stem rust	MR*p*				
Stripe rust	RMR*p*				
Leaf rust	S*p*				
Powdery mildew	-				
Flag smut	-				
Common bunt	-				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	-				
CCN	-				
Crown rot	-				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	-	-	-	-	-
Eastern	-	-	-	-	-
Katanning	-	-	-	-	-
Gibson	-	-	-	-	-
Agronomic traits					
Coleoptile length (cm)	-				
Black point	-				
Falling number index	-				
Maturity	Long (*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 TROJAN(ϕ)

APW (N)

Comments

LRPB Trojan is an APW (N) variety with a mid-long maturity. Trojan has a falling number rating of 5, which is similar to Mace. Trojan has a useful blackpoint rating and is MR to both leaf rust strains and to stripe rust, but is S to powdery mildew and MSS to yellow spot. Yields of Trojan have been surpassed by more recently released mid-long maturity varieties.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	91	93	94	87	81
Agzone 2	89	93	86	89	84
Agzone 3	86	93	88	88	85
Agzone 4	93	86	89	86	81
Agzone 5	84	95	88	82	81
Agzone 6	86	94	92	92	82
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MR*p*				
S. tritici blotch	MSS				
Yellow spot	MSS				
Stem rust	MRMS				
Stripe rust	MR				
Leaf rust	MR				
Powdery mildew	S				
Flag smut	SVS				
Common bunt	SVS				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	MSS				
CCN	MS				
Crown rot	MS				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	+10	+10	+5	+6	+4
Eastern	+10	+10	+3	+3	+2
Katanning	+12	+9	+1	+2	+1
Gibson	+10	+12	+11	+6	+7
Agronomic traits					
Coleoptile length (cm)	-				
Black point	MS				
Falling number index	5				
Maturity	Mid-long				
Variety information					
Pedigree	LPB 00LR000041/Sentinel				
Breeder/Seed licensee	LongReach Plant Breeders				
Access to seed	Free to trade farmer to farmer				
EPR ($/t, excl GST)	$4.00				

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

MAGENTA(ϕ)

APW

Comments

Magenta is an APW variety suitable for early to mid sowing opportunities. This variety has a good disease package so it's suitable for wheat on wheat situations. It also has a longer coleoptile than many other wheat varieties. Magenta has a low falling number index and is susceptible to black point, so is not suited to the south coast or areas that experience regular pre-harvest rainfall. Yields of Magenta have been surpassed by more recently released mid-long maturity varieties.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	102	93	102	85	79
Agzone 2	94	93	86	86	81
Agzone 3	83	94	89	85	83
Agzone 4	99	87	89	86	78
Agzone 5	81	95	89	84	81
Agzone 6	88	98	94	94	87
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MRMS				
Nodorum blotch (glume)	MRMS*p*				
S. tritici blotch	MRMS				
Yellow spot	MR				
Stem rust	RMR				
Stripe rust	MSS				
Leaf rust	RMR*				
Powdery mildew	MRMS				
Flag smut	MSS				
Common bunt	SVS				
RLN (*P. quasitereoides*)	MSS				
RLN (*P. neglectus*)	MSS				
CCN	S				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	+4	+3	+2	+9	+6
Eastern	+11	+7	+11	+7	+8
Katanning	+4	+6	+2	+3	+5
Gibson	+6	+7	+8	+3	+5
Agronomic traits					
Coleoptile length (cm)	7.5				
Black point	MSS				
Falling number index	3				
Maturity	Mid-long				
Variety information					
Pedigree	Carnamah/Tammin-18				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	$3.00				

p = provisional assessment

CALINGIRI

ANW

Comments

Calingiri has remained a popular mid-long maturing ANW. Its 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. To be downgraded to Feed for the 2022 harvest.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	94	89	99	83	84
Agzone 2	85	87	86	87	83
Agzone 3	84	90	85	85	85
Agzone 4	90	84	89	85	77
Agzone 5	76	88	79	77	78
Agzone 6	81	92	86	87	88
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MSS				
Nodorum blotch (glume)	MRMS*p*				
S. tritici blotch	MSS				
Yellow spot	MSS				
Stem rust	S				
Stripe rust	SVS				
Leaf rust	S				
Powdery mildew	S				
Flag smut	RMR				
Common bunt	MRMS				
RLN (*P. quasitereoides*)	S				
RLN (*P. neglectus*)	SVS				
CCN	–				
Crown rot	S				
Flowering					
Selected NVT trials	**Days after/before Scepter**				
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 length (cm)	6.4				
Black point	MS				
Falling number index	4				
Maturity	Mid-long				
Variety information					
Pedigree	Chino/Kulin//Reeves				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, excl GST)	nil				

p = provisional assessment

KINSEI(Ф)

ANW

Comments

Kinsei is a mid-long maturity 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. It is a notable improvement over Calingiri and Zen for early sowing. Kinsei has been in the NVTs for three years where it yields slightly less than Ninja, but out yields both Zen and Calingiri. Kinsei's disease ratings are marginally better than Ninja and Zen.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	-	-	103	93	94
Agzone 2	-	-	95	97	91
Agzone 3	-	-	97	95	94
Agzone 4	-	-	94	95	86
Agzone 5	-	-	90	85	86
Agzone 6	-	-	94	96	99
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MR*p*				
S. tritici blotch	S				
Yellow spot	MS				
Stem rust	MSS				
Stripe rust	MRMS				
Leaf rust	S				
Powdery mildew	S				
Flag smut	RMR				
Common bunt	RMR				
RLN (*P. quasitereoides*)	S*p*				
RLN (*P. neglectus*)	S				
CCN	MSS				
Crown rot	MSS				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	+10	+8	+6	+8	+5
Eastern	+17	+15	+9	+2	+1
Katanning	+11	+8	+3	+3	+4
Gibson	+11	+8	+7	+5	+2
Agronomic traits					
Coleoptile length (cm)	-				
Black point	S				
Falling number index	4				
Maturity	Mid-long				
Variety information					
Pedigree	Complex cross				
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. This variety is SVS to stem rust, S to powdery mildew and leaf rust. Rated MRMS to black point.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	103	99	102	95	94
Agzone 2	98	98	95	95	92
Agzone 3	95	99	97	95	93
Agzone 4	100	97	95	95	90
Agzone 5	93	98	94	91	90
Agzone 6	-	99	96	98	97
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MR*p*				
S. tritici blotch	MS				
Yellow spot	MRMS				
Stem rust	SVS				
Stripe rust	MS				
Leaf rust	S				
Powdery mildew	S				
Flag smut	MR				
Common bunt	RMR				
RLN (*P. quasitereoides*)	–				
RLN (*P. neglectus*)	S				
CCN	MS				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	+11	+6	+3	+6	+3
Eastern	+8	+8	+5	+1	+1
Katanning	+4	+2	+0	+1	+0
Gibson	na	na	na	na	na
Agronomic traits					
Coleoptile length (cm)	-				
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. It has a useful black point and RLN (*P.neglectus*) rating but has a weaker falling number index rating than Ninja and Kinsei.

Yield (% of Scepter)	2015	2016	2017	2018	2019
Agzone 1	96	96	97	95	93
Agzone 2	93	91	94	95	93
Agzone 3	95	92	93	96	95
Agzone 4	93	92	94	94	87
Agzone 5	91	90	87	85	87
Agzone 6	92	90	90	94	95
Disease resistance	**Adult rating**				
Nodorum blotch (leaf)	MS				
Nodorum blotch (glume)	MR*p*				
S. tritici blotch	S				
Yellow spot	MRMS				
Stem rust	S				
Stripe rust	MRMS				
Leaf rust	S				
Powdery mildew	S				
Flag smut	MS				
Common bunt	MR				
RLN (*P. quasitereoides*)	MS*p*				
RLN (*P. neglectus*)	MRMS				
CCN	S				
Crown rot	S				
Flowering	**Days after/before Scepter**				
2018 & 2019 DPIRD trials	**10-Apr**	**24-Apr**	**08-May**	**22-May**	**20-Jun**
Northern	+9	+4	+5	+6	+4
Eastern	+7	+8	+5	+2	+0
Katanning	+6	+4	+0	+0	+0
Gibson	na	na	na	na	na
Agronomic traits					
Coleoptile length (cm)	6.6				
Black point	MRMS				
Falling number index	3				
Maturity	Mid-long				
Variety information					
Pedigree	Calingiri/Wyalkatchem				
Breeder/Seed licensee	InterGrain				
Access to seed	Free to Trade				
EPR ($/t, excl GST)	$3.85				

p = provisional assessment

BARLEY

By Blakely Paynter, Jeremy Curry (DPIRD), Sanjiv Gupta (Murdoch), Geoff Thomas, Sarah Collins, Carla Wilkinson, Daniel Huberli, Kith Jayasena, Andrea Hills, and Dusty Severtson (DPIRD)

Introduction

The barley section of 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 2 of malt accreditation with Barley Australia and varieties only deliverable as feed (Tables 1 to 15; Figures 1 to 18).

The introduction of tariffs totalling 80.5% (comprising 73.6% as an anti-dumping duty and 6.9% as countervailing duties) on barley imports into China that were imposed on 19 May 2020 has made a material change to the export options for Australian malt and feed barley. While the China tariff decision is to be contested by the Australian barley industry, it is unlikely to be resolved quickly. In the meantime, the Australian barley industry is working with current and new end-users to find alternate markets for the malt and feed barley we have been exporting to China. In the short term, reductions in the price for feed barley and smaller premiums offered for malt barley will influence the area sown to barley, barley variety choice and the management package chosen.

As with previous years, the decision of 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:

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

At current market prices, there is likely to be a further reduction in the area sown to barley and a swing to a yield-centric, feed-quality focused production system for barley deliveries.

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 May-sowing targeting a density of 180-220 plants/m^2 with nutrition, herbicide and fungicide strategies in-line with the yield potential, deficiencies and risks of the site and the variety sown. Tables 1 and 2 outline key strengths and weakness of five established malt varieties and five new varieties that are currently under Barley Australia malt quality evaluation. New varieties (Beast, Buff, Laperouse, Leabrook and Maximus CL) are lifting the yield benchmark for barley relative to RGT Planet, Rosalind and Spartacus CL (relative yield is subject to regional and seasonal variation).

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 well as an awareness of CBH, Bunge and private

storage options. Growers are encouraged to deliver malt barley grain between 10.5-11.0% protein (even though the receival window is 9.5-12.8%) with a maximum of 20% screenings through 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. This makes choosing a variety or varieties that both suit a farming business and the needs of different customers complicated.

BARLEY VARIETY CHOICE IN 2021 – WHAT SHOULD I GROW?

Figure 1 outlines the change in variety popularity from 2018 to 2019 and is marked by a notable increase in the area sown to RGT Planet and Spartacus CL. In 2020, the area planted to RGT Planet and Spartacus CL is expected to increase again at the expense of La Trobe, Scope CL and Bass, with a rise in the popularity of Buff and Rosalind.

With the change in demand for WA malt barley due to tariffs imposed by China, 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.

Rosalind has been the yield benchmark in WA since its release and remains an attractive option when targeting high yielding feed barley 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.

New varieties such as Beast, Buff, Leabrook, Laperouse and Maximus CL are plausible competitors to the established varieties RGT Planet and Rosalind, based purely on yield potential. Sowing date, location, yield potential in different environments, disease pressure, soil type and herbicide systems will, however, drive individual choices.

Spartacus CL remains the most popular variety grown in WA and is likely to remain a suitable option as a malt variety in the future. Growers who are targeting feed-grade barley in an imi-herbicide management system should consider evaluating the performance of Maximus CL in their environment due to its improved yield performance in WA barley NVT (2018-2019).

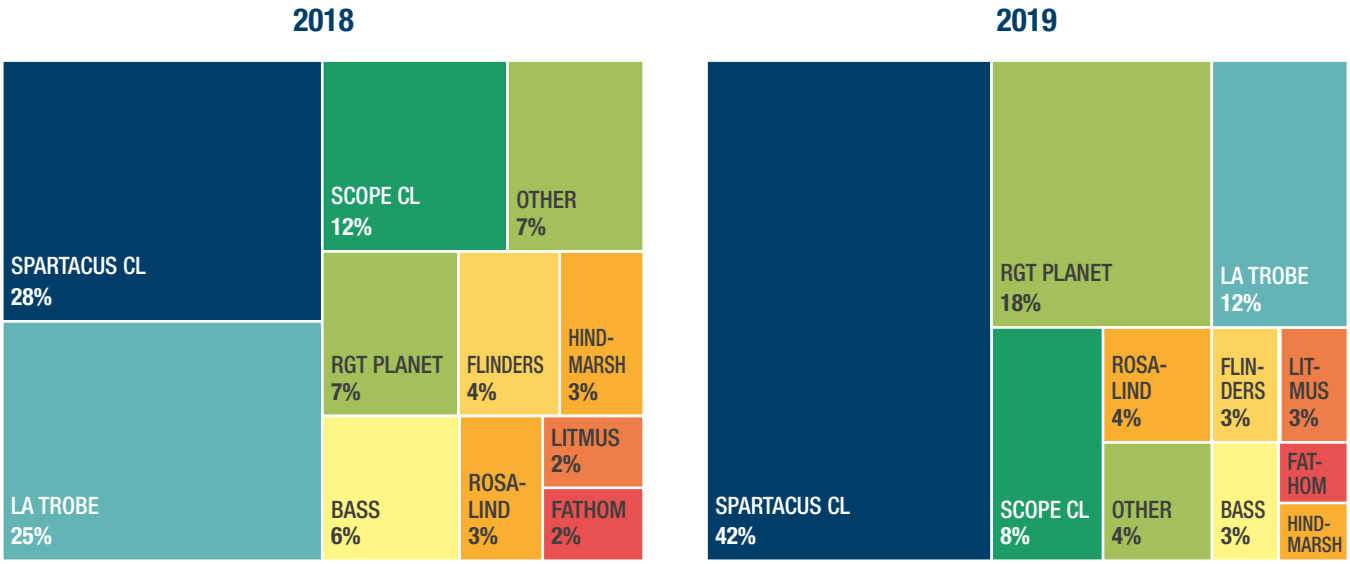


FIGURE 1. Popularity (per cent of barley area) of the top ten barley varieties plus the combined area sown to the other 20 varieties delivered in WA in 2018 and 2019. The top ten varieties occupied 93%, and 96% of the area planted to barley in 2018 and 2019 respectively.

Source: grower estimates as provided to CBH for 2018 and 2019

The preference of end-users for the quality of Bass, Flinders and La Trobe may see them remain an option for growers where malt grade barley is achievable, and malt premiums are offered (primarily in the Kwinana and Albany Port Zones). However, these varieties have been superseded for yield, and are likely to continue to decline in area sown. The domestic preference for Bass, Flinders and La Trobe may see the market offer a premium for them over RGT Planet and Spartacus CL.

There are also other options for specific agronomic situations like the sowing of Buff on soils with a sub-soil pH_{Ca} below 4.8; Scope CL for early sowing and grazing systems where an imidazolinone herbicide might be needed; Laperouse, Leabrook and Fathom where weed competition might be useful, or Fathom and Laperouse where spot-type net blotch (STNB) is a high risk.

Table 1 provides a comparison of six established barley varieties in WA, while Table 2 outlines some of the characteristics of five new barley varieties relative to Spartacus CL. More comments about each suggested barley variety for WA can be found in the variety snapshot section, with additional commentary on the newer barley varieties found in the following section 'What is new?'. For varieties received as malt, the 'Market feedback' section provides more specific market information published by the Grain Industry Association of Western Australia (GIWA).

WHAT IS NEW?

Barley lines in Stage 2 evaluation by Barley Australia that may be of interest to WA barley growers include Buff (tested as IGB1506), Leabrook (tested as WI4896), LG Alestar (tested as SMBA11-2341) and Maximus CL (tested as IGB1705T) (Table 2). As the seed of these varieties were available to growers in 2020, larger quantities of commercial seed are likely to be available in 2021. Also, SECOBRA Recherches, through SeedNet partners, will release limited quantities of Laperouse (tested as WI4592) for sale in 2021. Laperouse is in Stage 1 evaluation by Barley Australia. Commercial quantities of Beast (tested as AGTB0113), the first barley variety released by AGT, are also expected to be available for purchase in 2021. Beast has been accepted by Barley Australia for malting and brewing evaluation, with Stage 1 testing to commence in 2021.

Note that for any new variety under evaluation by Barley Australia, there is no guarantee of malt accreditation and market acceptance (and possible

TABLE 1. Summary of barley variety traits comparing Spartacus CL with five established barley varieties

Trait	Spartacus CL	Bass	Flinders	La Trobe	RGT Planet	Rosalind
First year in variety trials in WA	2014	2004	2007	2011	2016	2014
State-wide MET yield (% site mean)[1]	104%	93%	98%	105%	108%	112%
Maturity (sown in late May)	Early spring	Medium spring	Late spring	Early spring	Medium spring	Early spring
Deliverable as / accreditation stage[2]	Malt	Malt	Malt	Malt	Malt	Feed
Brewing demand (barley and malt)[3]	Acceptable	Preferred	Preferred	Preferred	Acceptable	–
Straw strength (excl. head loss)	Good	Very good	Very good	Moderately good	Good	Good
Scald	MR	MRMS	MSS	MR	MRMS	MSS
NTNB – Beecher virulent[4]	MSS	MRMS	MRMS	MS	SVS	MS
NTNB – Beecher avirulent	MS	MSS	MS	MS	MRMS	MR
NTNB – Oxford virulent	MSS	S	S	S	SVS	MSS
STNB	SVS	S	S	SVS	S	S
Powdery mildew	MRMS	MSS	R	MS	R	MRMS*
Leaf rust	MSS	SVS	MRMS (late APR)	S	MRMS (late APR)	MR

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

[1]Regional differences in grain yield are masked when using a state-wide average of the WA barley NVT MET data (2015-2019). 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: NTNB = net-type net blotch, STNB = spot-type net blotch, PM = powdery mildew, and APR = adult plant resistance.
*Rosalind may show a susceptible reaction in the presence of some strains of PM present in WA.

TABLE 2. Summary of barley variety traits comparing Spartacus CL with five new barley varieties

Trait	Spartacus CL	Beast	Laperouse	Leabrook	LG Alestar	Maximus CL
First year in variety trials in WA	2014	2019	2016	2015	2011	2018
State-wide MET yield (% site mean)[1]	104%	110%	109%	108%	98%	108%
Maturity (sown in late May)	Early spring	Early spring	Medium spring	Early spring	Medium spring	Medium spring
Deliverable as / accreditation stage[2]	Malt	Stage 0	Stage 1	Stage 2	Stage 2	Stage 2
Brewing demand (barley and malt)[3]	Acceptable	–	–	–	–	–
Straw strength (excl. head loss)	Good	–	Good	Fair	Good	Good
Scald	MR	SVS*p*	S	MSS	S	MR
NTNB – Beecher virulent[4]	MSS	MRMS*p*	MRMS	MRMS	MS	MSS
NTNB – Beecher avirulent	MS	MR*p*	MRMS	MRMS	MRMS	MRMS
NTNB – Oxford virulent	MSS	S*p*	S	S	MSS	S
STNB	SVS	MS*p*	MRMS	MS	S	MSS
Powdery mildew	MRMS	R*p*	R	MR	MR	RMR*
Leaf rust	MSS	MRMS*p* (APR)	S	MSS	MRMS	MSS

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

[1]Regional differences in grain yield are masked when using a state-wide average of the WA barley NVT MET data (2015-2019). 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: NTNB = net-type net blotch, STNB = spot-type net blotch, PM = powdery mildew, and APR = adult plant resistance. *Maximus CL may show a susceptible reaction in the presence of some strains of PM present in WA.

associated malt premiums). Therefore, be cautious in sowing large areas with the expectation of future segregations unless there is a clear agronomic or grain yield advantage for growing new varieties as a feed barley. Banks is an example of a variety failing in Stage 2 of Barley Australia accreditation. Compass is an example of a Barley Australia accredited variety not being segregated in WA.

When deciding which barley variety to sow, grain yield potential needs balancing 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. It is therefore vital to look across seasons and sites when assessing which variety best suits each farming business.

Why consider purchasing seed of Beast, Buff, Laperouse, Leabrook, LG Alestar and Maximus CL?

Beast

Key points:

- First barley variety released by AGT, who are well known for their wheat varieties such as Mace and Scepter.
- In Stage 0 assessment for malt accreditation in 2020, with the earliest accreditation date being March 2023.
- It is targeted for sowing in low to medium rainfall zones.
- Has only been tested in WA barley NVT for one season, so its strong performance exhibited in 2019 may or may not be representative of how it performs in subsequent and variable seasons.
- Scald and NTNB (Oxford virulent) need management.

Beast (tested as AGTB0113) is a tall height, early spring, two-row variety bred by AGT, and registered in August 2020. The breeder has advised that Beast (pedigree not yet released) is a Compass derivative, meaning Compass is one of its parents.

Beast has not yet undergone any evaluation by DPIRD in small plot trials (aside from phenology), and as such we have limited independent

information to help guide growers and industry of its weaknesses and strengths. With Beast only being tested in WA barley NVT for the first time in 2019, growers should not assume that its performance in 2019 will be representative of future performance. At least three seasons of data are generally required for a sound indication of long-term performance. Across 20 WA barley NVTs in 2019, Beast yielded less than RGT Planet in 15% of trials, the same in 15% and higher in 70%. Relative to Rosalind, it yielded lower in 30%, the same in 70% and higher in 0%.

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 similar plant height to Compass.

As Beast has only been screened in NVT disease trials in WA for one season (2019 only), its disease resistance ratings are provisional. Beast appears to have useful resistance to NTNB (Beecher virulent and avirulent), PM and BLR but may need management for scald and NTNB (Oxford virulent).

Seed is available for planting in 2021 from AGT Affiliates and resellers.

Buff

Key points:

- Like Litmus, has aluminium (Al) tolerance that improves grain yield in soil with low pH and high soluble Al.
- Supersedes Litmus due to more consistent yield across a range of soils and the absence of a blue aleurone that was present in Litmus.
- Grain yield is similar to or higher than Spartacus CL on non-acidic soils and higher than Spartacus CL on soils with an acidic profile.
- STNB, PM and BLR need management.
- Completed Stage 1 assessment by Barley Australia and has progressed to Stage 2. Due to the challenging season in 2019 in Buff-growing areas, there were insufficient quantities available for malting and brewing evaluation in 2020. Therefore, the earliest possible accreditation date for Buff has been delayed until March 2022.
- Grower production of Buff is increasing, particularly in the central and northern regions of WA.

Buff ((Yambla/3*VB0330)/(VB0229/3*VB0330)/(Haruna Nijo/4*VB0330)/(VB0128/98-041D*014/3*VB0330)/(Buloke/3*VB0330)) was tested as IGB1506. Buff is a medium height, early spring, two-row barley bred by Agriculture Victoria Service, licenced to InterGrain and registered in September 2018. Physically, Buff looks similar to Mundah (with Mundah representing 50% of its pedigree through VB0330) 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 Compass, Fathom, Leabrook, Mundah, La Trobe, Rosalind and Spartacus CL (where there are no imidazolinone residues) on non-acidic soils.

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. Unlike Litmus, Buff has a white aleurone, and its receival is not restricted as it is for Litmus (due to the blue aleurone trait in Litmus).

Buff has displayed a consistent yield advantage over Litmus, primarily on non-acidic soils. Across 27 barley NVT trials (2016-2017, 2019), Buff yielded less than Litmus in 8%, the same in 22% and higher in 70%. The overall yield advantage was 6% over Litmus across the trials (relative yield is subject to regional and seasonal variation).

The NVT multi-environment trial (MET) analysis (2016-2019) 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 56 WA barley NVT trials (2016-2019), Buff achieved the same yield as Spartacus CL in 29% of trials, a higher yield in 50% and a lower yield in 21% of trials. Buff appears to have an increased advantage over Spartacus CL as the site yield increases. Across 56 WA barley NVT trials (2016-2018), Buff yielded less than RGT Planet in 34% of trials, the same in 20% of trials and higher in 46%. Buff has a grain yield advantage over RGT Planet when the site yield is below 4t/ha and on acidic soils.

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

Relative to Litmus, Buff has improved tolerance to scald (as an adult) and NTNB (as both a seedling and an adult) but its disease resistance profile is poorer against PM. Relative to Spartacus CL, Buff has improved resistance to NTNB (Beecher virulent and avirulent) as an adult plant but weaker resistance to PM. Fungicides may be required to manage STNB, PM and BLR. The weak PM and BLR resistance of Buff will likely limit its practical use in higher rainfall areas.

Buff appears to be an improvement over Litmus for straw strength, although preliminary data from 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 2021 from Seedclub members and resellers. Seed is also free to trade farmer to farmer.

Laperouse

Key points:

- In Stage 1 assessment for malt accreditation in 2020, with the earliest accreditation date being March 2022.
- Improved adaptation, agronomic performance and grain yield over Commander in WA.
- Competitive with Rosalind for grain yield.
- Like Fathom, has intermediate resistance to STNB as an adult plant but better NTNB resistance.
- Scald and BLR need management.

Laperouse (WI4531/Commander//WI4593) was tested as WI4592. Laperouse is a medium height, medium spring, two-row barley bred by the now-defunct University of Adelaide barley-breeding program, licenced to SECOBRA Recherches, registered in September 2019, and is being commercialised by SeedNet.

Laperouse has been in WA barley NVT since 2016 and is a potential agronomic alternative to Bass, Flinders and RGT Planet (particularly where RGT Planet has been pushed as an early sowing option). In some areas, it could be an alternative to Fathom barley. Across 58 barley NVT trials (2016-2019), Laperouse has yielded less than Spartacus CL in 5% of trials, the same in 29% and higher in 66%. The overall yield advantage was 5% over Spartacus CL across these trials (relative yield is subject to regional and seasonal variation). Across 57 WA barley NVT trials (2016-2019), Laperouse yielded less than RGT Planet in 33% of trials, the same in 27% and higher in 40%. Laperouse appears to have a yield advantage over RGT Planet at sites where the site yield is below 4t/ha. Across 58 WA barley NVT trials (2016-2019), Laperouse yielded less than Rosalind in 34% of trials, the same in 57% and higher in 9%.

NVT pathology data indicates it has good tolerance to NTNB (except Oxford virulent) as an adult plant and matches Fathom for adult resistance to STNB (but Laperouse is susceptible as a seedling). Laperouse is less suited to areas where scald or BLR are regular constraints to production.

The breeder has indicated that Laperouse has good straw strength and head retention. Results from a single harvest delay trial at Gibson in 2019 concur with this observation but more data is needed to be more confident about the risk of Laperouse to lodging and head loss at harvest in WA.

Seed is available for planting in 2021 from SeedNet partners.

Leabrook

Key points:

- In Stage 2 assessment for malt accreditation in 2020, with the earliest accreditation date being March 2021.
- Similar agronomic attributes (including lodging risk) to Compass but with improved grain yield.
- BLR needs management.

Leabrook (County/Commander//Commander) was tested as WI4896. Leabrook is a tall height, early spring, two-row barley bred by the now-defunct University of Adelaide barley-breeding program, registered in September 2017, and is being commercialised by SeedNet. Due to its identical pedigree, Leabrook possesses many similar attributes to Compass including phenology, plant architecture and grain quality (i.e. lower than normal hectolitre weight combined with good grain plumpness) but with improvements in grain yield and malt quality (mostly malt extract).

Leabrook has been in WA barley NVT since 2015 and is a competitor to Buff (on non-acidic soils), Compass, Fathom, Laperouse, La Trobe and Spartacus CL (where there are no imidazolinone

residues) in low to medium rainfall zones. Across 85 WA barley NVT trials (2016-2019), Leabrook yielded less than Compass in 7% of trials, the same in 48% and higher in 45%. In the same trials, Leabrook yielded less than Spartacus CL in 16% of trials, the same in 33% and higher in 51%. The overall yield advantage of Leabrook across the trials was 2% over Compass and 3% over Spartacus CL (relative yield is subject to regional and seasonal variation). Across 64 WA barley NVT trials (2016-2019), Leabrook yielded less than RGT Planet in 38% of trials, the same in 23% and higher in 39%. Leabrook appears to have a yield advantage over RGT Planet at sites where the site yield is below 3.5t/ha.

The grain quality package of Leabrook is an improvement over Spartacus CL for grain plumpness and is comparable for grain brightness. However, Leabrook has a lower hectolitre weight and grain protein concentration than Spartacus CL (at the same grain yield). Relative to RGT Planet, the grain of Leabrook is plumper and brighter, with similar hectolitre weight and grain protein concentration (at the same grain yield).

Leabrook has a good overall disease resistance profile, being rated at least MSS to all leaf diseases (and their pathotypes) except BLR where it is susceptible. Lodging data collected in WA suggests that the straw strength of Leabrook is comparable to that of Compass. Fair straw strength may pose problems in higher-yielding years, high yielding environments (i.e. above 4t/ha) and when nitrogen supply is excessive. Straw strength is not expected to be a significant impediment to Leabrook's production in low to medium rainfall areas. Germ-end staining risk appears to be similar to Compass and La Trobe, with more data needed. There is not enough data to be definitive about the risk of head loss in Leabrook, but it does not appear to have a high risk.

Seed is available for planting in 2021 from SeedNet partners.

LG Alestar

Key points:

- In Stage 2 assessment for malt accreditation in 2020, with the earliest accreditation date being March 2021.
- Similar agronomic attributes to Granger.
- Similar grain yield to Flinders, with a generally inferior grain quality package.
- STNB needs management.

LG Alestar (Henley/NSL02-4136A) was tested as SMBA11-2341. LG Alestar is a medium height, late spring, two-row barley developed by Elders through its breeding partner Edstar Genetics from a cross made by Limagrain Europe. The grain of LG Alestar has a white aleurone, even though one of its parents Henley has a blue aleurone.

LG Alestar was first entered in WA barley NVT from 2011 until 2016 before being withdrawn in 2017 and then re-entered in 2019. It is a potential competitor to Bass, Flinders, Granger, La Trobe and RGT Planet in higher rainfall areas of WA.

LG Alestar has a higher grain yield than Bass, a similar grain yield to Flinders and is slightly below that of Granger across a range of site potentials. Across 47 WA barley NVT trials (2015-2016, 2019) LG Alestar yielded less than Granger in 55% of trials, the same in 45% and higher in 0%. Across 29 WA barley NVT trials (2016, 2019), LG Alestar yielded less than RGT Planet in 79% of trials, the same in 18% and higher in 3%.

The grain quality of LG Alestar is generally inferior to Bass and Flinders, with a lower hectolitre weight, higher screenings, comparable grain brightness and a lower grain protein concentration (at the same grain yield).

Relative to Bass, LG Alestar has improved resistance to PM and BLR and a comparable resistance profile to Flinders. The mechanism for resistance to PM in LG Alestar differs from Flinders and is based on the *mlo* gene, providing it with durable resistance. LG Alestar appears to possess additional resistance genes to BLR that are not yet characterised and not present in Flinders.

Lodging data collected in WA suggests that the straw strength of LG Alestar is comparable to that of Granger but is perhaps not quite as good as Bass or Flinders (noting regional and seasonal variation in straw strength exists). There are not enough data to be definitive on the head loss risk with LG Alestar.

Seed is available for planting in 2021 from Elders.

Maximus CL

Key points:

- In Stage 2 assessment for malt accreditation in 2020 with the earliest accreditation date being March 2021.
- Maximus CL possesses the gene conferring tolerance to label application rates of registered imidazolinone products.
- Similar agronomic attributes to Spartacus CL but with a higher grain yield potential and a different grain quality package.
- Some level of tolerance to all diseases except Oxford virulent NTNB and some pathotypes of PM.

Maximus CL (pedigree not yet released) was tested as IGB1705T. Maximus CL is a medium height, medium spring, imidazolinone-tolerant, two-row barley bred by Agriculture Victoria Services, licenced to InterGrain, and registered in November 2019. The plant architecture of Maximus CL is similar to Spartacus CL.

Maximus CL has been sown in WA barley NVT since 2018 and is a competitor to Buff (on non-acidic soils), Compass, Fathom, La Trobe, RGT Planet and Spartacus CL (where there are no imidazolinone residues). Across 40 WA barley NVT (2018-2019), Maximus CL yielded the same as Spartacus CL in 55% of trials and higher in 45%. It has yet to yield less than Spartacus CL in WA barley NVT trials. Across 39 WA barley NVT trials (2018-2019) Maximus CL yielded less than RGT Planet in 31% of trials, the same in 15% of trials and higher in 54%. Maximus CL appears to have a yield advantage over Spartacus CL at sites where the site yield is above 3t/ha and over RGT Planet at locations where the site yield is below 3.5t/ha.

The grain quality of Maximus CL is an improvement over Spartacus CL for grain plumpness, similar for grain protein concentration (at the same grain yield) but weaker for grain brightness with a similar or slightly lower hectolitre weight.

The main advantage of Maximus CL over Spartacus CL for disease resistance is with STNB, where Maximus CL is rated as MSS as both a seedling and an adult plant, while Spartacus CL is rated as SVS at both growth stages. It is possible that Maximus CL has different genes for resistance to PM than Spartacus CL and, therefore, may show variable reactions in the presence of some PM pathotypes.

Lodging data collected in WA suggest 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 data suggest it could be considered as 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 2021 from Seedclub members and resellers.

OTHER CONSIDERATIONS FOR BARLEY GROWERS

Changes in disease and insect pathogens

New pathotypes and new diseases detected in WA in recent years have ramifications for variety choice and fungicide strategies. Growers, particularly those on the south coast, should be watchful for the new and aggressive Oxford virulent NTNB pathotype, the newly identified leaf disease Ramularia leaf spot (RLS) and potential changes in the virulence of PM. The impact and likely distribution of fall armyworm and Russian wheat aphid (RWA) on barley production are unknown. Growers should be aware of that incursions of these new pests have been detected in the Geraldton (fall armyworm) and Esperance (RWA) port zones (as of August 2020) and be attentive when scouting. Suspected detections (or absence during scouting) should be reported using the MyPestGuide Reporter app (available at **agric.wa.gov.au/apps/mypestguide-reporter**), or by contacting the Pest and Disease Information Service (PaDIS) by calling +61 (0)8 9368 3080 or emailing **padis@dpird.wa.gov.au**.

Tips for managing grain protein in malt barley

The grain protein concentration of a crop is determined by the balance of nitrogen (N) supply and demand, a relationship that is heavily influenced by seasonal conditions. While it is common practice to apply the bulk of fertiliser N in the period 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 or Spartacus CL (where suitable) can result in up to 1% grain protein increase over 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 the N application.

Target plant density

When considering the rate of seed to be planted, it is essential to think in terms of 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 see a 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, then the target density can be adjusted down 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 2021/22 harvest

YES	This is a recommended variety for this production zone.
Limited	Limited segregations 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 only available if a marketer has sufficient tonnage to supply to a domestic or international customer. 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	YES	Limited	NO	NO	Limited	NO	Stable market demand with an excellent malt quality profile
Flinders	NO	NO	Niche	NO	NO	YES	Niche	Works well as a variety for post-malt blending and sugar-adjunct brewing
La Trobe	NO	Limited	Limited	Limited	Limited	Limited	Limited	Stable market demand with a recognised quality profile
RGT Planet	NO	YES	YES	NO	Limited	YES	YES	Market development for brewing end-use continuing
Spartacus CL	YES	YES	YES	YES	YES	YES	YES	Market development for brewing and shochu end-use continuing

Source: GIWA Barley Council

Market feedback

The following market feedback comes from Grain Industry Association of Western Australia (GIWA).

At the 2021/22 harvest, the following observations are relevant:

- The reduction in overall market demand for malt barley, associated with the tariffs imposed by China on the imports of Australian barley, favour the production of barley to maximise yield, reduce the focus on delivering grain suitable for segregation as Malt1, and will result in a further reduction of the total area sown to barley in 2021. Fortunately, the dominant barley varieties grown in Western Australia, RGT Planet and Spartacus CL, can be received into malt segregations, ensuring we can still respond to any increased demand for malt barley should market conditions change. Maintaining a supply of the premium malt varieties, Bass and Flinders, is critical to domestic processors and key international customers during this period of reduced demand and expected lower market price.
- Bass and Flinders will be the preferred malt barley varieties sought by the trade for malting and brewing end-use in south-east Asia and Japan, with demand for RGT Planet and Spartacus CL increasing in different market sectors.
- La Trobe is the preferred malt variety supplied to Japan for the manufacture of shochu. Associated with reduced grower production of La Trobe, limited segregations will be available for La Trobe to maintain supply to this premium market and support the needs of domestic processors.
- The rapid adoption of Spartacus CL has continued, with Spartacus CL now the most popular variety sown across all four port zones. Japan has proposed lifting the MRL for imazapyr from 0.1 to 0.7ppm. Should this occur in 2021, there is potential to export Spartacus CL to Japan for the manufacture of shochu, which would result in the phasing out of La Trobe after the 2021/22 harvest. If an import tolerance is implemented, shochu buyers will likely start making the switch over to Spartacus CL during the 2020/21 campaign.
- Scope CL has been phased out as a malt variety and will not be segregated after the 2020/21 harvest, as there is no longer any international demand for the malt profile of Scope CL barley. Growers can continue to sow Scope CL for the farming system benefits it offers and deliver it into feed segregations.
- Segregation opportunities for Bass, Flinders, La Trobe, RGT Planet, and Spartacus CL vary by port zone and for the Kwinana and Albany Ports, within a port zone (Table 3).

WHY RATIONALISE MALT VARIETIES?

In line with previous advice, the WA barley industry continues to support 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. Growing and segregating fewer malt varieties improves logistics, 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.

These malt barley variety receival recommendations have been developed by the Grain Industry Association of Western Australia (GIWA), through the GIWA Barley Council, in consultation with the Western Australian barley supply chain. The recommendations are a guide for growers and consultants to help with the planning of the 2021 barley cropping program. Review of the plan will occur in autumn 2021, and any changes in demand presented to growers. Malt variety recommendations in this document may differ to those in eastern Australia due to our focus on international markets.

While GIWA facilitates the publishing of 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 other sites may be able to offer two or more malt barley segregations. Growers can support segregation planning by submitting 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 is a breach of the Bulk Handling Act 1967.

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 new malt segregation adding to the cost of storage and handling.

The GIWA barley variety rationalisation plan attempts, therefore, 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 Western Australia has unique malting attributes. Consequently, brewers purchase varieties subject to their availability, their familiarity, their price, the 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 2021 (Table 3). In determining malt variety choice, market demand, pricing signals and the location of segregations 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 2021/22 harvest may differ to that proposed in this document. Growers should regularly liaise with their bulk handlers to confirm segregations.

The malt barley recommendations for the 2021 season are as follows:

Bass

- Bass is the ‘market leader’ for malt quality and is preferred for export as grain and as malt but has less competitive grain yield than other malt varieties in the marketplace. However, it has the highest selection rate for malt (aside from Flinders).
- 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.
- Can be malted without the use of the growth hormone gibberellic acid, an advantageous trait.
- Bass malt has excellent extract and filterability and is suited to markets where high levels of starch-adjuncts are used in the brewing process.
- Bass grain generally has a higher grain protein concentration than other malt varieties received, enhancing its preference from starch-adjunct brewers.
- Target production zone in 2021 is Kwinana-North (Midlands) with limited segregation opportunities in Kwinana-South and Albany-South (subject to production volumes).

Flinders

- Flinders is acceptable for export as grain and preferred for export as malt.
- Not suitable for the manufacture of shochu in Japan.
- Can be malted without the use of the growth hormone gibberellic acid, an advantageous trait.
- Flinders malt has excellent malt extract and filterability but at a lower enzyme potential than Bass malt.
- Flinders performs well in markets where sugar-adjunct brewing is practiced and when blended post-malting for starch-adjunct brewing markets.

- Growers in the Albany Port Zone who like the agronomic fit of Flinders on their farm are encouraged to talk to the domestic processors and consider delivering their grain to potential niche segregations in Kwinana-South rather than trucking to segregations in Albany-South.
- Target production zone in 2021 is Albany-South with potential niche segregation opportunities in Kwinana-South and the Esperance Port Zone (subject to production and demand).

La Trobe

- La Trobe is preferred for export as grain and as malt.
- La Trobe is a preferred variety for the manufacture of shochu in Japan and of the malt varieties segregated in Western Australia, is the only one accepted for that premium end-use.
- Widely accepted by all major malting and brewing customers of WA barley and malt.
- La Trobe malt has high extract with a high enzyme potential and is suitable for starch-adjunct brewing.
- Growers should be careful not to contaminate their seed stocks or ruin the integrity of La Trobe malt stacks by mixing them with either Hindmarsh or Spartacus CL barley or any other variety.
- Should Spartacus CL be accepted for shochu in Japan, La Trobe will be phased out.
- Due to reducing production volumes, limited segregations will be offered in Kwinana, Albany, and Esperance Port Zones in 2021.

RGT Planet

- RGT Planet is acceptable for export as grain and as malt.
- Not suitable for the manufacture of shochu in Japan.
- RGT Planet is used extensively in brewing markets in Europe and South America and is rapidly gaining acceptance in south-east Asian brewing markets.
- RGT Planet malt has excellent extract with a moderate enzyme potential and is suitable for starch-adjunct brewing.
- Target production zones in 2021 are Kwinana-North (Midlands), Kwinana-South, Albany-South, and Esperance Port Zones with limited segregation opportunities in Albany-North (subject to production volumes).

Spartacus CL

- Spartacus CL is acceptable for export as grain and as malt.
- Assessment of Spartacus CL for its suitability for the manufacture of shochu in Japan is on hold until there is a change in the import tolerances for imidazolinone residues in Japan. The MRL for imazapyr in Japan may be lifted from 0.1 to 0.7ppm during 2021, allowing Spartacus CL to complete its evaluation for shochu.
- Market feedback suggests that like La Trobe, Spartacus CL has high extract with very good enzyme potential and is suitable for starch-adjunct brewing.
- Growers should be careful not to contaminate their seed stocks or ruin the integrity of Spartacus CL malt stacks by mixing them with either Hindmarsh or La Trobe barley or any other variety.
- Use only 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 2021 are Geraldton, Kwinana, Albany, and Esperance Port Zones.

Grain yield

National Variety Trials (NVT) are managed by the Grains Research and Development Corporation (GRDC) to provide a nationally independent means of assessing varietal performance to 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 in comparison to the mean of the NVT site. Growers and consultants can select the state, region, location or group of locations of their choice to assist in choosing 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 are presented for each year (2015-2019) for each of the six Agzones in WA and then combined across the six Agzones to provide a state-wide 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 together environmental regions that give 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 2015 to 2019 helps explain the variability in relative varietal performance across seasons. While Agzones is a simple way to group trials across environments, it may not accurately reflect your location in every season.

Differences in comparative grain yield performance between varieties sometimes 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 'State-wide tables of yield and grain quality' available at **nvtonline.com.au**. Figures 2 to 6 use linear regression to compare varieties at different yield potentials and present varietal trends as the site mean yield increases (the average yield of the varieties compared).

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

TABLE 4. Grain yield of barley varieties in AGZONE 1 expressed as a per cent of the site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		1.78	4.22	2.07	4.29	1.18	3.02
Variety	(No. trials)	(1)	(2)	(2)	(2)	(1)	(8)
Deliverable as a malt variety							
Bass	(8)	87	94	93	95	91	**93**
Flinders	(6)	97	-	93	93	83	**93**
La Trobe	(8)	108	101	104	105	114	**105**
RGT Planet	(7)	-	106	101	103	100	**103**
Spartacus CL	(8)	111	99	102	103	111	**104**
Stage 2 malt accreditation							
Buff	(6)	-	111	120	116	134	**118**
Leabrook	(8)	106	107	110	113	130	**112**
LG Alestar	(2)	-	99	-	-	86	**-**
Maximus CL	(3)	-	-	-	108	120	**-**
Deliverable as a feed variety							
Banks	(8)	109	102	104	104	110	**105**
Beast	(1)	-	-	-	-	127	**-**
Compass	(8)	108	103	108	111	129	**110**
Fathom	(8)	104	106	113	114	133	**113**
Granger	(4)	102	-	95	-	85	**95**
Laperouse	(5)	-	106	-	111	125	**111**
Litmus	(6)	124	103	115	-	120	**112**
Mundah	(6)	107	-	105	102	110	**103**
Rosalind	(8)	126	106	114	113	130	**115**
Scope CL	(8)	101	99	105	103	110	**103**

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

TABLE 5. Grain yield of barley varieties in AGZONE 2 expressed as a per cent of the site mean yield for each trial year (2015-2019), and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		2.40	3.96	4.14	4.28	2.20	3.30
Variety	(No. trials)	(6)	(3)	(5)	(7)	(7)	(28)
Deliverable as a malt variety							
Bass	(27)	90	92	95	96	95	**94**
Flinders	(28)	100	94	97	96	95	**97**
La Trobe	(28)	110	99	101	105	109	**106**
RGT Planet	(21)	-	105	106	104	100	**104**
Spartacus CL	(28)	114	96	99	104	110	**106**
Stage 2 malt accreditation							
Buff	(21)	-	118	107	109	112	**110**
Leabrook	(28)	108	106	105	111	111	**109**
LG Alestar	(16)	97	99	-	-	94	**97**
Maximus CL	(14)	-	-	-	107	113	**109**
Deliverable as a feed variety							
Banks	(28)	109	102	102	104	106	**105**
Beast	(7)	-	-	-	-	114	**111**
Compass	(28)	109	102	102	109	113	**108**
Fathom	(28)	100	109	103	108	110	**106**
Granger	(21)	103	98	100	-	96	**99**
Laperouse	(19)	-	-	105	110	111	**109**
Litmus	(21)	110	108	99	-	112	**106**
Mundah	(23)	101	-	97	100	106	**101**
Rosalind	(28)	123	106	105	111	118	**114**
Scope CL	(27)	95	102	97	100	103	**99**

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

TABLE 6. Grain yield of barley varieties in AGZONE 3 expressed as a per cent of the site mean yield for each trial year (2015-2019), and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.80	3.59	4.40	3.63	4.28	3.96
Variety	(No. trials)	(5)	(1)	(2)	(3)	(4)	(15)
Deliverable as a malt variety							
Bass	(15)	88	90	90	94	93	**91**
Flinders	(15)	99	98	98	98	99	**99**
La Trobe	(15)	104	102	100	101	105	**103**
RGT Planet	(10)	-	111	112	109	109	**113**
Spartacus CL	(15)	103	101	99	99	106	**102**
Stage 2 malt accreditation							
Buff	(7)	-	-	-	107	105	**108**
Leabrook	(15)	110	105	105	105	108	**107**
LG Alestar	(10)	99	100	-	-	98	**99**
Maximus CL	(7)	-	-	-	103	109	**107**
Deliverable as a feed variety							
Banks	(15)	106	104	103	102	105	**104**
Beast	(4)	-	-	-	-	110	**110**
Compass	(15)	103	101	100	100	105	**102**
Fathom	(15)	98	100	100	100	100	**99**
Granger	(15)	105	103	103	102	102	**103**
Laperouse	(10)	-	107	107	106	110	**110**
Litmus	(8)	94	103	100	-	-	**98**
Mundah	(12)	89	-	93	94	96	**93**
Rosalind	(15)	114	111	108	105	112	**111**
Scope CL	(15)	88	95	94	95	94	**92**

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

TABLE 7. Grain yield of barley varieties in AGZONE 4 expressed as a per cent of the site mean yield for each trial year (2015-2019), and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		2.82	-	1.45	3.44	0.80	2.46
Variety	(No. trials)	(2)	(0)	(1)	(2)	(1)	(6)
Deliverable as a malt variety							
Bass	(6)	94	-	97	91	86	**92**
Flinders	(6)	99	-	98	94	84	**95**
La Trobe	(6)	112	-	125	97	104	**108**
RGT Planet	(4)	-	-	96	101	89	**99**
Spartacus CL	(6)	116	-	133	95	102	**110**
Stage 2 malt accreditation							
Buff	(4)	-	-	101	122	149	**117**
Leabrook	(6)	110	-	119	102	111	**109**
LG Alestar	(3)	95	-	-	-	95	**-**
Maximus CL	(3)	-	-	-	102	114	**-**
Deliverable as a feed variety							
Banks	(6)	108	-	114	102	107	**107**
Beast	(1)	-	-	-	-	117	**-**
Compass	(6)	113	-	128	100	114	**111**
Fathom	(5)	103	-	109	108	130	**110**
Granger	(4)	100	-	96	-	88	**97**
Laperouse	(3)	-	-	-	100	106	**-**
Litmus	(4)	109	-	115	-	154	**121**
Mundah	(6)	104	-	113	104	123	**109**
Rosalind	(6)	122	-	138	107	126	**120**
Scope CL	(6)	98	-	102	106	123	**106**

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 (2015-2019), and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.42	2.61	3.63	2.89	1.97	2.96
Variety	(No. trials)	(4)	(1)	(4)	(3)	(4)	(16)
Deliverable as a malt variety							
Bass	(16)	96	89	96	92	89	**93**
Flinders	(15)	100	-	100	99	97	**99**
La Trobe	(16)	111	96	103	105	117	**108**
RGT Planet	(12)	-	117	112	109	98	**108**
Spartacus CL	(16)	114	95	101	105	124	**110**
Stage 2 malt accreditation							
Buff	(12)	-	104	100	107	115	**105**
Leabrook	(16)	113	97	108	107	112	**109**
LG Alestar	(9)	94	105	-	-	93	**96**
Maximus CL	(7)	-	-	-	109	128	**113**
Deliverable as a feed variety							
Banks	(16)	107	102	103	105	113	**107**
Beast	(4)	-	-	-	-	126	**114**
Compass	(16)	112	90	103	104	118	**108**
Fathom	(16)	100	88	99	100	107	**101**
Granger	(16)	101	111	102	103	99	**102**
Laperouse	(12)	-	101	109	109	116	**112**
Litmus	(9)	92	93	88	-	-	**102**
Mundah	(15)	96	-	91	96	113	**98**
Rosalind	(16)	117	103	105	113	136	**117**
Scope CL	(9)	92	87	91	-	-	**95**

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 (2015-2019), and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.86	4.14	2.96	4.88	4.72	4.24
Variety	(No. trials)	(2)	(2)	(1)	(2)	(2)	(9)
Deliverable as a malt variety							
Bass	(9)	93	84	88	92	91	**90**
Flinders	(9)	104	100	110	100	101	**102**
La Trobe	(9)	102	96	87	98	101	**98**
RGT Planet	(7)	-	125	124	112	114	**118**
Spartacus CL	(9)	102	92	85	96	100	**96**
Stage 2 malt accreditation							
Buff	(4)	-	-	-	107	105	**103**
Leabrook	(9)	103	103	82	102	104	**101**
LG Alestar	(6)	101	104	-	-	101	**103**
Maximus CL	(4)	-	-	-	101	105	**101**
Deliverable as a feed variety							
Banks	(9)	103	103	97	102	103	**102**
Beast	(2)	-	-	-	-	107	**-**
Compass	(9)	97	91	72	96	98	**93**
Fathom	(9)	88	92	71	96	95	**90**
Granger	(9)	109	110	120	105	106	**109**
Laperouse	(6)	-	107	90	103	107	**104**
Litmus	(5)	84	89	84	-	-	**90**
Mundah	(7)	86	-	77	91	90	**86**
Rosalind	(9)	105	105	88	103	107	**103**
Scope CL	(5)	85	83	79	-	-	**87**

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

TABLE 10. Grain yield of barley varieties averaged across AGZONE 1-6 expressed as a percentage of the site mean yield for each trial year (2015-2019), and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.14	3.87	3.50	3.94	2.79	3.39
Variety	(No. trials)	(20)	(9)	(15)	(19)	(19)	(82)
Deliverable as a malt variety							
Bass	(81)	91	90	94	94	93	**93**
Flinders	(79)	100	97	98	96	97	**98**
La Trobe	(82)	108	99	101	103	108	**105**
RGT Planet	(61)	-	111	109	106	105	**108**
Spartacus CL	(82)	109	96	100	102	109	**104**
Stage 2 malt accreditation							
Buff	(54)	-	113	106	110	110	**108**
Leabrook	(82)	109	105	105	108	109	**108**
LG Alestar	(46)	97	101	-	-	96	**98**
Maximus CL	(38)	-	-	-	106	112	**108**
Deliverable as a feed variety							
Banks	(82)	107	102	103	103	106	**105**
Beast	(19)	-	-	-	-	114	**110**
Compass	(82)	107	99	101	105	109	**105**
Fathom	(81)	98	101	100	105	105	**102**
Granger	(69)	104	102	102	99	100	**101**
Laperouse	(55)	-	106	106	108	111	**109**
Litmus	(53)	98	101	97	-	108	**102**
Mundah	(69)	95	-	94	98	101	**97**
Rosalind	(82)	117	106	106	109	117	**112**
Scope CL	(70)	91	95	95	98	98	**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	Variety B	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			
Comparisons with RGT Planet							
Banks	RGT Planet	48%	28%	23%	64	2016-2019	Banks ≤ RGT Planet
Bass	RGT Planet	83%	16%	2%	63	2016-2019	Bass < RGT Planet
Beast	RGT Planet	15%	15%	70%	20	2019	Beast > RGT Planet
Buff	RGT Planet	34%	20%	46%	56	2016-2019	Buff = RGT Planet
Compass	RGT Planet	47%	16%	38%	64	2016-2019	Compass = RGT Planet
Fathom	RGT Planet	48%	16%	37%	63	2016-2019	Fathom = RGT Planet
Flinders	RGT Planet	80%	18%	2%	61	2016-2019	Flinders < RGT Planet
Granger	RGT Planet	75%	23%	2%	52	2016-2019	Granger < RGT Planet
La Trobe	RGT Planet	50%	19%	31%	64	2016-2019	La Trobe = RGT Planet
Laperouse	RGT Planet	33%	26%	40%	57	2016-2019	Laperouse = RGT Planet
Leabrook	RGT Planet	38%	23%	39%	64	2016-2019	Leabrook = RGT Planet
LG Alestar	RGT Planet	79%	17%	3%	29	2016,2019	LG Alestar < RGT Planet
Litmus	RGT Planet	56%	3%	41%	34	2016-2017,2019	Litmus = RGT Planet
Maximus CL	RGT Planet	31%	15%	54%	39	2018-2019	Maximus CL = RGT Planet
Mundah	RGT Planet	55%	20%	25%	51	2017-2019	Mundah = RGT Planet
Rosalind	RGT Planet	30%	22%	48%	64	2016-2019	Rosalind = RGT Planet
Scope CL	RGT Planet	63%	18%	20%	51	2016-2019	Scope CL ≤ RGT Planet
Spartacus CL	RGT Planet	50%	19%	31%	64	2016-2019	Spartacus CL = RGT Planet
Comparisons with Spartacus CL							
Banks	Spartacus CL	31%	39%	31%	85	2015-2019	Banks = Spartacus CL
Bass	Spartacus CL	85%	14%	1%	84	2015-2019	Bass < Spartacus CL
Beast	Spartacus CL	0%	50%	50%	20	2019	Beast ≥ Spartacus CL
Buff	Spartacus CL	21%	29%	50%	56	2016-2019	Buff ≥ Spartacus CL
Compass	Spartacus CL	14%	55%	31%	85	2015-2019	Compass = Spartacus CL
Fathom	Spartacus CL	48%	23%	30%	84	2015-2019	Fathom = Spartacus CL
Flinders	Spartacus CL	63%	24%	12%	82	2015-2019	Flinders ≤ Spartacus CL
Granger	Spartacus CL	49%	21%	31%	72	2015-2019	Granger = Spartacus CL
La Trobe	Spartacus CL	7%	86%	7%	85	2015-2019	La Trobe = Spartacus CL
Laperouse	Spartacus CL	5%	29%	66%	58	2016-2019	Laperouse ≥ Spartacus CL
Leabrook	Spartacus CL	16%	33%	51%	85	2015-2019	Leabrook ≥ Spartacus CL
LG Alestar	Spartacus CL	65%	19%	17%	48	2015-2016,2019	LG Alestar ≤ Spartacus CL
Litmus	Spartacus CL	44%	31%	24%	54	2015-2017,2019	Litmus ≤ Spartacus CL
Maximus CL	Spartacus CL	0%	55%	45%	40	2018-2019	Maximus CL ≥ Spartacus CL
Mundah	Spartacus CL	75%	21%	4%	71	2015,2017-2019	Mundah < Spartacus CL
RGT Planet	Spartacus CL	31%	19%	50%	64	2016-2019	RGT Planet = Spartacus CL
Rosalind	Spartacus CL	0%	13%	87%	85	2015-2019	Rosalind > Spartacus CL
Scope CL	Spartacus CL	69%	17%	14%	72	2015-2019	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	Variety B	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			
Comparisons with Rosalind							
Banks	Rosalind	79%	19%	2%	85	2015-2019	Banks < Rosalind
Bass	Rosalind	94%	5%	1%	84	2015-2019	Bass < Rosalind
Beast	Rosalind	30%	70%	0%	20	2019	Beast = Rosalind
Buff	Rosalind	45%	25%	30%	56	2016-2019	Buff = Rosalind
Compass	Rosalind	76%	24%	0%	85	2015-2019	Compass < Rosalind
Fathom	Rosalind	75%	20%	5%	84	2015-2019	Fathom < Rosalind
Flinders	Rosalind	89%	7%	4%	82	2015-2019	Flinders < Rosalind
Granger	Rosalind	71%	19%	10%	72	2015-2019	Granger < Rosalind
La Trobe	Rosalind	88%	11%	1%	85	2015-2019	La Trobe < Rosalind
Laperouse	Rosalind	34%	57%	9%	58	2016-2019	Laperouse ≤ Rosalind
Leabrook	Rosalind	54%	36%	9%	85	2015-2019	Leabrook ≤ Rosalind
LG Alestar	Rosalind	83%	8%	8%	48	2015-2016,2019	LG Alestar < Rosalind
Litmus	Rosalind	76%	15%	9%	54	2015-2017,2019	Litmus < Rosalind
Maximus CL	Rosalind	48%	53%	0%	40	2018-2019	Maximus CL ≤ Rosalind
Mundah	Rosalind	94%	6%	0%	71	2015,2017-2019	Mundah < Rosalind
RGT Planet	Rosalind	48%	22%	30%	64	2016-2019	RGT Planet = Rosalind
Scope CL	Rosalind	94%	6%	0%	72	2015-2019	Scope CL < Rosalind
Spartacus CL	Rosalind	87%	13%	0%	85	2015-2019	Spartacus CL < Rosalind

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

GRAIN YIELD – COMPARISONS

The highest yielding barley varieties in WA are Rosalind and RGT Planet (Figures 2 to 6, Tables 1, 2, 4 to 12). RGT Planet appears to have the highest yield at sites with a potential above 5t/ha. Buff has the advantage below 4t/ha and on soils with an acidic profile (pH_{Ca} below 4.8) while Rosalind has the advantage below 4.5t/ha. Banks and Compass are two other feed barley options. Neither, however, are yield competitive with RGT Planet (above 3t/ha) or Rosalind. Banks is worth considering for early sowing opportunities due to its longer duration to flower than RGT Planet and Rosalind. Compass is useful where a weed-competitive variety is beneficial in environments below 3t/ha.

RGT Planet is the highest yielding variety segregated for malt, being higher yielding in four of every five comparisons with Bass and Flinders, and in one of every two comparisons with La Trobe and Spartacus CL. The advantage of RGT Planet starts to appear above 3t/ha and becomes noticeable above 4t/ha. Still, for most growers with harvested yield most likely between 2-4t/ha, there is unlikely to be any significant difference between La Trobe, RGT Planet and Spartacus CL. Below 2t/ha, La Trobe and Spartacus CL have a clear advantage over RGT Planet.

While La Trobe and Spartacus CL yielded the same in nearly nine out of every ten WA barley NVT trials, La Trobe may have a slight advantage above 3.5t/ha. This subtle difference, however, will be relatively inconsequential when choosing whether to grow La Trobe or Spartacus CL. The need for an imidazolinone herbicide, the presence of imidazolinone residue, market signals and differences in grain quality will have a more significant bearing on which variety to grow. Growers have primarily switched to Spartacus CL over La Trobe, even in rotations where there is no imidazolinone herbicide use.

Three of the varieties undergoing Stage 2 malt accreditation (Buff, Leabrook, and Maximus CL) and one variety in Stage 1 malt accreditation (Laperouse) have a yield advantage over Bass, Flinders, La Trobe, and Spartacus CL above 1t/ha. These four varieties are also competitive with RGT Planet at higher yield potentials. Buff, Laperouse,

Leabrook and Maximus CL appear to be higher-yielding options than RGT Planet in environments where the site yield is below 4t/ha for Buff and Laperouse, and 3.5t/ha for Leabrook and Maximus CL. Current malt varieties Bass and Flinders, however, have only yielded higher ($p<0.05$) than RGT Planet at 2% of the WA barley NVT sites. La Trobe and Spartacus CL, on the other hand, have yielded higher than RGT Planet at 31% of barley NVT sites.

LG Alestar, the fourth variety in Stage 2 malt accreditation, has a similar grain yield to Flinders (yielding the same in three out of every four WA barley NVT). Based on grain yield only, LG Alestar is a less competitive option than Buff, Laperouse, Leabrook and Maximus CL. LG Alestar has yielded less ($p<0.05$) than RGT Planet in nearly four out of every five barley WA NVT trials and less than Spartacus CL in two-thirds of WA barley NVT.

Beast, a new entry in WA barley NVT in 2019, performed strongly in its first season in NVT. More years and locations of data are needed to confirm if will perform consistently in the WA environment, and where it will excel. Beast is in Stage 0 malt accreditation in 2020.

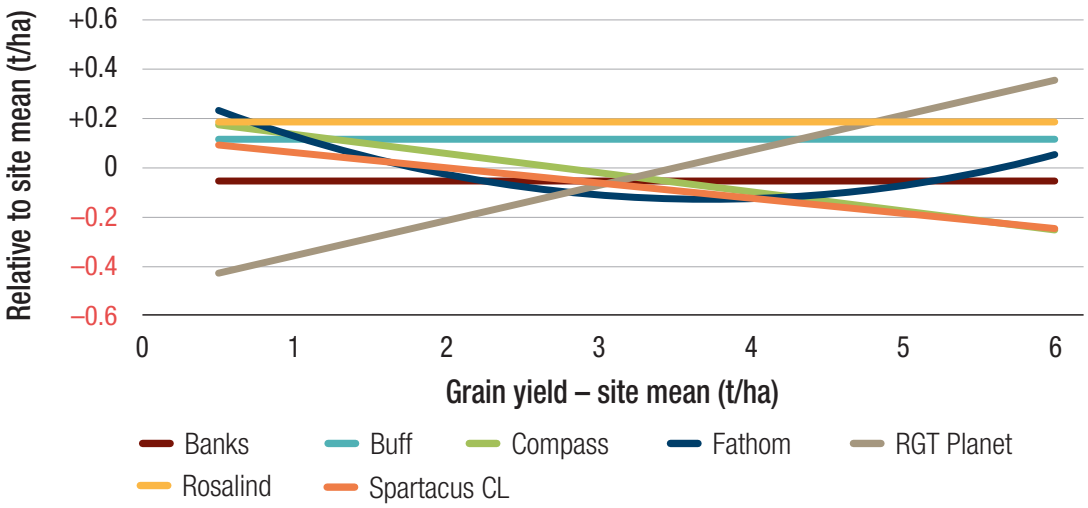


FIGURE 2. Fitted grain yield of Banks, Buff, Compass, Fathom, RGT Planet, Rosalind, and Spartacus CL at different site mean yields.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 54 trial-years of data.

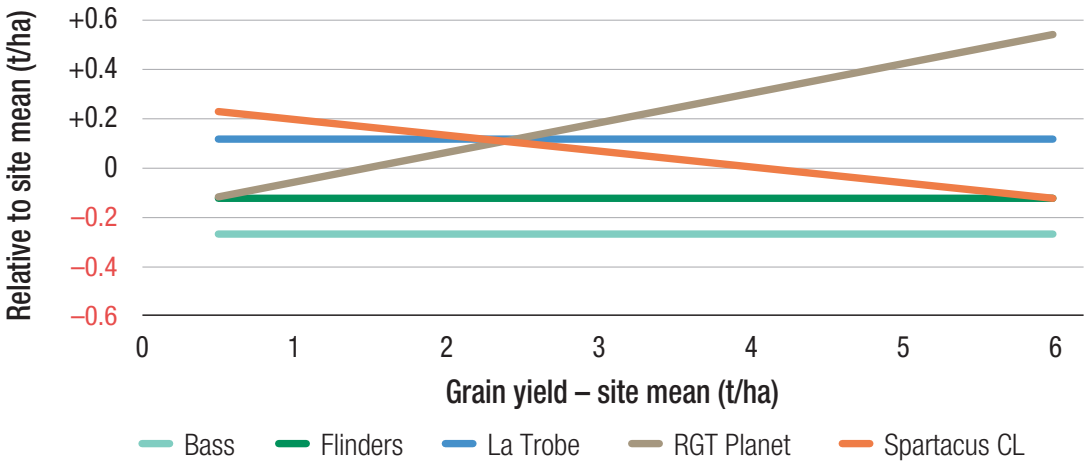


FIGURE 3. Fitted grain yield of Bass, Flinders, La Trobe, RGT Planet, and Spartacus CL at different site mean yields.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 58 trial-years of data.

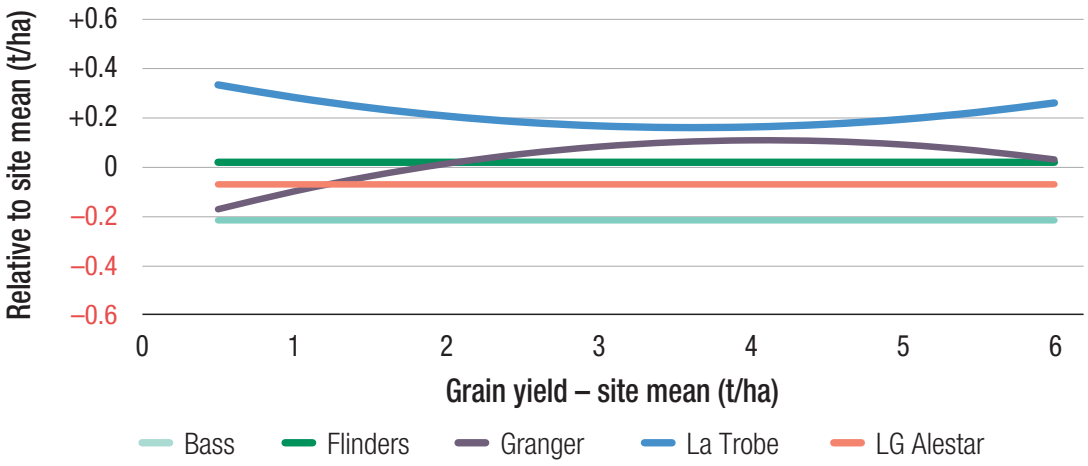


FIGURE 4. Fitted grain yield of Bass, Flinders, Granger, La Trobe, and LG Alestar at different site mean yields.

Source: based on NVT state-wide tables of yields and grain quality (2011-2016, 2019), **nvtonline.com.au**. Each variety sown in all 98 trial-years of data.

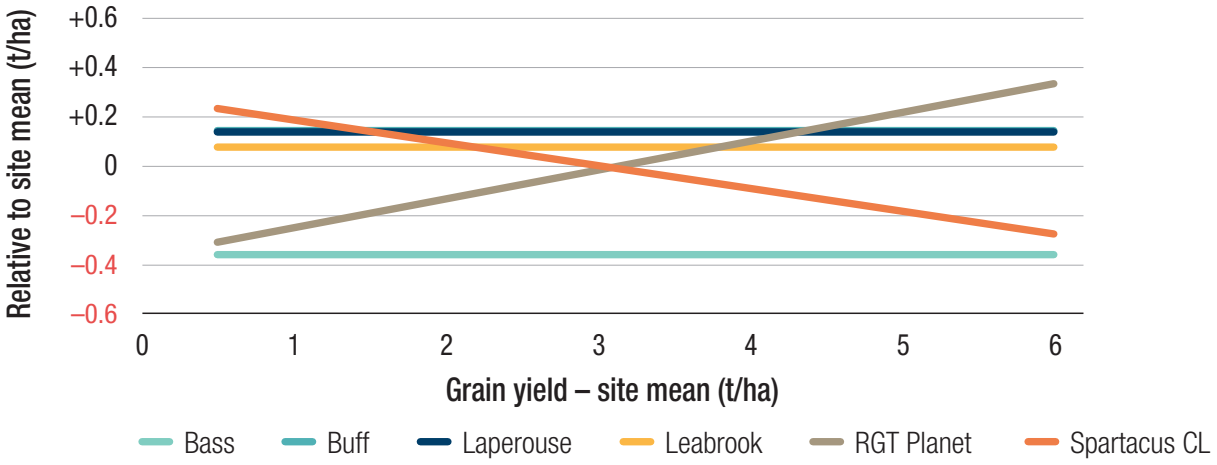


FIGURE 5. Fitted grain yield of Bass, Buff, Laperouse, Leabrook, RGT Planet, and Spartacus CL at different site mean yields.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 50 trial-years of data.

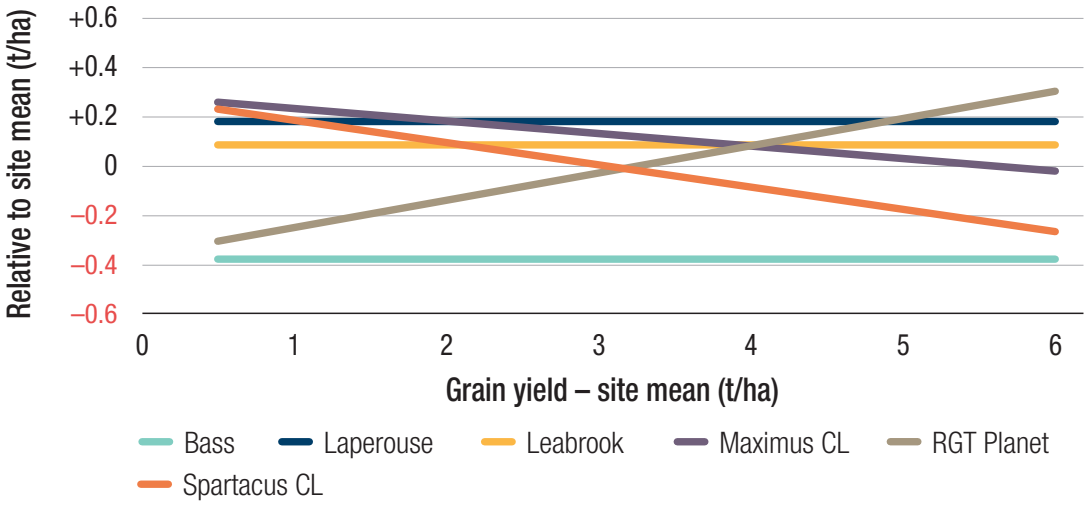


FIGURE 6. Fitted grain yield of Bass, Laperouse, Leabrook, Maximus CL, RGT Planet, and Spartacus CL at different site mean yields.

Source: based on NVT state-wide tables of yields and grain quality (2018-2019), **nvtonline.com.au**. Each variety sown in all 39 trial-years of data.

Grain quality

When comparing feed barley varieties, grain yield potential is a necessary trait to consider 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 almost equally as important for those chasing the premium on offer for delivery as a Malt1 barley.

As with the grain yield data presented in Figures 2 to 6, the physical grain quality (hectolitre weight, screenings through a 2.5mm slotted sieve and grain brightness) of a malt variety has been plotted relative to the site mean as the site mean increases (Figures 7 to 18). 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 'State-wide tables of yield and grain quality' tables available at **nvtonline.com.au**.

Figures 7 to 10 compare the hectolitre weight of varieties segregated for malt in WA and those under malting and brewing evaluation, Figures 11 to 14 present grain plumpness comparisons (per cent through a 2.5mm sieve), while Figures 15 and 18 depict grain brightness comparisons.

GRAIN QUALITY – HECTOLITRE WEIGHT COMPARISONS

Bass is the current benchmark variety for hectolitre weight of the five varieties segregated for malt in WA. Flinders, La Trobe, and Spartacus CL displayed a similar hectolitre weight to Bass over the four years from 2016 to 2019 (Figure 7). The hectolitre weight of RGT Planet was significantly lower, being 2-3kg/hL lower ($p<0.05$) than the other four varieties segregated for malt in WA. 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 grain shape of RGT Planet kernels.

Of the new varieties under evaluation for their malting and brewing potential, Buff, Leabrook, and LG Alestar are like RGT Planet in displaying a lower hectolitre weight than current malt varieties (Figures 8 to 10, $p<0.05$). The hectolitre weight of Laperouse and Maximus CL appears to be very similar to that of Bass ($p>0.05$).

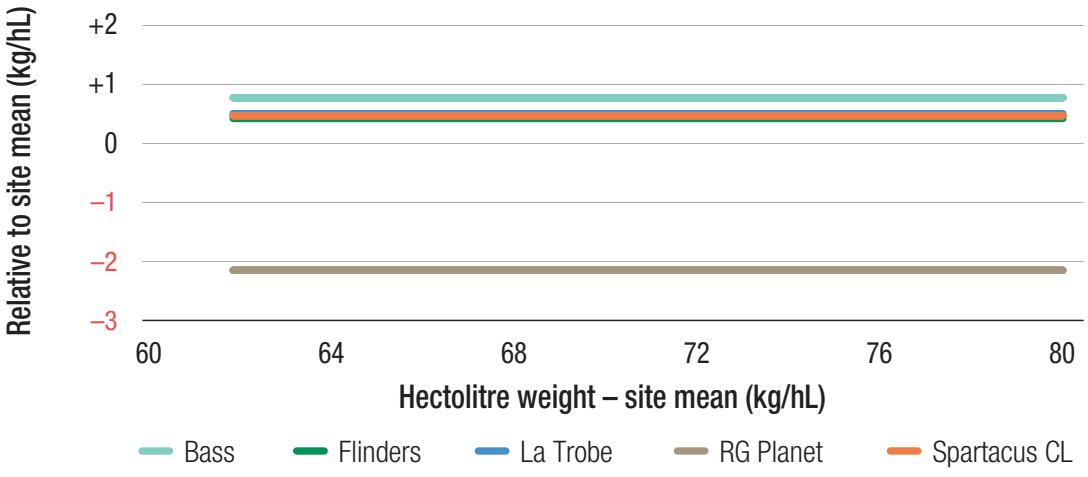


FIGURE 7. Fitted hectolitre weight of Bass, Flinders, La Trobe, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 58 trial-years of data.

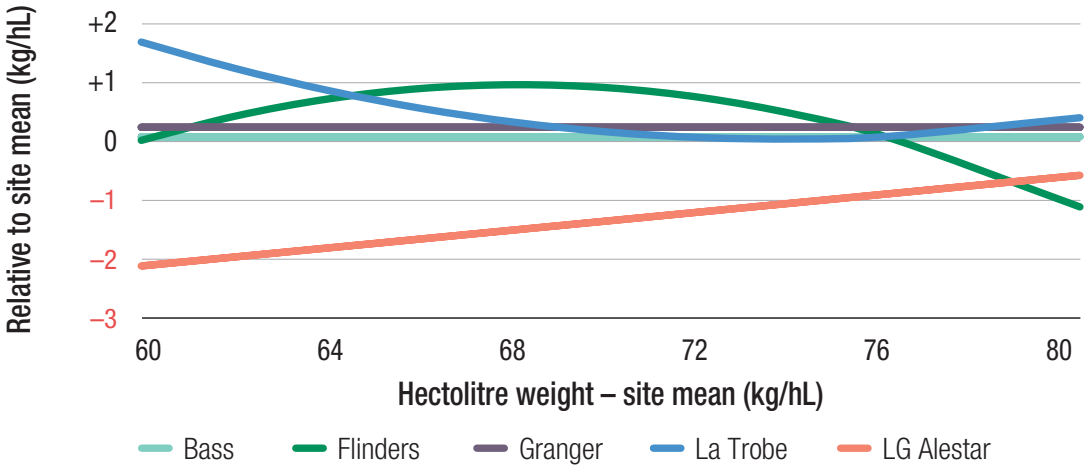


FIGURE 8. Fitted hectolitre weight of Bass, Flinders, Granger, La Trobe, and LG Alestar at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2011-2016, 2019), **nvtonline.com.au**. Each variety sown in all 98 trial-years of data.

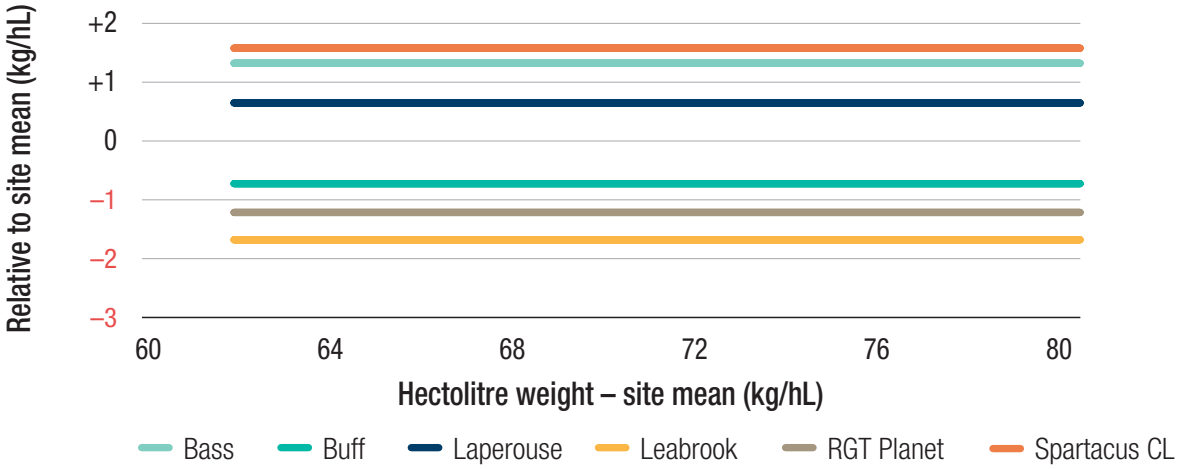


FIGURE 9. Fitted hectolitre weight of Bass, Buff, Laperouse, Leabrook, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 50 trial-years of data.

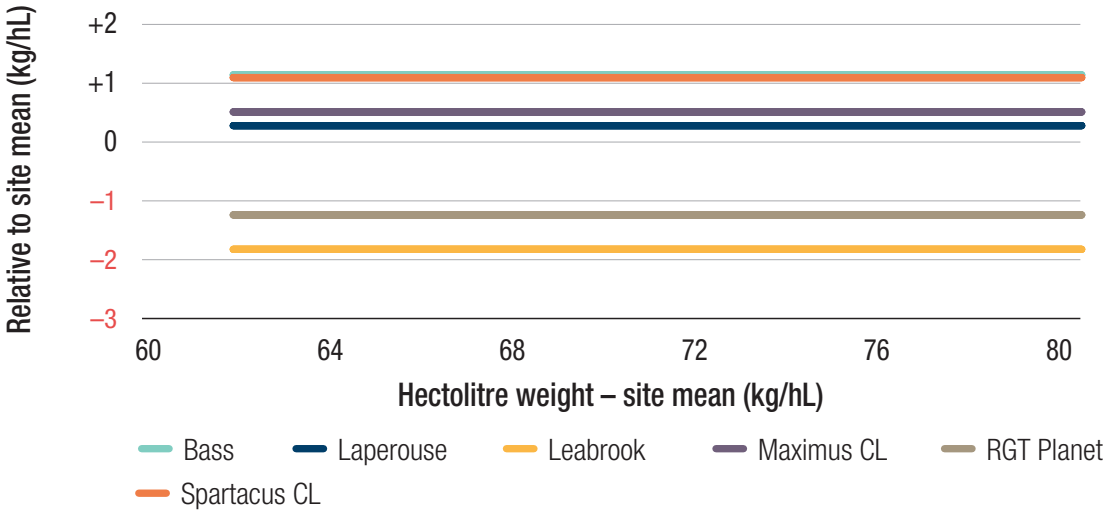


FIGURE 10. Fitted hectolitre weight of Bass, Laperouse, Leabrook, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2018-2019), **nvtonline.com.au**. Each variety sown in all 39 trial-years of data.

GRAIN QUALITY – GRAIN PLUMPNESS COMPARISONS

The benchmark malt variety for grain plumpness is Bass (Figure 8), showing lower screenings (per cent though a 2.5mm sieve) than the other varieties segregated for malt in WA over a range of screenings levels. Flinders, although generally less plump than Bass, showed improved plumpness compared to La Trobe and RGT Planet and was comparable to Spartacus CL from 2016 to 2019. Screenings of Spartacus CL are likely to be around 3% less than La Trobe under the same agronomy. RGT Planet appears to behave more like Baudin (data not shown) than Bass or Flinders, with screenings comparable to or slightly higher than La Trobe. At very low screenings, most varieties are similar. Around the Malt1 limit of 20% screenings, genetic differences are notable, and this may influence Malt1 selection rates across paddocks and seasons, and in response to management treatments.

Of the new varieties under evaluation for the malting and brewing potential, Laperouse, Leabrook and Maximus CL are plumper than Spartacus CL with Leabrook appearing to be plumper than Bass. Buff and LG Alestar appear to be between Spartacus CL and RGT Planet in their grain plumpness.

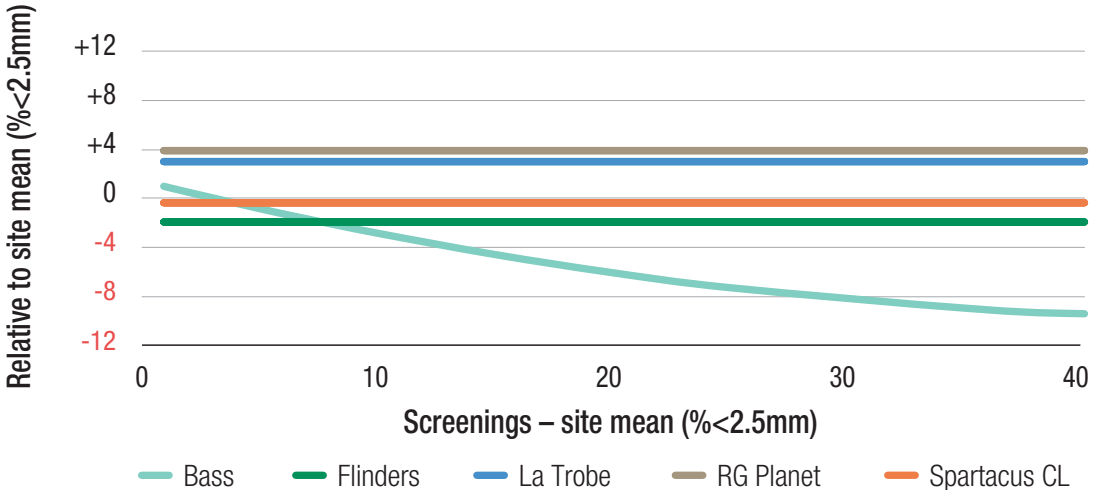


FIGURE 11. Fitted grain plumpness of Bass, Flinders, La Trobe, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 58 trial-years of data.

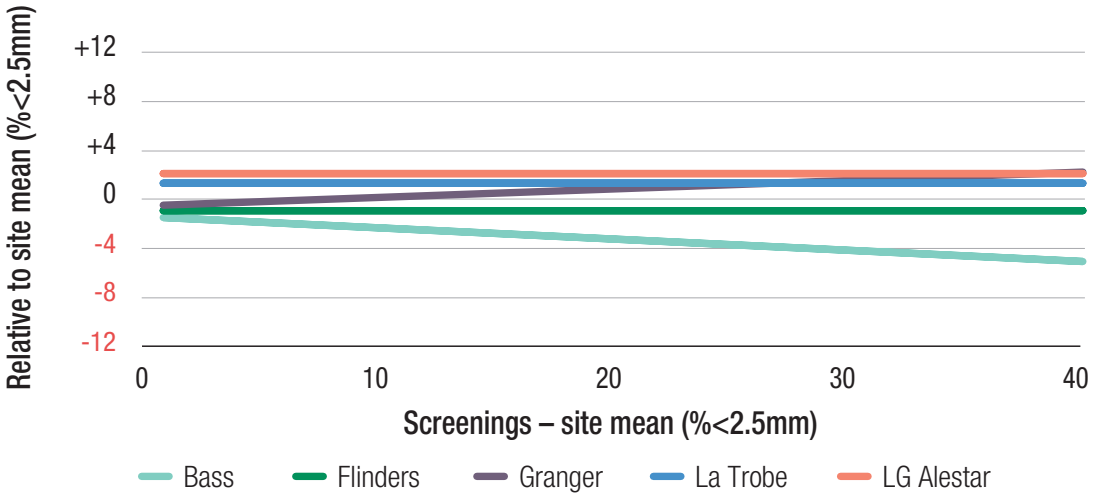


FIGURE 12. Fitted grain plumpness of Bass, Flinders, Granger, La Trobe, and LG Alestar at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2011-2016, 2019), **nvtonline.com.au**. Each variety sown in all 98 trial-years of data.

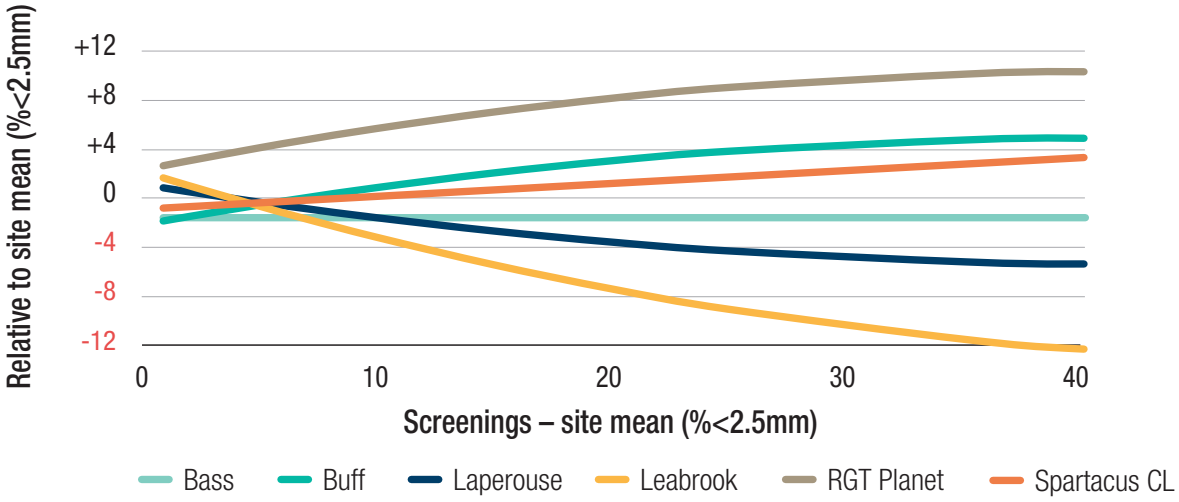


FIGURE 13. Fitted grain plumpness of Bass, Buff, Laperouse, Leabrook, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 50 trial-years of data.

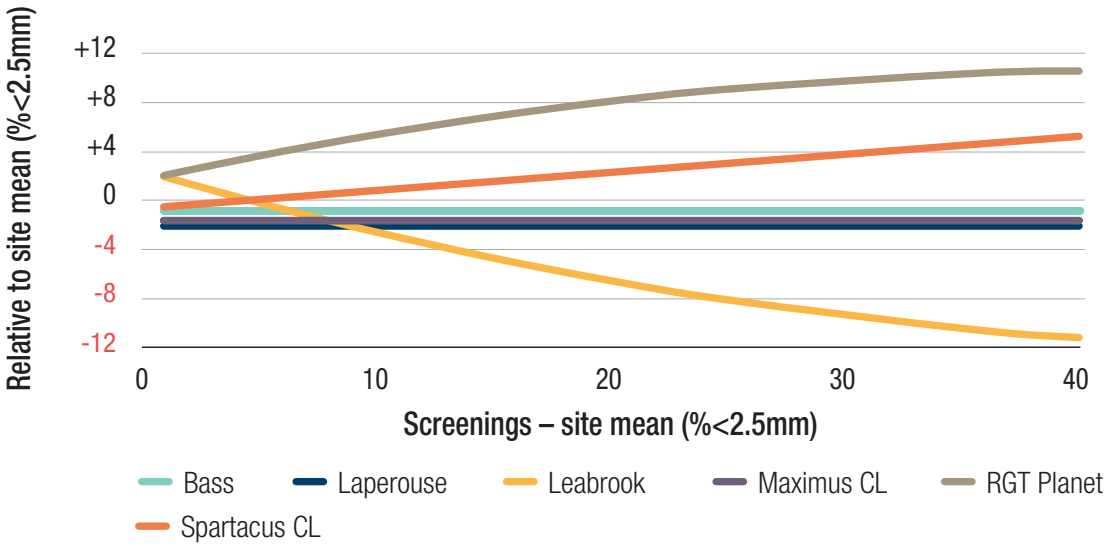


FIGURE 14. Fitted grain plumpness of Bass, Laperouse, Leabrook, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2018-2019), **nvtonline.com.au**. Each variety sown in all 39 trial-years of data.

GRAIN QUALITY – GRAIN BRIGHTNESS COMPARISONS

At grain brightness levels below 60'L*', the benchmark malt varieties are Bass and Flinders (Figures 15 and 16), which are similar to or slightly darker than the previous benchmark, Baudin (data not shown). La Trobe kernels can be up to 2'L*' darker than Bass kernels. The grain brightness of Spartacus CL is a slight improvement over La Trobe, being higher on average by 0.5'L*' ($p<0.001$) across a range of grain brightness levels. Below 60'L*' RGT Planet appears to have a grain brightness between Bass and La Trobe.

Of the new varieties under evaluation for their malting and brewing potential, LG Alestar is comparable to La Trobe but brighter than Granger. Below 60'L*' it is up to 0.5'L*' darker than Bass kernels (Figure 16). Buff and Laperouse appear to have good grain brightness being similar to Bass below 60'L*', while Leabrook is similar to Spartacus CL (Figure 17 and 18). Maximus CL has the darkest kernels of the newer varieties, being like RGT Planet. Below a grain brightness of 60'L*' its kernels are darker than Bass and Spartacus CL kernels.

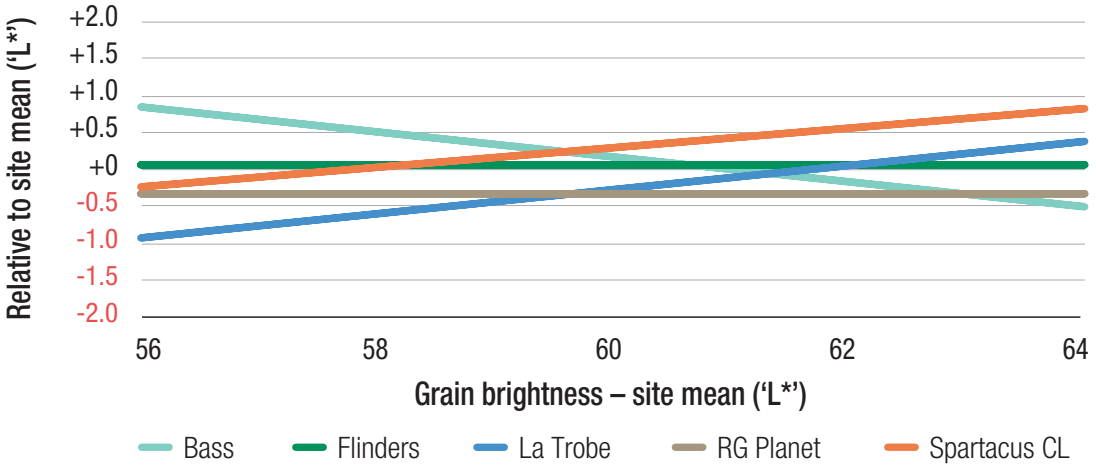


FIGURE 15. Fitted grain brightness of Bass, Flinders, La Trobe, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 58 trial-years of data.

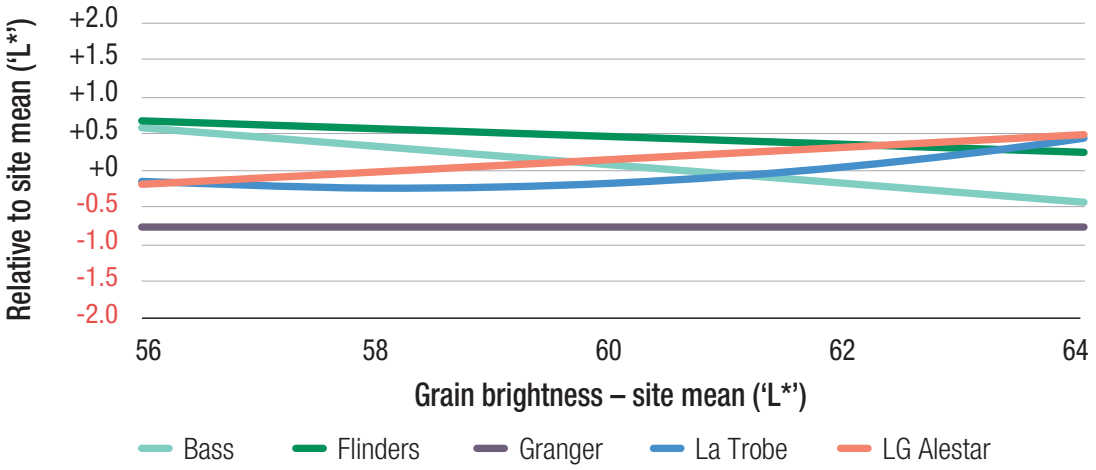


FIGURE 16. Fitted grain brightness of Bass, Flinders, Granger, La Trobe, and LG Alestar at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2011-2016, 2019), **nvtonline.com.au**. Each variety sown in all 94 trial-years of data.

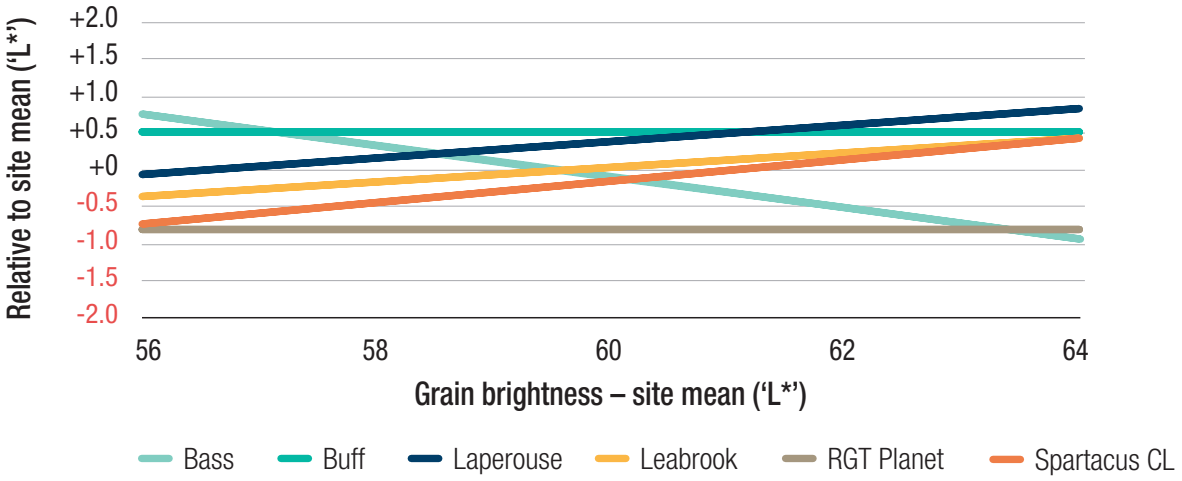


FIGURE 17. Fitted grain brightness of Bass, Buff, Laperouse, Leabrook, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 50 trial-years of data.

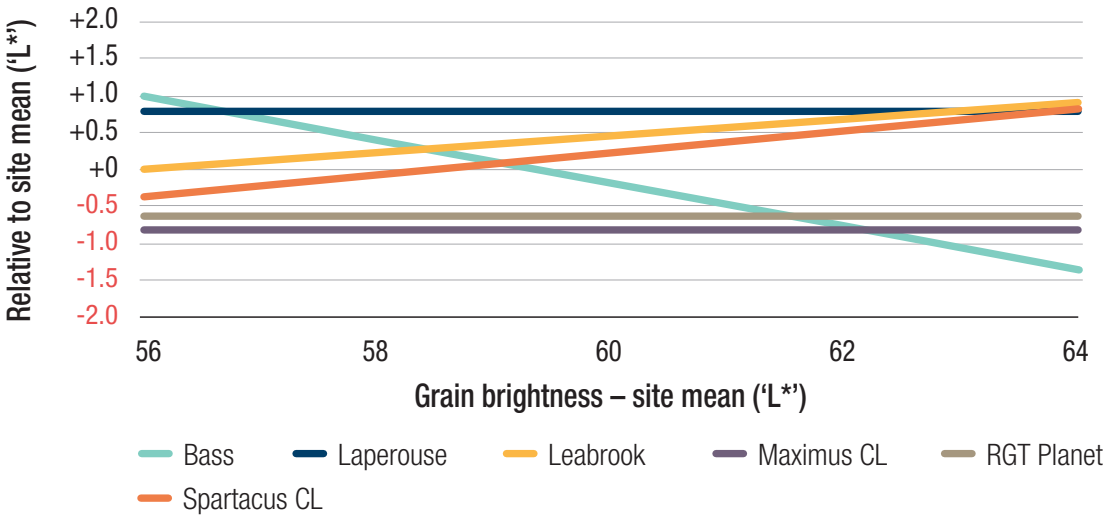


FIGURE 18. Fitted grain brightness of Bass, Laperouse, Leabrook, Maximus CL, RGT Planet, and Spartacus CL at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2018-2019), **nvtonline.com.au**. Each variety sown in all 39 trial-years of data.

Disease and pest resistance

Foliar disease abbreviations

- NTNB = net-type net blotch
- STNB = 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 again in the variety snapshots. Leaf disease ratings in this guide include both seedling and adult stage resistance ratings for the foliar leaf diseases NTNB, STNB, PM and BLR. There are no seedling data for scald, so only the adult stage resistance is presented.

Seedling ratings are applicable at early growth stages (two to the three-leaf stage) and are important for making decisions on the use of seed or fertiliser applied fungicide treatments. They are also useful for assessing the likely response of a variety if there is early disease pressure. Varieties susceptible to stubble-borne diseases such as scald, NTNB and STNB 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, in some varieties and for some diseases the adult ratings may be relevant as early as late tillering to stem elongation. Variations in seedling and adult ratings of a variety are mostly due to the differential effectiveness of resistance genes at one stage or the other.

The ratings of varieties may vary over time. Seasonal changes occur with time mainly due to differences in disease pressure, the spread of the disease in the region, changes in climatic conditions, stubble retention and development of new pathotypes/races. There have been some minor changes in the resistance score of the varieties listed since the last sowing guide, usually up or down one resistance score. Still, there have been no significant changes in resistance score as the result of a new pathotype in this guide.

NEW PATHOTYPE – NET-TYPE NET BLOTCH (NTNB)

Be watchful for increasing NTNB with a new aggressive pathotype, named Oxford virulent, detected across the south coast. Banks and Granger have the best overall resistance to this new pathotype, being rated as MRMS as seedlings and MS as adult plants. The next best resistance is Buff (MS as seedling and adult), and Rosalind (MSS as seedling and adult).

NEW LEAF DISEASE – RAMULARIA LEAF SPOT (RLS)

Growers should also be watchful for the new leaf disease RLS caused by the fungus *Ramularia collo-cygni*. In 2018, RLS detections occurred in three separate locations across the south coast of WA. Testing in 2019 showed that it was present in seed samples from the mid-west, central and southern wheatbelt, including low rainfall areas. This disease was first detected in Tasmania in 2016 and then WA in 2018. It is also present in our neighbouring countries New Zealand (first detected in 1997) and South Africa (first detected in 2015) as well as being found in important barley growing regions in Europe and South America.

Where established, yield losses commonly up to 25% and in extreme cases up to 70% are reported through a significant decrease of kernel size and quality. The fungus is primarily a disease of barley, however, can infect a wide range of hosts including oats, wheat and some other grasses. Infected seeds are likely to be the primary source of long-distance disease spread and introduction to new areas. More localised disease spread is from airborne spores coming from infected barley and grasses. However, this generally requires prolonged periods of leaf wetness. As a result, we expect a higher level of RLS incidence in the medium and high rainfall areas.

Identification of the disease can be difficult as lesions are generally not evident until after flowering. RLS can be easily confused with other similar fungal leaf spotting diseases such as STNB or abiotic symptoms caused by physiological leaf spotting (PLS) and boron toxicity (however, these abiotic spots are not likely to respond to fungicide application). The potential impact this disease may have in WA barley crops is unknown. There are no specific management recommendations for the disease in WA at this stage although the fungicides currently used to manage net blotches in barley, when applied at the booting stage, are likely to be active on RLS. Note that RLS is at high risk of developing fungicide resistance and the sustainable rotation of fungicides should always be practised to avoid this.

NEW INSECT PEST – FALL ARMYWORM

Be watchful for the presence of a new insect pest, fall armyworm (*Spodoptera frugiperda*). Fall armyworm was first detected in WA in Kununurra in March 2020 and since then has been progressively detected at more southern locations. A single adult moth was collected in a pheromone trap located near Geraldton in late July 2020. The potential presence and impact of fall armyworm on cereals, canola and pulse crops at various growth stages are not yet known. Until we acquire a greater understanding of fall armyworm in southern grain-growing regions of WA, growers should monitor their crops for fall armyworm in a similar way as they do for existing caterpillar pests. Fall armyworm is similar in size to existing caterpillar pests and causes comparable damage to vegetative and reproductive parts of plants.

Suspected detections of fall armyworm should be reported using the MyPestGuide Reporter app (available at **agric.wa.gov.au/apps/mypestguide-reporter**), or by contacting the Pest and Disease Information Service (PaDIS) by calling **+61 (0)8 9368 3080** or emailing **padis@dpird.wa.gov.au**.

PATHOTYPE SURVEILLANCE AND FUNGICIDE RESISTANCE

Growers and consultants observing barley varieties rated as MRMS, MR or R to leaf disease that are carrying significantly higher levels of disease 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, NTNB, STNB and BLR leaf material in paper envelopes marked with the location, variety, disease and date collected. Fold the leaf in half so infected area is on the inside. Please do not wrap leaf material in plastic or send in plastic-lined envelopes. Unlike other leaf diseases, it is preferable for PM that infected leaves are 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, NTNB and STNB 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**.

Forward samples of PM infected leaf material (placed into agar tubing) to the Centre for Crop and Disease Management (CCDM), Curtin University, Kent Street, Bentley, WA 6102. To arrange sample collection kits, contact Simon Ellwood via email at **simon.ellwood@curtin.edu.au** or phone **+61 (0)8 9266 9915**. Where agar tubing is not available, express post leaves infected with PM to the CCDM.

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 NTNB, STNB 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 (for instance, fluxapyroxad and bixafen). Avoiding repetitive applications of single active ingredients or fungicide group is another critical tool in reducing the risk of resistance. In situations of concern over disease response to fungicide control in barley crops, samples from any disease can be sent to the CCDM, Curtin University, Kent Street, Bentley, WA 6102. Contact the Fungicide Resistance Group via email at **frg@curtin.edu.au** for details on how to collect and submit a sample.

Plants with symptoms suspected to be RLS or in cases where symptoms thought to be PLS respond to fungicide application, send samples 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 an infection can kill leaves prematurely and reduce seed weight. Increased plantings of varieties with a susceptible rating increases the prevalence of scald, especially with early sowing opportunities. A severe initial infection can reduce the head number and grain number. 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 carried through infected seed.

The varieties with the highest scald risk are Banks, Beast, Laperouse, LG Alestar, Litmus and Mundah. A concern going forward is that the widespread adoption of Banks, Beast, Laperouse, and LG Alestar could see scald re-emerge in prevalence as a severe disease affecting the performance of barley in WA. Use of seed dressings and in-crop fungicides plus avoiding sowing these varieties in 'barley-on-barley' situations will be important when growing such varieties.

NET-TYPE NET BLOTCH (NTNB)

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

Populations of NTNB 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. There is also a population in the Esperance region with reduced sensitivity to the DMI fungicides tebuconazole and propiconazole. Fungicide management of NTNB 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 (for example, azoxystrobin and pyraclostrobin) and SDHI (for instance, fluxapyroxad, benzovindiflupyr and bixafen). Fungicide management is often required to manage the disease when resistance in the variety is low or if there is a pathotype change.

Virulence of the NTNB pathogen can vary across time and regions depending on the varieties and resistance genes deployed. Historically, there were two distinct pathotypes of NTNB prevalent 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. In recent seasons, another pathotype, Oxford virulent, has become evident, particularly in the Albany and Esperance port zones.

As there are different pathotypes of NTNB present in WA, varietal responses vary accordingly. Litmus is the most vulnerable variety to NTNB, being susceptible to all three major NTNB pathotypes present in WA. In the presence of the Oxford virulent pathotype, Banks, Buff, Granger, and Rosalind have

slighter better resistance, 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 NTNB. This is due to the lack of seedling resistance in commercially grown varieties.

SPOT-TYPE NET BLOTCH (STNB)

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

The CCDM has reported the discovery of DMI resistant STNB populations in the South Stirlings region and more recently in the Esperance port zone. The compounds most affected by this resistance are tebuconazole and propiconazole. The resistant population is slightly less sensitive, however, to the newer DMIs such as prothioconazole. Fungicide management of STNB, to address current resistance issues in the southern regions 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 (for example, azoxystrobin and pyraclostrobin) and SDHI (for instance, fluxapyroxad and bixafen). As outlined in the disease introduction, where fungicide resistance is suspected, 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 to STNB of the current varieties followed by Laperouse (MS as a seedling and MRMS as an adult). Compass has some tolerance to STNB, rated as MRMS as a seedling and MSS as an adult. Leabrook is MS at both growth stages.

Some varieties susceptible at the adult plant stage have some tolerance at the seedling stage (i.e. Bass has intermediate resistance at the seedling stage but is vulnerable at the adult stage). Partial tolerance at the seedling stage reduces the likelihood of severe early infection, but STNB 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 the 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 yield 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 (for example, tebuconazole, triadimefon, flutriafol) in controlling powdery mildew at label rates. Higher value DMI fungicides and alternative modes of action, such as strobilurins (for example, azoxystrobin and pyraclostrobin), SDHI (for instance, fluxapyroxad) and amines (for example, spiroxamine) have uncompromised activity 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 Granger, 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. Testing by the CCDM for PM virulence on Oxford, suggests that the *Ml(St)* gene in Oxford may be compromised, rendering a susceptible reaction in the presence of this mutation. This new pathotype is currently restricted to the south coast.

The nine broad groups separated by known or postulated resistance genes that are effective (in brackets) include the following varieties:

- Group 1 (*MlGa*) – Fathom
- Group 2 (*MlLa*) – La Trobe, Lockyer, Rosalind, Spartacus CL
- Group 3 (*MlGa*, *MlLa*) – Compass, Leabrook
- Group 4 (*Mla7*, *MlLa*) – Scope CL
- Group 5 (*Mla7*, *MlLa*, *Mlk1*) – Dash
- Group 6 (*Ml(Ch)*, *Mlra*) – Yagan
- Group 7 (*Ml(St)*) – Oxford
- Group 8 (*Mla1*) – Flinders
- Group 9 (*mlo*) – Granger, LG Alestar, RGT Planet

Virulence to the *MlLa* gene has been detected in barley growing in northern NSW and Queensland resulting in varieties such as Compass, La Trobe, Rosalind, and Spartacus CL being more susceptible to PM than in previous years. Field screening of varieties with different genes, however, has not yet confirmed any significant regional variation in the field resistance of varieties to PM in WA, except for Oxford. There are reports, however, of increased virulence on varieties other than Oxford (Rosalind and possibly Maximus CL) in the South Stirlings area. Growers should report a suspected breakdown in varietal resistance for varieties rated as MRMS and above to PM.

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 cases of heavy infection. As the crop matures, pustules darken and produce black spores embedded in leaf tissue. BLR can reduce grain yield by over 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. 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 any 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, Granger and RGT Planet all carry two APR genes (*Rph20* and *Rph24*), their field reaction may vary depending on which allele they have and other minor genes they may carry. LG Alestar also possesses additional APR genes (not yet characterised). Under very high rust pressure, response to fungicide application may still be evident in the retention of green leaf area in varieties with APR resistance. The late APR resistance in Fathom only protects it late in the season, so it is still vulnerable to rust infection before heading.

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.

CROWN ROT

Crown rot (*Fusarium pseudograminearum*) is a fungal 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. In individual plants, the infected tiller bases are honey-brown in colour, especially under leaf sheaths, and 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 in seasons with good spring rain, whiteheads may not occur, even in infected crops. Significant yield losses can occur when high disease levels coincide with moisture stress during grain fill. Affected heads have shrivelled or no grain.

There are no fungicide options to control crown rot once the crop has established. Including non-cereals into 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 occurs in the field, the resistance score reflects the rating to both being present. However, BYD is more frequent than CYD at a ratio of approximately 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. Varietal resistance to BYD and CYD, therefore, 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).

RUSSIAN WHEAT APHID (RWA)

Russian wheat aphid (RWA, *Diuraphis noxia*) was first detected in WA in the Esperance region in August 2020 following its discovery in South Australia, then Victoria, parts of New South Wales and Tasmania in 2016. RWA injects salivary toxins during feeding that can retard crop growth resulting in reduced grain yield and can even kill the plant with heavy infestations. Affected plants often show white, yellow and red streaky leaf markings and rolling of leaves. The aphid spreads quickly by the wind and on live plant material. The development of barley varieties with resistance to RWA is one of the tools in an integrated pest management strategy that includes green bridge management, agronomic practices, strategic use of insecticides and exploitation of natural enemies of the pest. Unlike oat and corn leaf aphids, RWA is not suspected of being a significant carrier of viruses, with damage caused directly by feeding and associated toxins.

Growers should implement the 'FITE' strategy (Find, Identify, Threshold approach and Enact) and report any incursions. When detected, everyone must adopt best-practice farm hygiene procedures to retard the spread of the pest between paddocks and adjacent properties. Keeping machinery out of affected areas and minimising movement in neighbouring areas are necessary control measures.

Chemical control is the primary cultural means of reducing damage from RWA. Seed dressings such as imidacloprid and insecticides, including chlorpyrifos and pirimicarb, are registered for control. Three Australian Pesticides and Veterinary Medicines Authority (APVMA) emergency use permits control their use. Prophylactic spraying is discouraged, and growers should only spray when economic thresholds are reached. An understanding of the behaviour, reproductive cycle, damage levels, thresholds and best management practices under Australian conditions are currently being developed.

Eradication of RWA in WA is not feasible, so biosecurity responses include surveillance of spread and appropriate management in-crop. In WA, report suspected RWA detections (including scouting resulting in no detection) using the MyPestGuide Reporter app (available at **agric.wa.gov.au/apps/mypestguide-reporter**), or by contacting the Pest and Disease Information Service (PaDIS) by calling +61 (0)8 9368 3080 or emailing **padis@dpird.wa.gov.au**.

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. RLN can be found in approximately 6.25 million ha (or ~74%) of the winter cropping area of WA. *Pratylenchus neglectus* is the dominant species and is 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 yield losses of up to 18% in barley.

The key to managing RLN is to identify paddocks with yield-limiting numbers and incorporate resistant crops and varieties to reduce their number. The *P. neglectus* and *P. quasitereoides* nematode resistance scores in this sowing guide are from WA observations only. The ratings are from both glasshouse and field trials. Provisional ratings provided for varieties with fewer than three observations, or where there has been no field trial verification of the glasshouse rating.

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 to 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 the three-leaf stage) leaf disease resistance profiles when grown in WA

Disease[1]	Scald	Net-type net blotch[4]			Spot-type 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	MSS	SVS
Flinders	-	MRMS	MSS	SVS	MSS	R	MS
La Trobe	-	MS	MRMS	S	S	MSS	MS
RGT Planet	-	MRMS	MRMS	S	S	R	MSS
Spartacus CL	-	MS	MRMS	S	SVS	MS	MS
Stage 2 malt accreditation							
Buff	-	MS	MRMS	MS	MSS	S	SVS
Leabrook	-	MRMS	S	MS	MS	MR	SVS
LG Alestar	-	MS	S	S	SVS	RMR	MS
Maximus CL	-	MSS	MRMS	S	MSS	MR*	S
Deliverable as a feed variety							
Banks	-	MRMS	MS	MRMS	MSS	MRMS	S
Beast		MSS*p*	MRMS*p*	MSS*p*	MS*p*	MR*p*	MSS*p*
Compass	-	MRMS	S	S	MRMS	MRMS	S
Fathom	-	S	MSS	SVS	MR	MS	MSS
Granger	-	MRMS	MRMS	MRMS	S	R	MS
Laperouse	-	S	S	S	MS	R	MSS
Litmus	-	S	S	S	S	MS	S
Mundah	-	S	S	MSS	MSS	SVS	S
Rosalind	-	MR	MR	MSS	MSS	MS	MRMS
Scope CL	-	MR	MR	S	MSS	R	S

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

[1]Resistance rating: VS = very susceptible, S = susceptible, MS = moderately susceptible, MRMS = intermediate, MR = 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. On-farm reactions of varieties may, therefore, differ if the pathotype present differs to 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-type net blotch: three pathotypes (95NB100, 97NB1 and Oxford) of NTNB 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, a new pathotype (Oxford) is present in the southern regions.

[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 Maximus CL may show a susceptible reaction to some strains of PM present in WA.

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

Disease[1]	Scald	Net-type net blotch[4]			Spot-type net blotch	Powdery mildew[5]	Barley leaf rust
Pathotype[2]	Medina	Beecher virulent (95NB100)	Beecher avirulent (97NB1)	Oxford virulent (EDRS)	(South Perth)	(South Perth)	(5457 P-)
Growth stage[3]	Seedling	Seedling	Seedling	Seedling	Seedling	Seedling	Seedling
Deliverable as a malt variety							
Bass	MRMS	MRMS	MSS	S	S	MSS	SVS
Flinders	MSS	MRMS	MS	S	S	R	MRMS (late APR)
La Trobe	MR	MS	MS	S	SVS	MS	S
RGT Planet	MRMS	SVS	MRMS	SVS	S	R	MRMS (late APR)
Spartacus CL	MR	MSS	MS	MSS	SVS	MRMS	MSS
Stage 2 malt accreditation							
Buff	MSS	MRMS	MRMS	MS	S	S	S
Leabrook	MSS	MRMS	MRMS	S	MS	MR	MSS
LG Alestar	S	MS	MRMS	MSS	S	MR	MRMS
Maximus CL	MR	MSS	MRMS	S	MSS	RMR*	MSS
Deliverable as a feed variety							
Banks	S	MS	MS	MS	S	MR	MSS
Beast	SVS*p*	MRMS*p*	MR*p*	S*p*	MS*p*	R*p*	MRMS*p* (APR)
Compass	MS	MRMS	MS	S	MSS	MRMS	S
Fathom	MR	S	MS	SVS	MRMS	MRMS	MRMS (late APR)
Granger	MSS	MS	MRMS	MS	SVS	R	MRMS (APR)
Laperouse	S	MRMS	MRMS	S	MRMS	R	S
Litmus	SVS	S	S	S	S	MR	S
Mundah	S	S	MS	S	S	MSS	S
Rosalind	MSS	MS	MR	MSS	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, S = susceptible, MS = moderately susceptible, MRMS = intermediate, MR = 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. On-farm reactions of varieties may, therefore, differ if the pathotype present differs to the pathotype used in testing.

[3]Growth stage: the adult resistance score reflects resistance after flag leaf emergence.

[4]Net-type net blotch: three pathotypes (95NB100, 97NB1 and Oxford) of NTNB 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, a new pathotype (Oxford) is present in the southern regions.

[5]Powdery mildew: *Rosalind and Maximus CL may show a susceptible reaction to some strains of PM present in 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 nematode5
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	MS	MSS	MSS	S
Flinders	High	MRMS	MS	MS*p*	S
La Trobe	Moderate	S	MS	MSS	R
RGT Planet	-	MRMS	MSS	MS*p*	R*p*
Spartacus CL	Moderate	MSS	S	MS*p*	R
Stage 2 malt accreditation					
Buff	-	MRMS	-	MS*p*	S*p*
Leabrook	-	MSS	-	MS*p*	R
LG Alestar	-	MRMS	-	-	R
Maximus CL	-	MRMS	-	-	R
Deliverable as a feed variety					
Banks	-	MS	-	MS*p*	-
Beast	-	MS*p*	-	-	MR*p*
Compass	High	MSS	MSS	S	R
Fathom	Moderate	MRMS	MS*p*	MSS	R
Granger	High	MRMS	MS	MSS	R
Laperouse	-	MRMS	-	-	S
Litmus	Low	S	-	MS*p*	MS
Mundah	Moderate	MS	-	MS*p*	S
Rosalind	Moderate	MS	-	MS*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, S = susceptible, MS = moderately susceptible, MRMS = intermediate, MR = 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 impact of the virus on plant growth but does not reduce the effect 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:

- five varieties (Bass, Flinders, La Trobe, RGT Planet and Spartacus CL) that can be delivered into malt segregations in WA at the 2021/22 harvest (as per the GIWA Western Australian malt barley variety receival recommendations for the 2021/22 harvest);
- four varieties undergoing Stage 2 malt accreditation with Barley Australia (Buff, Leabrook, LG Alestar and Maximus CL); and
- ten varieties that can only be delivered into feed segregations (Banks, Beast, Compass, Fathom, Granger, Laperouse, Litmus, Mundah, Rosalind and Scope CL).

Each snapshot describes essential characteristics of a variety 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 2015 to 2019. 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 under the same agronomy (in the same trial).

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

Phenology information is an output of the new flowering date predictive program, 'FlowerPower' barley (available at **agric.wa.gov.au** by searching for Barley module of 'Flower Power'). 'FlowerPower' barley is a statistical model that predicts the date of awn emergence (Z49) for barley in WA environments. Model predictions are based on historical temperature data back to 1966 and are provided for warmer than average (decile 8-10), normal (decile 4-7) and colder than average (decile (1-3) seasons. The phenology data presented in the snapshots are the median predicted date to Z49 (date predicted for 50% of 'normal' seasons) based on 'FlowerPower' barley version 6.1.2. Data is 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 include:

- coleoptile length where short = 40-60mm, medium = 60-80mm and long = 80-100mm,
- target plant density in plants/m^2 when weeds are present,
- 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,
- straw strength based on lodging scores taken at maturity and ranked relative to control varieties,
- head loss risk assessed in small plot trials and ranked based on counting heads post-harvest at sites where high levels of head loss recorded in high-risk varieties (i.e. Scope CL), and
- 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 data from NVT trials (2005-2019) and DPIRD-GRDC funded barley agronomy trials (2006-2019). 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 under the same level of input, as grain yield increases, grain protein concentration decreases (because of 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 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**).

BASS(ɒ)

DELIVERABLE AS A MALT VARIETY

Comments

Bass is a short height, medium spring, malt barley preferred for export as grain and as malt but not for shochu. Bass has strong market demand from domestic maltsters and international brewing customers, which can often result in a price premium. Best suited to environments with a yield potential above 3t/ha. Across 63 WA barley NVT (2016-2019), Bass yielded less than RGT Planet in 83% of trials, the same in 15% and higher in 2%. Along with Flinders, 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. Can show a moderate head loss risk in the Esperance Port Zone, but not in other port zones. Fungicides may be required to manage NTNB (Oxford virulent), STNB, PM and BLR. Weed competitiveness similar to other semi-dwarf varieties. Despite strong market demand, the area sown to Bass is continuing to decline and it accounted for just under 3% of the state's barley acreage in 2019. Target production zone in 2021 is Kwinana-North (Midlands) with limited segregation opportunities in Kwinana-South and Albany-South (subject to production volumes).

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	78	95	91	92	82
Agzone 2	79	96	96	92	86
Agzone 3	85	89	91	95	88
Agzone 4	81	-	73	96	84
Agzone 5	84	94	95	88	72
Agzone 6	91	91	104	96	91
State-wide	83	94	94	92	85

Disease resistance	Seedling	Adult
Scald	-	MRMS
NTNB (Beecher virulent)	MR	MRMS
NTNB (Beecher avirulent)	S	MSS
NTNB (Oxford virulent)	SVS	S
STNB	MRMS	S
Powdery mildew	MSS	MSS
Leaf rust (5457P-)	SVS	SVS
BYD and CYD	MS	MS
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	+5	+4	+4
Cunderdin	+7	+6	+5	+4
Katanning	+7	+7	+5	+4
Grass Patch	+8	+6	+4	+5

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Medium
Target plant density	150-180 plants/m^2
Plant height	Short
Straw strength	Very good
Head loss risk	Medium
Grain protein deviation	Higher

Variety information	
Pedigree	WABAR2023/Alexis
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.50

p = provisional assessment

FLINDERS(ɒ)

DELIVERABLE AS A MALT VARIETY

Comments

Flinders is a short height, late spring, malt barley that is acceptable for export as grain and preferred for export as malt but not for shochu. Flinders has gained limited adoption by growers. It is 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 61 WA barley NVT (2016-2019), Flinders yielded less than RGT Planet in 80% of trials, the same in 18% and higher in 2%. Flinders has good physical grain characteristics, and is an improvement on La Trobe, RGT Planet and Spartacus CL with malt receival rates similiar to Bass. Flinders is resistant to PM (non-*mlo*) but fungicides may be required to manage NTNB (Oxford virulent), STNB and BLR (despite having APR). Weed competitiveness is similar to other semi-dwarf varieties. The area sown to Flinders is declining, and it accounted for just over 3% of the state's barley acreage in 2019. Target production zone in 2021 is Albany-South with potential niche segregation opportunities in Kwinana-South and the Esperance Port Zone (subject to production volumes and market demand).

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	87	-	91	90	75
Agzone 2	88	98	98	92	86
Agzone 3	96	97	99	99	93
Agzone 4	85	-	74	99	82
Agzone 5	88	-	99	94	78
Agzone 6	102	109	129	104	101
State-wide	92	101	98	94	89

Disease resistance	Seedling	Adult
Scald	-	MSS
NTNB (Beecher virulent)	MRMS	MRMS
NTNB (Beecher avirulent)	MSS	MS
NTNB (Oxford virulent)	SVS	S
STNB	MSS	S
Powdery mildew	R	R
Leaf rust (5457P-)	MS	MRMS (late APR)
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MS	MS
RLN (*P. quasitereoides*)	MS*p*	MS*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	+9	+8	+8
Cunderdin	+9	+10	+10	+8
Katanning	+10	+11	+9	+8
Grass Patch	+10	+9	+10	+8

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Short
Target plant density	150-180 plants/m^2
Plant height	Short
Straw strength	Very good
Head loss risk	Low
Grain protein deviation	Slightly higher

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

p = provisional assessment

LA TROBE(Þ)

DELIVERABLE AS A MALT VARIETY

Comments

La Trobe is a medium height, early spring, malt barley that is preferred for export as grain, malt and for shochu. La Trobe, like Bass, is more likely to attract and maintain a premium over feed when the market is oversupplied. La Trobe is the only malt variety currently segregated in WA accepted for shochu manufacture in Japan. Best suited to environments with a yield potential below 4t/ha. Across 64 WA barley NVT (2016-2019), La Trobe yielded less than RGT Planet in 50% of trials, the same in 19% and higher in 31%. Better suited than RGT Planet to environments with a shorter grain-filling period. Like Spartacus CL, La Trobe is more responsive to applied nitrogen than other malt varieties segregated in WA. Fungicides may be required to manage smut, NTNB (Oxford virulent), STNB and BLR. Do not ruin the integrity of La Trobe seed crops or malt stacks by contaminating them with Hindmarsh or Spartacus CL barley. La Trobe was the third most popular barley variety in 2019, accounting for just over 12% of the state's barley acreage but its popularity declined in 2020. Target production zones in 2021 are Kwinana, Albany, and Esperance Port Zones where limited segregations will be offered in line with the reduced plantings.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	97	102	102	102	103
Agzone 2	96	103	102	101	99
Agzone 3	101	101	101	102	99
Agzone 4	97	-	94	102	102
Agzone 5	97	101	102	100	94
Agzone 6	100	104	102	102	101
State-wide	99	103	101	101	99

Disease resistance	Seedling	Adult
Scald	-	MR
NTNB (Beecher virulent)	MS	MS
NTNB (Beecher avirulent)	MRMS	MS
NTNB (Oxford virulent)	S	S
STNB	S	SVS
Powdery mildew	MSS	MS
Leaf rust (5457P-)	MS	S
BYD and CYD	S	S
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	+2	+1	+1	+0
Cunderdin	+2	+1	+1	+0
Katanning	+2	+2	+1	+0
Grass Patch	+2	+1	+1	+1

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Target plant density	150-180 plants/m^2
Plant height	Medium
Straw strength	Moderately good
Head loss risk	Medium
Grain protein deviation	Slightly lower

Variety information	
Pedigree	Dash/VB9409
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$4.00

p = provisional assessment

RGT PLANET(Þ)

DELIVERABLE AS A MALT VARIETY

Comments

RGT Planet is a medium height, medium spring, malt barley acceptable 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, to paddocks with a year-in-year-out potential above 5t/ha. Due to its early vigour, RGT Planet is suited to mixed farms where grain and graze is practised. Across 64 WA barley NVT (2016-2019), RGT Planet yielded less than Rosalind in 48% of trials, the same in 22% and higher in 30%. The physical grain quality package of RGT Planet is inferior to Bass, Flinders and Spartacus CL, being comparable to La Trobe. Excellent resistance to PM (due to *mlo* gene) and useful resistance to BLR (due to APR gene). Fungicides may be required to manage NTNB (Beecher virulent and Oxford virulent), STNB and BLR (under high pressure). 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 2019, and its acreage is growing. It accounted for two out of every ten barley hectares in 2019. Target production zones in 2021 are Kwinana-North (Midlands), Kwinana-South, Albany-South, and Esperance Port Zones with limited segregation opportunities in Albany-North (subject to production volumes).

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	-	107	99	100	90
Agzone 2	-	109	107	100	91
Agzone 3	-	110	113	110	103
Agzone 4	-	-	72	106	87
Agzone 5	-	123	111	104	79
Agzone 6	-	136	146	117	114
State-wide	-	116	109	104	96

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

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

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	-
Target plant density	150-180 plants/m^2
Plant height	Medium
Straw strength	Good
Head loss risk	Low
Grain protein deviation	Slightly lower

Variety information	
Pedigree	Tamtam/Concerto
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 is a medium height, early spring, malt barley acceptable for export as grain and as malt. An increase in the MRL for imidazolinone in Japan will restart its evaluation for shochu. Across 64 WA barley NVT (2016-2019), Spartacus CL yielded less than RGT Planet in 50% of trials, the same in 19% and higher in 31%. Replacing La Trobe due to its lower lodging risk, lower head loss risk, slightly plumper grain, higher grain protein and slightly brighter grain with similar phenology and germ-end staining risk. Spartacus CL is replacing Scope CL where imidazolinone herbicides are needed or have been used and where its improved agronomy is a benefit. Fungicides may be required to manage smut, NTNB (Oxford virulent), STNB and BLR. Spartacus CL appears to be a weak competitor with weeds (based on data from eastern Australia). Do not ruin the integrity of Spartacus CL seed stocks or malt stacks by contaminating it with La Trobe or Scope CL barley. Spartacus CL was the most popular barley variety in 2019, accounting for four out of every every ten barley hectares, and with increased production in 2020. Target production zones in 2021 are Geraldton, Kwinana, Albany, and Esperance Port Zones.

Yield (% La Trobe)	2015	2016	2017	2018	2019
Agzone 1	103	98	98	98	97
Agzone 2	104	97	98	99	101
Agzone 3	99	99	99	98	101
Agzone 4	103	-	106	98	98
Agzone 5	103	99	98	100	106
Agzone 6	100	96	98	98	99
State-wide	101	97	99	99	101

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

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

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Target plant density	150-180 plants/m^2
Plant height	Medium
Straw strength	Good
Head loss risk	Low
Grain protein deviation	Slightly higher

Variety information	
Pedigree	Scope/4*Hindmarsh//HMVB0325-106
Breeder / Seed licensee	InterGrain
Access to seed	Seedclub members and resellers
EPR ($/t, excl. GST)	$4.25

p = provisional assessment

BUFF(Þ)

STAGE TWO MALT ACCREDITATION

Comments

Buff (tested as IGB1506) is a medium height, early spring barley under evaluation by Barley Australia to supersede Litmus. Buff has similar Al tolerance genetics to Litmus but, unlike Litmus, it has a white aleurone. Receival of Buff will therefore not be restricted (as it is for Litmus) due to aleurone colour. Unlike Litmus, Buff is a competitor on non-acidic soils to Fathom, La Trobe (and its derivatives) and Rosalind. Across 56 WA barley NVT (2016-2019), Buff yielded less than Rosalind in 45% of trials, the same in 25% and higher in 30%. Across 27 WA barley NVT trials (2016-2017, 2019) Buff has yielded less than Litmus in 7%, the same in 23% and higher in 70%. The overall disease resistance profile of Buff is similar to Litmus with improvements in tolerance to scald and NTNB. Fungicides may be required to manage STNB, PM and BLR. Its weed competitiveness has not been tested. Straw strength is an improvement over Litmus. Preliminary head loss data suggest that Buff may be at a medium risk of head loss. Buff has passed Stage One of the Barley Australia accreditation process. Due to a lack of grain in specification Stage Two will commence in 2021, with the earliest accreditation date being March 2022.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	-	112	118	113	121
Agzone 2	-	123	108	105	102
Agzone 3	-	-	-	108	99
Agzone 4	-	-	76	128	146
Agzone 5	-	109	99	102	93
Agzone 6	-	-	-	111	105
State-wide	-	118	106	108	101

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

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

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Medium
Target plant density	150-180 plants/m^2
Plant height	Medium
Straw strength	Moderately good
Head loss risk	-
Grain protein deviation	Slightly higher

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

p = provisional assessment

LEABROOK(ɒ)

STAGE TWO MALT ACCREDITATION

Comments

Leabrook (tested as WI4896) is a tall height, early spring barley under evaluation by Barley Australia. It is potentially a better option than RGT Planet in environments with a yield potential below 4t/ha where barley leaf rust is not a year-in-year-out problem. Across 64 WA barley NVT (2016-2019) Leabrook yielded less than RGT Planet in 38% of trials, the same in 23% and higher in 39%. Leabrook is a sister line to Compass and possesses many similar agronomic attributes including phenology, plant architecture, straw strength, and grain quality but with improvements in grain yield and malt quality (mostly malt extract). While its grain has a lower hectolitre weight than Spartacus CL grain, its grain is plumper with similar brightness. Being able to hold grain size across seasons would be an advantage if segregated. There is not enough data to assess its head loss risk, but it does not appear to be high. Fungicides may be required to manage NTNB (Oxford virulent) and BLR, although it does not appear to be as susceptible as Compass to BLR. Leabrook's weed competitiveness has not been tested but is likely to be similar to Compass. Leabrook has passed Stage One of the Barley Australia accreditation process and will continue with Stage Two evaluation during 2020, with the earliest accreditation date being March 2021.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	95	108	108	110	117
Agzone 2	95	110	106	107	101
Agzone 3	107	104	106	106	102
Agzone 4	95	-	89	107	109
Agzone 5	99	102	107	102	90
Agzone 6	101	112	96	106	104
State-wide	100	109	105	106	100

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

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

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	-
Target plant density	150-180 plants/m^2
Plant height	Tall
Straw strength	Fair
Head loss risk	-
Grain protein deviation	Slightly lower

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

p = provisional assessment

LG ALESTAR(ɒ)

STAGE TWO MALT ACCREDITATION

Comments

LG Alestar (tested as SMBA11-2341) is a medium height, late spring barley under evaluation by Barley Australia. Best suited to environments above 3t/ha where both powdery mildew and BLR are a problem. Across 29 WA barley NVT (2016, 2019), LG Alestar yielded less than RGT Planet in 79% of trials, the same in 18% and higher in 3%. The grain of LG Alestar has a white aleurone, even though one of its parents Henley has a blue aleurone. It has many similar agronomic attributes to Granger with improved grain brightness but a lower hectolitre weight. The grain quality of LG Alestar is generally inferior to Bass and Flinders. It has durable resistance to PM (based on the *mlo* gene) and resistance to BLR (seedling and adult). Fungicides may be required to manage scald and STNB. Its weed competitiveness has not been tested. It appears to have good straw strength, but there is not enough data to assess its head loss risk. LG Alestar has passed Stage One of the Barley Australia accreditation process and will continue with Stage Two evaluation during 2020, with the earliest accreditation date being March 2021.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	-	100	-	-	77
Agzone 2	85	103	-	-	85
Agzone 3	96	99	-	-	92
Agzone 4	82	-	-	-	93
Agzone 5	82	111	-	-	75
Agzone 6	99	113	-	-	101
State-wide	89	105	-	-	88

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

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

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	-
Target plant density	150-180 plants/m^2
Plant height	Medium
Straw strength	Good
Head loss risk	-
Grain protein deviation	Slightly lower

Variety information	
Pedigree	Henley/NSL02-4136A
Breeder / Seed licensee	Limagrain / Elders
Access to seed	Elders
EPR ($/t, excl. GST)	$3.80

p = provisional assessment

MAXIMUS CL(ϕ)

STAGE TWO MALT ACCREDITATION

Comments

Maximus CL (tested as IGB1705T) is an imidazolinone tolerant, medium height, medium spring barley under evaluation by Barley Australia. Across 39 WA barley NVT (2018-2019), Maximus CL yielded less than RGT Planet in 31% of trials, the same in 15% and higher in 54%, performing better in environments that yielded less than 4t/ha. The WA NVT MET (2015-2019) suggests that Maximus CL has a yield advantage of 4% over Spartacus CL. Maximus CL grain appears to be plumper than Spartacus CL grain with a similar hectolitre weight, although it appears to have a darker kernel. Phenology data indicates that it may reach awn emergence 2-4 days later than Spartacus CL across a range of sowing dates. Maximus CL is a general improvement over Spartacus CL for NTNB (Beecher avirulent) as an adult, STNB (as both a seedling and an adult plant) and for PM as a seedling. Fungicides may be required to manage NTNB (Oxford virulent) and some pathotypes of PM. Preliminary data suggest that Maximus CL may have a low risk of head loss. Maximus CL has passed Stage One of the Barley Australia accreditation process and will continue with Stage Two evaluation during 2020, with the earliest accreditation date being March 2021.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	-	-	-	105	108
Agzone 2	-	-	-	103	103
Agzone 3	-	-	-	104	103
Agzone 4	-	-	-	107	112
Agzone 5	-	-	-	104	103
Agzone 6	-	-	-	105	105
State-wide	-	-	-	104	103

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

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

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Target plant density	150-180 plants/m^2
Plant height	Medium
Straw strength	Good
Head loss risk	-
Grain protein deviation	Slightly higher

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

p = provisional assessment

BANKS(ϕ)

DELIVERABLE AS A FEED VARIETY

Comments

Banks (tested as IGB1305) is a short height, late spring, feed barley. Best suited to environments with a yield potential above 3t/ha. Across 64 WA barley NVT trials (2016-2019), Banks has yielded less than RGT Planet in 48% of trials, the same in 29% and higher in 23%. Banks does not have the top-end yield potential of RGT Planet, appears to yield similarly between 3-4t/ha and higher below 3t/ha. Banks has a similar plant type and phenology to Flinders, being 1-2cm taller than Bass at maturity. In some commercial crops there have been observations of brackling (buckling in the lower part of the stem) and lodging in Banks. Straw strength appears to be comparable to RGT Planet, but not as robust as either Bass or Flinders. Fungicides may be required to manage scald, STNB and BLR. Its weed competitiveness has not been evaluated. Banks failed malt accreditation and can only be delivered as a feed barley. Banks is a new feed variety and in 2019 accounted for less than 0.2% of the state's barley acreage.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	98	103	102	101	99
Agzone 2	96	106	103	100	96
Agzone 3	103	103	104	103	99
Agzone 4	93	-	86	107	105
Agzone 5	94	107	102	100	91
Agzone 6	101	112	114	106	103
State-wide	98	106	103	101	97

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

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+3	+8	+9	+9
Cunderdin	+5	+9	+11	+9
Katanning	+5	+10	+10	+9
Grass Patch	+5	+8	+10	+10

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Short
Target plant density	180-220 plants/m^2
Plant height	Short
Straw strength	Moderately good
Head loss risk	-

Variety information	
Pedigree	WABAR2312/WABAR2332
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$4.00

p = provisional assessment

BEAST(Þ)

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, has good initial canopy size and ground coverage as well as a sound grain package. In 2019, its first year of NVT testing in WA, Beast performed very well, but growers should be cautious in their expectations for this variety due to the lack of years of public data. Across 20 WA barley NVT in 2019, Beast yielded less than Rosalind in 30% of trials, the same in 70% and higher in 0%. As Beast has only been screened in NVT yield and disease trials in WA for one season (2019 only), its disease resistance ratings are provisional. Beast appears to have useful resistance to NTNB (Beecher virulent and avirulent), PM and BLR, but may need management for NTNB (Oxford virulent) and scald. Beast is in Stage Zero of Barley Australia accreditation but is being released as a feed barley while under evaluation for its malting and brewing end-use.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	-	-	-	-	114
Agzone 2	-	-	-	-	104
Agzone 3	-	-	-	-	104
Agzone 4	-	-	-	-	115
Agzone 5	-	-	-	-	102
Agzone 6	-	-	-	-	107
State-wide	-	-	-	-	105

Disease resistance	Seedling	Adult
Scald	-	SVS*p*
NTNB (Beecher virulent)	MSS*p*	MRMS*p*
NTNB (Beecher avirulent)	MRMS*p*	MR*p*
NTNB (Oxford virulent)	MSS*p*	S*p*
STNB	MS*p*	MS*p*
Powdery mildew	MR*p*	R*p*
Leaf rust (5457P-)	MSS*p*	MRMS*p* (APR)
BYD and CYD	MS*p*	MS*p*
RLN (*P. neglectus*)	-	-
RLN (*P. quasitereoides*)	-	-
CCN	MR*p*	MR*p*
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
Target plant density	180-220 plants/m^2
Plant height	Tall
Straw strength	-
Head loss risk	-

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

p = provisional assessment

COMPASS(Þ)

DELIVERABLE AS A FEED VARIETY

Comments

Compass is a tall height, early spring barley deliverable only 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 La Trobe and Spartacus CL in WA, and in about of a quarter of situations is higher yielding than Fathom and can out-yield RGT Planet where the yield potential is below 3t/ha. Across 85 WA barley NVT (2015-2019), Compass yielded less than Rosalind in 76% of trials, the same in 24% and higher in 0%. Compass is susceptible to lodging, particularly in high yielding situations. Compass has shown good physical grain quality with high grain plumpness. Fungicides may be required to control seedling infection of NTNB (Beecher avirulent and Oxford virulent), adult infection of NTNB (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 only as a feed variety in WA. Compass was the twelfth most popular barley variety in 2019, accounting for just under 1% of the state's barley acreage.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	97	104	106	108	116
Agzone 2	96	106	103	105	103
Agzone 3	100	100	101	101	99
Agzone 4	97	-	96	105	112
Agzone 5	98	95	102	99	95
Agzone 6	95	99	85	100	98
State-wide	98	103	101	103	100

Disease resistance	Seedling	Adult
Scald	-	MS
NTNB (Beecher virulent)	MRMS	MRMS
NTNB (Beecher avirulent)	S	MS
NTNB (Oxford virulent)	S	S
STNB	MRMS	MSS
Powdery mildew	MRMS	MRMS
Leaf rust (5457P-)	S	S
BYD and CYD	MSS	MSS
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	+1	+2	+2
Cunderdin	+0	+1	+2	+2
Katanning	+0	+2	+2	+2
Grass Patch	+0	+1	+2	+3

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Medium
Target plant density	180-220 plants/m^2
Plant height	Tall
Straw strength	Fair
Head loss risk	Medium

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

p = provisional assessment

FATHOM[Φ]

DELIVERABLE AS A FEED VARIETY

Comments

Fathom 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 STNB. Across 84 WA barley NVT (2015-2019), Fathom yielded less than Rosalind in 75% of trials, the same in 20% and higher in 5%. Fungicides may be required to manage early infections of NTNB and BLR. Fathom has the highest level of resistance to STNB 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 being similar to Compass and RGT Planet in eastern states' weed competition trials. Fathom was the ninth most popular barley variety in 2019, accounting for just over 1% of the state's barley acreage.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	94	107	111	111	120
Agzone 2	88	114	104	104	100
Agzone 3	95	99	101	101	94
Agzone 4	89	-	82	114	127
Agzone 5	88	93	98	95	86
Agzone 6	86	100	84	100	95
State-wide	90	105	100	103	96

Disease resistance	Seedling	Adult
Scald	-	MR
NTNB (Beecher virulent)	S	S
NTNB (Beecher avirulent)	MSS	MS
NTNB (Oxford virulent)	SVS	SVS
STNB	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	+13	+10	+6	+3
Cunderdin	+15	+11	+8	+3
Katanning	+15	+12	+7	+3
Grass Patch	+15	+10	+7	+4

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Medium
Target plant density	180-220 plants/m^2
Plant height	Medium
Straw strength	Fair
Head loss risk	Low

Variety information	
Pedigree	JE013D-020/WI3806-1
Breeder / Seed licensee	University of Adelaide / SeedNet
Access to seed	SeedNet Partners
EPR ($/t, excl. GST)	$2.00

p = provisional assessment

GRANGER[Φ]

DELIVERABLE AS A FEED VARIETY

Comments

Granger is a medium height, medium spring barley no longer segregated as a malt variety in WA and deliverable only into feed stacks. Best suited to environments with a yield potential above 3t/ha where powdery mildew and BLR are a problem. Across 72 WA barley NVT (2015-2019), Granger yielded less than Rosalind in 71% of trials, the same in 19% and higher in 10%. Granger has resistance to PM due to the *mlo* gene and to BLR due to the *Rph20* gene. Fungicides may be required to manage STNB and early infections of BLR. Weed competitiveness appears similar to other semi-dwarf varieties. While it was accredited as a malt variety by Barley Australia in March 2013, malt segregations are no longer offered in WA. Therefore, Granger is received only as a feed variety in WA. Granger was the thirteenth most popular barley variety in 2019, accounting for just over 0.5% of the state's barley acreage.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	92	-	93	-	77
Agzone 2	90	102	101	-	87
Agzone 3	102	102	104	103	96
Agzone 4	86	-	72	-	86
Agzone 5	89	117	101	98	80
Agzone 6	107	120	141	109	106
State-wide	95	106	102	97	92

Disease resistance	Seedling	Adult
Scald	-	MSS
NTNB (Beecher virulent)	MRMS	MS
NTNB (Beecher avirulent)	MRMS	MRMS
NTNB (Oxford virulent)	MRMS	MS
STNB	S	SVS
Powdery mildew	R	R
Leaf rust (5457P-)	MS	MRMS (APR)
BYD and CYD	MRMS	MRMS
RLN (*P. neglectus*)	MS	MS
RLN (*P. quasitereoides*)	MSS	MSS
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	+4	+5	+5	+6
Cunderdin	+6	+7	+7	+6
Katanning	+6	+7	+6	+6
Grass Patch	+6	+6	+6	+7

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Medium
Target plant density	180-220 plants/m^2
Plant height	Medium
Straw strength	Good
Head loss risk	Low

Variety information	
Pedigree	Braemar/Adonis
Breeder / Seed licensee	Limagrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$2.95

p = provisional assessment

LAPEROUSE(b)

DELIVERABLE AS A FEED VARIETY

Comments

Laperouse (tested as WI4952) is a medium height, medium spring barley being evaluated by Barley Australia. Performs well in a range of environments, better than RGT Planet when the site yield is below 4t/ha and will be useful where STNB is a problem. Across 58 WA barley NVT (2016-2019), Laperouse yielded less than Rosalind in 34% of trials, the same in 57% and higher in 9%. Fungicides may be required to manage scald, NTNB (Oxford virulent) and BLR. Its weed competitiveness has not been evaluated. Appears to have good straw strength, and the limited data we have suggest it has a low head loss risk. Laperouse is currently being evaluated in Stage One of the Barley Australia accreditation process, with the earliest accreditation date being March 2022.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	-	107	-	108	113
Agzone 2	-	-	106	106	101
Agzone 3	-	106	108	107	104
Agzone 4	-	-	-	105	104
Agzone 5	-	106	108	104	94
Agzone 6	-	116	106	107	107
State-wide	-	110	106	106	102

Disease resistance	Seedling	Adult
Scald	-	S
NTNB (Beecher virulent)	S	MRMS
NTNB (Beecher avirulent)	S	MRMS
NTNB (Oxford virulent)	S	S
STNB	MS	MRMS
Powdery mildew	R	R
Leaf rust (5457P-)	MSS	S
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	-	-	-	-
Cunderdin	-	-	-	-
Katanning	-	-	-	-
Grass Patch	-	-	-	-

Agronomic traits	
Early growth habit	Erect
Coleoptile length	-
Target plant density	180-220 plants/m^2
Plant height	Medium
Straw strength	Good
Head loss risk	Low

Variety information	
Pedigree	WI4531/Commander//WI4593
Breeder / Seed licensee	SECOBRA Recherches / SeedNet
Access to seed	SeedNet Partners
EPR ($/t, excl. GST)	$3.80

p = provisional assessment

LITMUS(b)

DELIVERABLE AS A FEED VARIETY

Comments

Litmus is a tall height, early spring, feed barley with improved tolerance to low soil pH and high soil Al that is superseded by Buff. Best suited to environments where the sub-soil (10-30cm) has a pH_{Ca} below 4.8. Across 17 WA barley NVT (2016-2017, 2019), Litmus yielded less than Buff in 42% of trials, the same in 50% and higher in 8%. 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 seventh most popular barley variety in 2019, accounting for 3% of the state's barley acreage, with production restricted to the Geraldton and Kwinana Port Zones.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	112	104	113	-	108
Agzone 2	96	113	100	-	102
Agzone 3	91	102	101	-	-
Agzone 4	94	-	86	-	151
Agzone 5	81	98	87	-	-
Agzone 6	82	97	99	-	-
State-wide	90	105	97	-	99

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

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	-7	-4	-3	-1
Cunderdin	-9	-5	-2	-2
Katanning	-8	-4	-3	-2
Grass Patch	-8	-4	-2	-1

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Target plant density	180-220 plants/m^2
Plant height	Tall
Straw strength	Fair
Head loss risk	Medium

Variety information	
Pedigree	WB229/2*Baudin//WABAR2238
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.80

p = provisional assessment

MUNDAH

DELIVERABLE AS A FEED VARIETY

Comments

Mundah 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 71 WA barley NVT (2015, 2017-2019), Mundah yielded less than Rosalind in 94% of trials, the same in 6% and higher in 0%. Mundah can suffer from head loss and lodging. Fungicides may be required to manage scald, NTNB (Beecher virulent and Oxford virulent), STNB 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 nearly 1% of the state's barley acreage.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	96	-	103	99	99
Agzone 2	89	-	98	96	96
Agzone 3	86	-	94	95	91
Agzone 4	90	-	85	109	121
Agzone 5	84	-	90	91	91
Agzone 6	84	-	91	95	90
State-wide	87	-	94	96	93

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

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

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Medium
Target plant density	180-220 plants/m^2
Plant height	Medium
Straw strength	Fair
Head loss risk	Medium

Variety information	
Pedigree	Yagan/O'Connor
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	No EPR payable

p = provisional assessment

ROSALIND

DELIVERABLE AS A FEED VARIETY

Comments

Rosalind is a medium height, early spring, feed barley. 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 85 WA barley NVT (2015-2019), Rosalind yielded less than Spartacus CL in 0% of trials, the same in 13% and higher in 87%, with an overall yield advantage of 7% in the state-wide 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 64 WA barley NVT (2016-2019), Rosalind yielded less than RGT Planet in 30% of trials, the same in 22% and higher in 48%, with an overall advantage of 4% in the state-wide MET. Good straw strength and head retention. Fungicides may be required to manage NTNB (Oxford virulent) and STNB. Growers should report powdery mildew infection on Rosalind as it may indicate the presence of a new pathotype. Its weed competitiveness is unknown. Rosalind was the fifth most popular barley variety in 2019, accounting for just over 4% of the state's barley acreage, being more popular in southern cropping areas than northern cropping areas. The popularity of Rosalind is growing.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	114	107	112	110	117
Agzone 2	108	110	106	107	107
Agzone 3	111	110	109	106	106
Agzone 4	105	-	104	113	124
Agzone 5	103	108	104	108	110
Agzone 6	103	114	104	107	107
State-wide	107	110	106	107	107

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

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

Agronomic traits	
Early growth habit	Erect
Coleoptile length	Short
Target plant density	180-220 plants/m^2
Plant height	Medium
Straw strength	Good
Head loss risk	Low

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

p = provisional assessment

SCOPE CL(ᵖ)

DELIVERABLE AS A FEED VARIETY

Comments

Scope CL is a tall height, medium spring barley no longer segregated as a malt variety in WA and deliverable only into feed stacks. Suited to environments where Intercept®, Intervix® and Sentry® are useful for controlling brome and barley grass or where there are imidazolinone residues. Better suited than Spartacus CL to April sowing opportunities when sowing into non-Clearfield® wheat stubble (so the in-crop wheat volunteers can be controlled). Across 72 WA barley NVT (2016-2019), Scope CL yielded less than Spartacus CL in 69% of trials, the same in 17% and higher in 4%. Fungicides may be required to manage NTNB (Oxford virulent), STNB 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 fourth most popular barley variety across WA in 2019.

Yield (% Spartacus CL)	2015	2016	2017	2018	2019
Agzone 1	91	100	103	100	99
Agzone 2	83	106	98	96	94
Agzone 3	85	94	95	96	89
Agzone 4	84	-	77	112	121
Agzone 5	81	92	90	-	-
Agzone 6	83	90	93	-	-
State-wide	83	99	95	96	90

Disease resistance	Seedling	Adult
Scald	-	MS
NTNB (Beecher virulent)	MR	MRMS
NTNB (Beecher avirulent)	MR	MRMS
NTNB (Oxford virulent)	S	S
STNB	MSS	S
Powdery mildew	R	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	High yield loss (>20%)	

'FlowerPower' predicted flowering date (days to Z49)	Relative to Spartacus CL			
	15-Apr	05-May	25-May	15-Jun
Carnamah	+11	+9	+6	+6
Cunderdin	+12	+10	+9	+5
Katanning	+13	+11	+8	+5
Grass Patch	+13	+9	+8	+6

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Short
Target plant density	180-220 plants/m^2
Plant height	Tall
Straw strength	Fair
Head loss risk	High

Variety information	
Pedigree	Franklin/VB9104//VB9104
Breeder / Seed licensee	AgVic Services / SeedNet
Access to seed	SeedNet Partners
EPR ($/t, excl. GST)	$3.50

p = provisional assessment

ACKNOWLEDGEMENTS

The information contained in this sowing guide uses data generated by many research scientists, technical officers, plant breeders, industry personnel and private service providers. The authors would like to thank the following groups and staff:

- DPIRD agronomy: Raj Malik, Rod Bowey, Helen Cooper, Stacey Power and Shelley Hall.
- DPIRD biometrics: Andrew van Burgel.
- DPIRD plant pathology: Simon Rogers, Miriam Connor and Kris Gajda.
- DPIRD nematology: Sean Kelly, Helen Hunter and John Lewis (SARDI).
- DPIRD research support: Esperance, Geraldton, Katanning, Manjimup, Merredin, Northam and Wongan Hills.
- GIWA Barley Council: for excerpts from their industry report detailing malt barley variety receival recommendations for the 2021/22 harvest published in August 2020.
- Breeding companies and seed licensees: AGT, Edstar Genetics, Elders, InterGrain, SECOBRA Recherches, SeedForce and SeedNet.
- GRDC: National Variety Trials (plant pathology, grain yield and grain quality data) and their service providers.

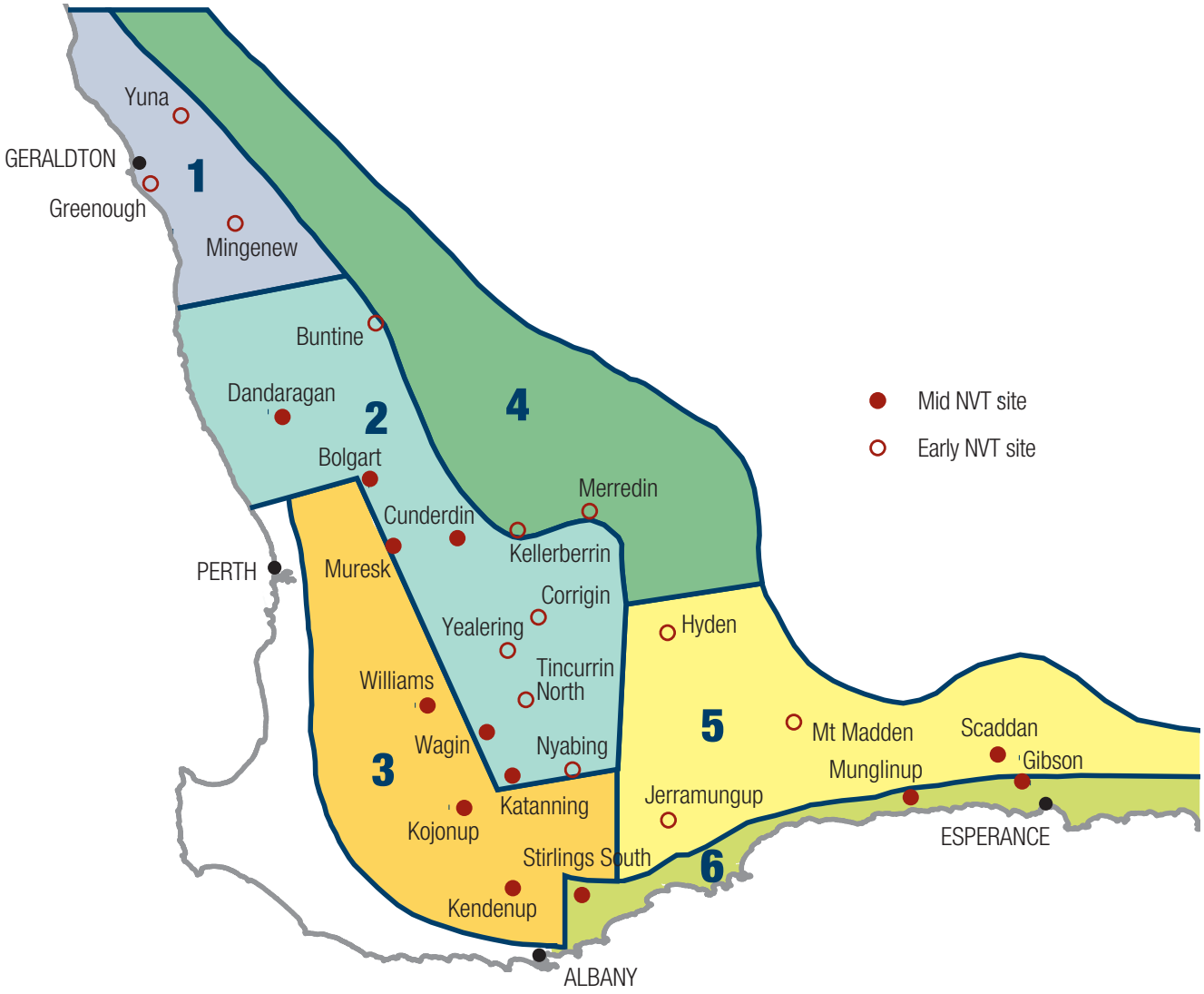


FIGURE 1. Location of Mid and Early canola NVT trials across Agzones in Western Australia

CANOLA

By Jackie Bucat, DPIRD

Choosing a canola variety

When selecting a canola variety, it is important to:

- Determine the appropriate herbicide tolerance type. Consider combination (or 'stacked') hybrids for particular weed managment or protection from Imidazolinone (IMI) soil residue carryover.
- Target varieties with high yields and reliability over different seasons and yield ranges. The GRDC NVT is a source of high-quality scientific data.
- The blackleg resistance rating is important in high blackleg situations. Information about blackleg groups is only important when looking to mitigate blackleg pressure by swapping to an entirely new blackleg group (with no common letters – see Table 2).
- Match maturity rating 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.
- Consider height, oil content and preference for PodGuard® trait (reduced pod shatter at maturity) or TruFlex® trait (increased range of glyphosate timing and rate) as suited for your cropping systems.

CANOLA HERBICIDE TOLERANCE GROUPS AND NEW VARIETY RELEASES

TABLE 1. Canola herbicide tolerance groups

Herbicide tolerance	Abbreviation	Description	New variety releases (maturity)
Triazine tolerant	TT	Tolerant of selected triazine herbicides. Some varieties open pollinated	• HyTTec Trifecta (5) • InVigor T 6010 (6) • SF Dynatron TT (5) • Hyola Blazer TT (4) • AFP Cutubury (4)
Glyphosate tolerant	GT	Tolerant of Monsanto glyphosate herbicide. Includes both Roundup Ready® and TruFlex® varieties	• InVigor R 4520P (4) • Xseed Condor (5)
Clearfield®	CL	Tolerant of Imidazolinone (IMI) herbicides, marketed as Clearfield®	• Pioneer 44Y94 CL (4)
Conventional canola	CC	Only tolerant to clopyralid and grass selective herbicides.	
Triazine tolerant and glyphosate tolerant	TT+GT	Combined tolerance	
Triazine tolerant and Clearfield®	TT+CL	Combined tolerance	• Hyola Enforcer CT (5)
Glyphosate tolerant and Clearfield®	GT+CL	Combined tolerance	• Hyola Garrison XC (5)

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

Canola varieties are available with a range of herbicide tolerances (TT, GT and CL) and in combinations (Table 1). TruFlex® has an extended spray window and greater flexibility of herbicide applications, compared with Roundup Ready® types. Always check suitability of herbicides by referring to herbicide label.

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

There are ten new canola varieties available for the 2021 growing season, including TT, GT, CL and combination TT+CL and GT+CL varieties (Table 1).

Varieties withdrawn from sale include:

- TT varieties: ATR Flathead, Hyola 550TT, Hyola 650TT.
- GT varieties: Pioneer 45Y25RR, Hyola 506RR.
- CL variety: Hyola 575CL.

BUYING CANOLA FOR SEED AND SELLING CANOLA GRAIN

All canola varieties have plant breeder rights (PBR) and are not free to trade. Canola seed must be purchased from registered commercial sellers (Table 2). Harvested OP TT canola can be retained on-farm for use as seed. Retained seed from hybrid crops will not be the same as the Hybrid F1 plants or the individual parents and often has reduced performance.

Some varieties have an end point royalty (EPR) and it is imperative that growers continue to pay EPRs to support further variety development and releases.

Current canola varieties available for 2021

TABLE 2. Herbicide tolerance, harvest maturity, oil content, blackleg ratings and commercial information of current canola varieties

Variety	Herbicide tolerance	Type	Harvest maturity	Oil content (diff. to mean)	Blackleg resistance rating	Blackleg group	EPR $/t	Release	Seed access
AFP Cutubury	TT	OP	4	-	-	-	4	2020	Agronomy for Profit
ATR Bonito	TT	OP	4	1.0	MS	A	5	2013	Nuseed
ATR Gem	TT	OP	4	1.1	MS[2018]	A	-	2011	Nuseed
ATR Mako	TT	OP	4	-0.6	MR	A	5	2015	Nuseed
ATR Stingray	TT	OP	3	0.4	MR	C	-	2011	Nuseed
ATR Wahoo	TT	OP	6	0.4	MS	A	5	2013	Nuseed
DG 670TT	TT	hybrid	6	-1.1	MR	BF	-	2017	Seednet
Hyola 350TT	TT	hybrid	3	-0.8	R	ABDF	-	2017	Pacific Seeds
Hyola 559TT	TT	hybrid	5	0.9	R	ABD	-	2012	Pacific Seeds
Hyola Blazer TT	TT	hybrid	4	0.0	R	?	-	2020	Pacific Seeds
HyTTec Trident	TT	hybrid	3	0.5	R	AD	10	2019	Nuseed
HyTTec Trifecta	TT	hybrid	5	0.6	R	ABD	10	2020	Nuseed
HyTTec Trophy	TT	hybrid	4	0.1	R	AD	10	2017	Nuseed
InVigor T 3510	TT	hybrid	3	-0.5	MRMS	BF	-	2018	BASF
InVigor T 4510	TT	hybrid	4	-0.5	MR	BF	-	2016	BASF
InVigor T 6010	TT	hybrid	6	0.4	MS	BC	-	2020	BASF
Pioneer 44T02 TT	TT	hybrid	4	0.0	R	ABD	-	2016	Pioneer
Pioneer 45T03 TT	TT	hybrid	5	-0.3	R	ABD	-	2018	Pioneer
SF Dynatron TT	TT	hybrid	5	0.6	MRMS	BC	10	2020	Seed Force
SF Ignite TT	TT	hybrid	5	-0.3	MR	BF	10^	2017	Seed Force
SF Spark TT	TT	hybrid	3	0.3	R	ABDS	10^	2018	Seed Force
SF Turbine TT	TT	hybrid	4	-0.9	MRMS	BF	10^	2015	Seed Force
Yetna	TT	OP	4	-2.9	-		4	2015	Agronomy for Profit
BASF 3000TR	TT+GT (RR)	hybrid	3	0.2	MSS	B	-	2016	BASF
Hyola 530XT	TT+GT (TF)	hybrid	5	1.0	MR	ABD	-	2018	Pacific Seeds
Hyola 580CT	TT+CL	hybrid	5	-1.0	R	BC	-	2018	Pacific Seeds
Hyola Enforcer CT	TT+CL	hybrid	5	0.3	R	?	-	2020	Pacific Seeds
DG 408RR	GT (RR)	hybrid	4	1.7	MRMS	AC	-	2017	Seednet
Hyola 404RR	GT (RR)	hybrid	4	1.0	RMR	ABD	-	2010	Pacific Seeds
Hyola 410XX	GT (TF)	hybrid	4	1.0	RMR	ABD	-	2018	Pacific Seeds
InVigor R 3520	GT (RR)	hybrid	3	0.0	RMR	?	-	2017	BASF
InVigor R 4022P	GT (TF)	hybrid	4	0.1	MR	ABC	-	2019	BASF
InVigor R 4520P	GT (TF)	hybrid	4	-0.9	MR	B	-	2020	BASF
InVigor R 5520P	GT (RR)	hybrid	5	-0.5	MR	ABC	-	2016	BASF

[Table 2. continued following page...]

TABLE 2. Herbicide tolerance, harvest maturity, oil content, blackleg ratings and commercial information of current canola varieties (cont'd)

Variety	Herbicide tolerance	Type	Harvest maturity	Oil content (diff. to mean)	Blackleg resistance rating	Blackleg group	EPR $/t	Release	Seed access
Nuseed GT-42	GT (RR)	hybrid	4	-0.8	R[2019]	ABDF	-	2016	Nuseed
Nuseed GT-53	GT (RR)	hybrid	5	-0.5	R	ABDF	-	2016	Nuseed
Pioneer 43Y23 RR	GT (RR)	hybrid	3	-1.7	RMR	B	-	2012	Pioneer
Pioneer 43Y29 RR	GT (RR)	hybrid	3	0.1	RMR	BC	-	2018	Pioneer
Pioneer 44Y27 RR	GT (RR)	hybrid	4	-0.3	RMR	B	-	2017	Pioneer
Pioneer 45Y28 RR	GT (RR)	hybrid	5	0.5	MR[2019]	BC	-	2018	Pioneer
Xseed Condor	GT (TF)	hybrid	5	0.8	R	ABD	-	2020	Nuseed
Xseed Raptor	GT (TF)	hybrid	4	0.3	R	AD	-	2019	Nuseed
Hyola 540XC	GT(TF)+CL	hybrid	5	-1.2	R	?	-	2019	Pacific Seeds
Hyola Garrison XC	GT(TF)+CL	hybrid	5	0.0	R	?	-	2020	Pacific Seeds
Banker CL	CL	hybrid	6	-0.8	MR	A	-	2016	Barenbrug Australia
Pioneer 43Y92 CL	CL	hybrid	3	-0.6	R	B	-	2017	Pioneer
Pioneer 44Y90 CL	CL	hybrid	4	-0.5	R	B	-	2015	Pioneer
Pioneer 44Y94 CL	CL	hybrid	4	0.9	R	BC	-	2020	Pioneer
Pioneer 45Y91 CL	CL	hybrid	5	0.4	RMR	B	-	2016	Pioneer
Pioneer 45Y93 CL	CL	hybrid	5	0.8	R	BC	-	2018	Pioneer
Hyola 970CL	CL	hybrid	winter	-	R	H	-	2018	Pacific Seeds
Phoenix CL	CL	hybrid	winter	-	R	B	-	2018	AGF Feeds
SF Edimax CL	CL	hybrid	winter	-	RMR	C	-	2014	Seed Force

^ EPR applies from 2021/22 harvest for these varieties.

Varieties listed in alphabetical order within herbicide tolerance groups; = yellow shading indicates new varieties.

Herbicide tolerance: TT = triazine tolerant, CL= Clearfield® (Imidazolinone tolerant), GT = glyphosate tolerant (RR = Roundup Ready type, TF = TruFlex® type).

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

Oil content averages: TT = 44.1, GT = 45.1 and CL = 45.2 (data from 2015-2019 NVT).

Blackleg resistance rating key: R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible.
= orange shading indicates where blackleg resistance rating is MRMS or lower.

Blackleg information from GRDC Blackleg Management Guide 2020 Spring Fact Sheet, unless noted, see further information at:
grdc.com.au/GRDC-FS-BlacklegManagementGuide

NVT results 2015-2019

This section presents predicted yields from the long-term Multi-Environment Trial (MET) analysis of all WA National Variety Trials (NVT) from 2015-2019. There were 192 successful canola trials in WA during this period and 685 nationally (190 in NSW, 166 in Vic and 137 in SA). Results are shown where varieties were present in at least two trials. All trial results are available online, at nvtonline.com.au or on the NVT long-term yield app. The National Variety Trial (NVT) scheme is a GRDC investment.

The NVT long-term MET analysis is the best source of predictive yield data for canola varieties. Generating the MET data involves two stages of analysis. First, the data were analysed from each individual NVT trial. Herbicide tolerance trials (TT, GT or CL) at the same location were analysed together to reduce variability in the results.

For the secondary analysis, all raw plot data and spatial models from the single site analysis of individual NVT sites were combined spatially (across all sites in Australia) and temporally (across growing seasons), to produce the multi-environment trial (MET) dataset. In the analysis, relationships between variety performances were established by comparing results at similar environments. Any issues with variable establishment or variable sites (for example due to different soil types or insect attack in one part of the trial) were accounted for by the linkages between environments, so there would be 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 analysis also generates a predictive yield even when a variety was not present in a specific trial, by comparing its performance with other varieties in similar environments to the missing trial (as indicated by an asterisk in Tables 3-11). This is a great advantage of the MET analysis, particularly for canola for which new varieties are often released with limited NVT testing.

Predicted yields from individual NVTs are available from nvtonline.com.au under the 'current trial results' tab. The long-term MET predicted yields are available at nvtonline.com.au, by accessing the 'long-term yield reporter'. Results from aggregated Agzones are reported in Tables 3 and 4 and results from individual Agzones in Tables 5-11.

'EARLY' AND 'MID' TRIALS

The locations of WA canola variety trials are shown in Figure 1. 'Early trials' are sown in shorter-season environments in northern and eastern areas that suit early-maturity varieties, largely in Agzones 1, 2, 4 and 5 (Tables 5-8). While 'Mid trials' are sown in longer-season environments, that suit mid-maturity varieties, largely in Agzones 2, 3 and 6 (Tables 9-11). Both the Early-trials and Mid-trials have similar sowing times.

TABLE 3. Yield of canola varieties in all *EARLY series WA NVT expressed as percentage of site mean yield for each trial year (2015-2019)

TRIAZINE TOLERANT (TT), TT+RR and TT+CL					2015	2016	2017	2018	2019
Site mean yield (t/ha)					1.55	2.16	1.74	1.57	1.15
Variety	Herbicide tolerance	Type	Harvest maturity	No. trials	(4)	(9)	(8)	(7)	(8)
HyTTec Trident	TT	hybrid	3	(18)	115 *	113 *	116	124	120
Hyola 350TT	TT	hybrid	3	(21)	108 *	109 *	109	112	111
InVigor T 3510	TT	hybrid	3	(15)	108 *	108 *	110 *	109	110
SF Spark TT	TT	hybrid	3	(9)	102 *	102 *	102 *	103	103
ATR Stingray	TT	OP	3	(19)	93	92	92	90	90
InVigor T 4510	TT	hybrid	4	(32)	111 *	111	114	114	115
HyTTec Trophy	TT	hybrid	4	(23)	110 *	110 *	113	113	113
Hyola Blazer TT	TT	hybrid	4	(2)	110 *	108 *	112 *	113 *	115
Pioneer 44T02 TT	TT	hybrid	4	(35)	107	107	108	109	109
SF Turbine TT	TT	hybrid	4	(22)	104	105	105	103	105 *
ATR Mako	TT	OP	4	(2)	101	101 *	101	100 *	101 *
ATR Bonito	TT	OP	4	(36)	97	94	97	97	96
Yetna	TT	OP	4	(3)	84	86 *	81 *	80 *	74 *
SF Dynatron TT	TT	hybrid	5	(8)	111 *	108 *	115 *	112 *	114
Hyola 559TT	TT	hybrid	5	(24)	108	108	110	111	111 *
BASF 3000TR	TT+GT (RR)	hybrid	3	(27)	99	101	97	101	99
Hyola Enforcer CT	TT+CL	hybrid	4	(5)	108 *	105 *	109 *	115 *	111
Hyola 580CT	TT+CL	hybrid	5	(2)	97 *	97 *	97	96	96 *
GLYPHOSATE TOLERANT (GT) and TF+CL					**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)					**1.09**	**2.30**	**1.88**	**1.79**	**1.11**
Variety	Herbicide tolerance	Type	Harvest maturity	No. trials	(2)	(7)	(6)	(5)	(8)
Pioneer 43Y29 RR	GT (RR)	hybrid	3	(14)	110 *	109 *	107	98 *	106
InVigor R 3520	GT (RR)	hybrid	3	(26)	103 *	104	102	103	106
Pioneer 43Y23 RR	GT (RR)	hybrid	3	(28)	102	102	102	105	103
Pioneer 44Y27 RR	GT (RR)	hybrid	4	(25)	111 *	110	110	109	110
InVigor R 4022P	GT (TF)	hybrid	4	(8)	111 *	111 *	108 *	104 *	111
Xseed Raptor	GT (TF)	hybrid	4	(8)	107 *	104 *	110 *	113 *	104
DG 408RR	GT (RR)	hybrid	4	(21)	106 *	104	107	108	105
Hyola 410XX	GT (TF)	hybrid	4	(8)	105 *	102 *	107 *	111 *	102
InVigor R 4520P	GT (TF)	hybrid	4	(8)	103 *	106 *	99 *	96 *	106
Hyola 404RR	GT (RR)	hybrid	4	(28)	96	95	98	102	96
Nuseed GT-42	GT (RR)	hybrid	4	(13)	95	93	97	98	92 *
Xseed Condor	GT (TF)	hybrid	5	(8)	118 *	113 *	119 *	117 *	112
Pioneer 45Y28 RR	GT (RR)	hybrid	5	(6)	112 *	112 *	109	106 *	111 *
Nuseed GT-53	GT (RR)	hybrid	5	(19)	103	101	105	104	100
Pioneer 45Y25 RR	GT (RR)	hybrid	5	(6)	103	104	101 *	95 *	103 *
Hyola Garrison XC	GT (TF)+CL	hybrid	4	(8)	110 *	106 *	111 *	111 *	105
Hyola 540XC	GT (TF)+CL	hybrid	5	(2)	102 *	102 *	103 *	102 *	103
CLEARFIELD (CL)					**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)					**-**	**2.18**	**1.68**	**1.75**	**0.72**
Variety	Herbicide tolerance	Type	Harvest maturity	No. trials	(0)	(2)	(2)	(2)	(2)
Pioneer 43Y92 CL	CL	hybrid	3	(8)	-	105	111	112	110
Pioneer 44Y90 CL	CL	hybrid	4	(8)	-	107	110	109	108
Banker CL	CL	hybrid	6	(2)	-	108 *	107	93 *	96 *

Varieties grouped by herbicide type and maturity, then ordered by yield. Source: NVT Online, **nvtonline.com.au**

* EARLY series trials are sown in shorter-season environments in northern and eastern areas which may suit early-maturity varieties, largely in Agzones 1, 2, 4 and 5 (Fig. 1 and Tables 5-8). Both Early- and Mid-trials have similar sowing times.

***** = show predicted yield from MET analysis, where a variety was NOT present in trials.

TABLE 4. Yield of canola varieties in all *MID series WA NVT expressed as percentage of site mean yield for each trial year (2015-2019)

TRIAZINE TOLERANT (TT), TT+RR and TT+CL					2015	2016	2017	2018	2019
Site mean yield (t/ha)					2.01	2.56	1.93	2.15	2.05
Variety	Herbicide tolerance	Type	Harvest maturity	No. trials	(10)	(9)	(12)	(10)	(12)
HyTTec Trident	TT	hybrid	3	(18)	120 *	121 *	115	124	115
InVigor T 3510	TT	hybrid	3	(5)	111 *	108 *	107 *	107	107 *
Hyola 350TT	TT	hybrid	3	(26)	109 *	108 *	105	108	106
SF Spark TT	TT	hybrid	3	(9)	103 *	102 *	102 *	102	102
ATR Stingray	TT	OP	3	(25)	93	92	95	89	95
HyTTec Trophy	TT	hybrid	4	(28)	117 *	118 *	115	118	114
InVigor T 4510	TT	hybrid	4	(43)	116 *	115	113	113	112
SF Turbine TT	TT	hybrid	4	(39)	108	107	106	107	105
Pioneer 44T02 TT	TT	hybrid	4	(30)	106	105	101	109	103 *
ATR Bonito	TT	OP	4	(47)	96	96	97	94	97
ATR Mako	TT	OP	4	(36)	95	95	96	95	96 *
ATR Gem	TT	OP	4	(10)	93	94 *	96 *	92 *	96 *
Yetna	TT	OP	4	(2)	88	87 *	89 *	88 *	91 *
HyTTec Trifecta	TT	hybrid	5	(19)	122 *	123 *	121*	120	118
SF Dynatron TT	TT	hybrid	5	(7)	116 *	118 *	118 *	113 *	114
SF Ignite TT	TT	hybrid	5	(41)	108 *	111	112	106	109
Hyola 559TT	TT	hybrid	5	(46)	106	106	102	110	103
Pioneer 45T03 TT	TT	hybrid	5	(11)	101 *	101 *	102 *	98	101
InVigor T 6010	TT	hybrid	6	(6)	118 *	119 *	118 *	115 *	115
DG 670TT	TT	hybrid	6	(38)	109 *	110	111	106	108
ATR Wahoo	TT	OP	6	(19)	94	97	100	93	98 *
BASF 3000TR	TT+GT (RR)	hybrid	3	(10)	98 *	96 *	93	99	96
Hyola 530XT	TT+GT (RR)	hybrid	5	(11)	101 *	101 *	101	102 *	101
Hyola Enforcer CT	TT+CL	hybrid	4	(9)	111 *	109 *	106 *	111 *	106
Hyola 580CT	TT+CL	hybrid	5	(29)	99 *	100 *	100	100	100
GLYPHOSATE TOLERANT (GT) and TF+CL					**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)					**1.98**	**2.66**	**2.10**	**2.33**	**2.26**
Variety	**Herbicide tolerance**	**Type**	**Harvest maturity**	**No. trials**	**(8)**	**(6)**	**(8)**	**(6)**	**(10)**
Pioneer 43Y29 RR	GT (RR)	hybrid	3	(10)	108 *	109 *	110	104 *	108
Pioneer 43Y23 RR	GT (RR)	hybrid	3	(15)	102	101	101	101	101 *
InVigor R 3520	GT (RR)	hybrid	3	(13)	100 *	97	94 *	100	96
InVigor R 4520P	GT (TF)	hybrid	4	(10)	117 *	118 *	119 *	109 *	115
InVigor R 4022P	GT (TF)	hybrid	4	(10)	109 *	109 *	112 *	101 *	108
Xseed Raptor	GT (TF)	hybrid	4	(11)	109 *	110 *	106	111 *	106
Pioneer 44Y27 RR	GT (RR)	hybrid	4	(25)	108 *	109	106	108	106
Hyola 410XX	GT (TF)	hybrid	4	(11)	105 *	104 *	101	107 *	102
DG 408RR	GT (RR)	hybrid	4	(14)	104 *	104	102	105	102
Nuseed GT-42	GT (RR)	hybrid	4	(28)	98	97	96	100	97 *
Hyola 404RR	GT (RR)	hybrid	4	(25)	95	93	92	97	94
Xseed Condor	GT (TF)	hybrid	5	(10)	114 *	116 *	114 *	112 *	112
Pioneer 45Y28 RR	GT (RR)	hybrid	5	(9)	109 *	111 *	109	108	108 *
Nuseed GT-53	GT (RR)	hybrid	5	(38)	106	108	104	110	105
Pioneer 45Y25 RR	GT (RR)	hybrid	5	(30)	104	106	108	103	106
InVigor R 5520P	GT (RR)	hybrid	5	(28)	102	102	104	98 *	102
Hyola Garrison XC	GT (TF)+CL	hybrid	4	(10)	107 *	108 *	105 *	108 *	105
Hyola 540XC	GT (TF)+CL	hybrid	5	(11)	93 *	94 *	95	96 *	95

[Table 4. continued following page...]

TABLE 4. Yield of canola varieties in all *MID series WA NVT expressed as percentage of site mean yield for each trial year (2015-2019) (cont'd)

CLEARFIELD (CL)					2015	2016	2017	2018	2019
Site mean yield (t/ha)					2.05	2.92	1.99	2.22	2.36
Variety	Herbicide tolerance	Type	Harvest maturity	No. trials	(7)	(4)	(7)	(6)	5
Pioneer 43Y92 CL	CL	hybrid	3	(9)	112 *	108	108	107	103 *
Pioneer 44Y94 CL	CL	hybrid	4	(4)	118 *	121 *	119 *	119 *	114
Pioneer 44Y90 CL	CL	hybrid	4	(26)	110	111	112	108	109
Pioneer 45Y93 CL	CL	hybrid	5	(12)	110 *	113 *	117	107	113
Pioneer 45Y91 CL	CL	hybrid	5	(16)	104 *	105	107	101	106
Banker CL	CL	hybrid	6	(22)	107	108 *	112	103	109

Varieties grouped by herbicide type and maturity, then ordered by yield. Source: NVT Online, **nvtonline.com.au**

*MID series trials are sown in longer-season environments, which may suit mid-maturity varieties, largely in Agzones 2, 3 and 6 (Fig 1 and Tables 9-11). Both the Early-trials and Mid-trials have similar sowing times.

***** = show predicted yield from MET analysis, where a variety was NOT present in trials.

RESULTS FOR EARLY SERIES NVT

In the Early series TT variety trials, the early maturity variety HyTTec Trident proved a good fit for the Early series environments, generating the highest overall yield (Table 3). HyTTec Trident also demonstrated its adaptability, as it was the top-yielding variety in each of Agzones 1, 2, 4 and 5 (Tables 5-8). These results are highly reliable, with 18 trials over three seasons.

The early-mid maturity varieties InVigor T 4510 and HyTTec Trophy achieved the second and third highest yields in the TT variety trials, respectively. InVigor T4510 had slightly higher yields than HyTTec Trophy in all Early series Agzones. Initial testing (only two trials), showed that the new variety Hyola Blazer TT generated yields just behind HyTTec Trophy (Table 3).

SF Dynatron TT was the fifth highest yielding variety over WA Early series, despite it being a mid maturity variety. However, this was assessed from just one year of data. Other varieties with yields just behind those varieties discussed above were Hyola 350TT, Hyola 559TT, InVigor T 3510 and Pioneer 44T02 TT (Table 3).

TT hybrids continued to out-yield OP varieties. The hybrids named above achieved yields 10-24% higher than ATR Bonito.

The new combination TT+CL variety, Hyola Enforcer CT, achieved higher yields than Hyola 580CT (more than 10%) and has a slightly shorter maturity.

With limited NVT data for the Early series glyphosate tolerant varieties, Pioneer 44Y27 RR is the proven high yielding variety across the Agzones and growing seasons. New releases, Xseed Condor, Pioneer 45Y28 RR and InVigor R 4022P have shown high yield results, but only a single season of testing. Other varieties to be considered for their high yields in NVT are Xseed Raptor and DG 408RR, followed by Pioneer 43Y29 RR, DG 408RR and Hyola 410XX.

The Clearfield® varieties Pioneer 43Y92 CL and Pioneer 44Y90 CL achieved the highest predicted yields in the CL variety trials.

TABLE 5. Yield of canola varieties in AGZONE 1 EARLY series NVT expressed as percentage of site mean yield for each trial year (2015-2019)

TRIAZINE TOLERANT (TT), TT+GT and TT+CL				2015	2016	2017	2018	2019
Site mean yield (t/ha)				-	3.06	1.30	1.52	1.27
Variety	Herbicide tolerance	Harvest maturity	No. trials	(0)	(2)	(2)	(1)	(2)
HyTTec Trident	TT	3	(4)	-	104 *	127	129	122
SF Dynatron TT	TT	5	(2)	-	119 *	118 *	99 *	112
InVigor T 4510	TT	4	(7)	-	115	116	106	113
HyTTec Trophy	TT	4	(5)	-	113 *	115	106	112
Hyola 559TT	TT	5	(5)	-	110	113	107	110 *
InVigor T 3510	TT	3	(3)	-	112 *	110 *	103	109
Hyola 350TT	TT	3	(5)	-	104 *	112	115	111
Pioneer 44T02 TT	TT	4	(7)	-	106	109	110	109
SF Turbine TT	TT	4	(2)	-	109 *	102	99	103 *
SF Spark TT	TT	3	(2)	-	100 *	103 *	105 *	103
ATR Bonito	TT (OP)	4	(7)	-	96	101	95	98
BASF 3000TR	TT+GT (RR)	3	(7)	-	92	98	110	100
Hyola 580CT	TT+CL	5	(2)	-	-	95	95	96
GLYPHOSATE TOLERANT (GT) and TF+CL				**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)				**-**	**3.07**	**1.27**	**1.52**	**1.32**
Variety	**Herbicide tolerance**	**Harvest maturity**	**No. trials**	**(0)**	**(2)**	**(2)**	**(1)**	**(2)**
Xseed Condor	GT (TF)	5	(2)	-	116 *	129 *	112 *	121
Pioneer 43Y29 RR	GT (RR)	3	(4)	-	121 *	106	87 *	104
Pioneer 44Y27 RR	GT (RR)	4	(7)	-	110	112	108	110
InVigor R 4022P	GT (TF)	4	(2)	-	114 *	105 *	103 *	107
Pioneer 45Y28 RR	GT (RR)	5	(2)	-	112 *	105	107 *	107 *
Xseed Raptor	GT (TF)	4	(2)	-	101 *	119 *	114 *	113
DG 408RR	GT (RR)	4	(5)	-	102	110	110	108 *
Hyola 410XX	GT (TF)	4	(2)	-	98 *	116 *	112 *	110
Nuseed GT-53	GT (RR)	5	(5)	-	103	111	101	106 *
Pioneer 45Y25 RR	GT (RR)	5	(1)	-	111	97 *	91 *	98 *
InVigor R 3520	GT (RR)	3	(7)	-	100	97	108	102
InVigor R 4520P	GT (TF)	4	(2)	-	107 *	90 *	98 *	97
Pioneer 43Y23 RR	GT (RR)	3	(7)	-	96	102	110	103
Nuseed GT-42	GT (RR)	4	(5)	-	95	103	96	99 *
Hyola 404RR	GT (RR)	4	(7)	-	91	101	105	100
Hyola Garrison XC	GT (TF)+CL	4	(2)	-	108 *	119 *	107 *	113
Hyola 540XC	GT (TF)+CL	5	(2)	-	-	103 *	-	103

Varieties listed in decreasing yield, within each herbicide tolerance group. Source: NVT Online, **nvtonline.com.au**

EARLY series trials are sown in shorter season environments that may suit-early maturity varieties (see Figure 1)

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

***** = show predicted yield from MET analysis, where a variety was NOT present in trials.

TABLE 6. Yield of canola varieties in AGZONE 2 EARLY series NVT expressed as percentage of site mean yield for each trial year (2015-2019)

TRIAZINE TOLERANT (TT), TT+GT and TT+CL				2015	2016	2017	2018	2019
Site mean yield (t/ha)				1.08	2.06	1.89	1.69	1.00
Variety	Herbicide tolerance	Harvest maturity	No. trials	(2)	(3)	(2)	(3)	(2)
HyTTec Trident	TT	3	(7)	117 *	113 *	117	124	104
InVigor T 4510	TT	4	(10)	114 *	108	112	113	107
HyTTec Trophy	TT	4	(7)	113 *	108 *	111	112	106
Hyola 350TT	TT	3	(6)	110 *	109 *	110	112	108
Hyola 559TT	TT	5	(10)	111	107	109	110	105 *
SF Dynatron TT	TT	5	(2)	114 *	106 *	111 *	110 *	101
Pioneer 44T02 TT	TT	4	(12)	109	107	108	109	107
InVigor T 3510	TT	3	(5)	110 *	106 *	109 *	108	106
SF Turbine TT	TT	4	(10)	106	103	104	103	108 *
SF Spark TT	TT	3	(3)	102 *	102 *	102 *	104	102
ATR Bonito	TT (OP)	4	(12)	95	95	96	97	87
ATR Stingray	TT (OP)	3	(10)	91	93	92	90	92
Yetna	TT (OP)	4	(2)	80	86 *	82 *	81 *	-
BASF 3000TR	TT+GT (RR)	3	(12)	98	102	100	102	104
GLYPHOSATE TOLERANT (GT) and GT+CL				2015	2016	2017	2018	2019
Site mean yield (t/ha)				1.09	2.04	1.89	1.89	1.01
Variety	Herbicide tolerance	Harvest maturity	No. trials	(2)	(3)	(2)	(2)	(3)
Xseed Condor	GT (TF)	5	(3)	118 *	110 *	116 *	118 *	102
Pioneer 45Y28 RR	GT (RR)	5	(2)	112 *	109 *	110	107 *	115 *
InVigor R 4022P	GT (TF)	4	(3)	111 *	108 *	109 *	106 *	117
Pioneer 44Y27 RR	GT (RR)	4	(9)	111 *	108	110	109	109
DG 408RR	GT (RR)	4	(10)	106 *	105	106	108	101
Xseed Raptor	GT (TF)	4	(3)	107 *	104 *	108 *	112 *	93
InVigor R 3520	GT (RR)	3	(10)	103 *	105	103	103	111
Pioneer 43Y29 RR	GT (RR)	3	(5)	110 *	102 *	107	100 *	109
InVigor R 4520P	GT (TF)	4	(3)	103 *	104 *	102 *	98 *	118
Hyola 410XX	GT (TF)	4	(3)	105 *	103 *	105 *	110 *	92
Pioneer 43Y23 RR	GT (RR)	3	(12)	102	103	102	104	103
Pioneer 45Y25 RR	GT (RR)	5	(4)	103	101	102 *	97 *	109 *
Nuseed GT-53	GT (RR)	5	(12)	103	100	103	104	93
Hyola 404RR	GT (RR)	4	(12)	96	98	97	101	92
Nuseed GT-42	GT (RR)	4	(5)	95	94	95 *	98 *	85 *
Hyola Garrison XC	GT (TF)+CL	4	(3)	110 *	104 *	109 *	111 *	97

Varieties listed in decreasing yield, within each herbicide tolerance group. Source: NVT Online, **nvtonline.com.au**

EARLY series trials are sown in shorter season environments that may suit early-maturity varieties (see Figure 1)

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

***** = show predicted yield from MET analysis, where a variety was NOT present in trials.

TABLE 7. Yield of canola varieties in AGZONE 4 EARLY series NVT expressed as percentage of site mean yield for each trial year (2015-2019)

TRIAZINE TOLERANT (TT), TT+GT and TT+CL				2015	2016	2017	2018	2019
Site mean yield (t/ha)				-	2.25	2.22	1.79	0.92
Variety	Herbicide tolerance	Harvest maturity	No. trials	(0)	(1)	(1)	(2)	(2)
HyTTec Trident	TT	3	(5)	-	130 *	122	124	124
Hyola 350TT	TT	3	(4)	-	119 *	111	111	113
InVigor T 4510	TT	4	(6)	-	110	113	111	117
HyTTec Trophy	TT	4	(5)	-	109 *	112	110	115
Hyola 559TT	TT	5	(3)	-	110	111 *	109	113 *
Pioneer 44T02 TT	TT	4	(6)	-	113	109	108	110
SF Dynatron TT	TT	5	(2)	-	100 *	112 *	109 *	115
InVigor T 3510	TT	3	(4)	-	106 *	109 *	106	111
SF Spark TT	TT	3	(2)	-	106 *	103 *	103 *	103
SF Turbine TT	TT	4	(2)	-	103	103	101 *	105 *
ATR Bonito	TT (OP)	4	(6)	-	90	98	99	96
ATR Stingray	TT (OP)	3	(4)	-	86 *	91 *	91	89
BASF 3000TR	TT+GT (RR)	3	(6)	-	111	100	102	99
GLYPHOSATE TOLERANT (GT) and GT+CL				**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)				**-**	**2.25**	**2.22**	**1.78**	**1.03**
Variety	**Herbicide tolerance**	**Harvest maturity**	**No. trials**	**(0)**	**(1)**	**(1)**	**(2)**	**(3)**
Xseed Condor	GT (TF)	5	(3)	-	111 *	121 *	120 *	115
Xseed Raptor	GT (TF)	4	(3)	-	110 *	113 *	115 *	108
Pioneer 44Y27 RR	GT (RR)	4	(7)	-	112	111	109	110
Hyola 410XX	GT (TF)	4	(3)	-	107 *	110 *	112 *	105
DG 408RR	GT (RR)	4	(4)	-	110	108	108	106 *
InVigor R 4022P	GT (TF)	4	(3)	-	111 *	107 *	103 *	109
Pioneer 43Y23 RR	GT (RR)	3	(7)	-	112	103	104	104
InVigor R 3520	GT (RR)	3	(7)	-	114	102	101	105
Hyola 404RR	GT (RR)	4	(7)	-	101	99	102	98
Pioneer 43Y29 RR	GT (RR)	3	(4)	-	91 *	105	99 *	104
InVigor R 4520P	GT (TF)	4	(3)	-	107 *	97 *	94 *	103
Hyola Garrison XC	GT (TF)+CL	4	(3)	-	104 *	113 *	113 *	108

Varieties listed in decreasing yield, within each herbicide tolerance group. Source: NVT Online, **nvtonline.com.au**

EARLY series trials are sown in shorter season environments that may suit early-maturity varieties (see Figure 1)

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

***** = show predicted yield from MET analysis, where a variety was NOT present in trials.

TABLE 8. Yield of canola varieties in AGZONE 5 EARLY series NVT expressed as percentage of site mean yield for each trial year (2015-2019)

TRIAZINE TOLERANT (TT), TT+GT and TT+CL				2015	2016	2017	2018	2019
Site mean yield (t/ha)				2.01	1.73	1.77	0.65	1.31
Variety	Herbicide tolerance	Harvest maturity	No. trials	(2)	(3)	(3)	(1)	(2)
SF Dynatron TT	TT	5	(2)	109 *	103 *	118 *	177 *	125
HyTTec Trident	TT	3	(2)	114 *	117 *	107 *	116 *	127
InVigor T 4510	TT	4	(9)	-	108	115	158	121
HyTTec Trophy	TT	4	(6)	108 *	107 *	113	150	119
InVigor T 3510	TT	3	(3)	106 *	106 *	112 *	143	114
Hyola 559TT	TT	5	(6)	107	107	110 *	136	116 *
Hyola 350TT	TT	3	(6)	107 *	111 *	105	110	112
Pioneer 44T02 TT	TT	4	(10)	106	108	106	117 *	110
SF Turbine TT	TT	4	(8)	103	103	108	127 *	105 *
SF Spark TT	TT	3	(2)	102 *	103 *	100 *	99 *	103
ATR Bonito	TT (OP)	4	(11)	98	93	96	96	101
ATR Stingray	TT (OP)	3	(5)	94	91 *	94 *	84	89
BASF 3000TR	TT+GT (RR)	3	(2)	99 *	105	93	64 *	94 *
Hyola Enforcer CT	TT+CL	4	(2)	108 *	108 *	102 *	107 *	119

Varieties listed in decreasing yield, within each herbicide tolerance group. Source: NVT Online, **nvtonline.com.au**

EARLY series trials are sown in shorter season environments that may suit early-maturity varieties (see Figure 1)

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

***** = show predicted yield from MET analysis, where a variety was NOT present in trials.

RESULTS FOR MID SERIES NVT

The four highest yielding TT varieties in the Mid series of the MET analysis for WA covered a wide maturity range: HyTTec Trifecta (5 maturity), HyTTec Trident (3), InVigor T6010 (6) and HyTTec Trophy (4) (Table 4). HyTTec Trident achieved the highest comparative yields in Agzone 2 while in the higher rainfall Agzones 3 and 6, the highest yielding varieties were the longer season varieties HyTTec Trifecta, followed by InVigor T 6010.

In the 2020 blackleg testing, the blackleg resistance rating of HyTTec Trophy was increased to R from R-MR, so all three HyTTec varieties have the highest resistance rating of R. InVigor T 6010 has a blackleg rating of MS where it is recommended that a blackleg seed dressing is applied or be avoided in high blackleg situations.

Other varieties that yielded well in the Mid series were SF Dynatron TT, InVigor T 4510, SF Ignite, and DG 670TT. However, there was only a single season of NVT results for InVigor T 6010 and SF Dynatron TT. In the 2020 blackleg testing SF Ignite and DG 670TT achieved a blackleg resistance rating of MR, InVigor T 4510 was upgraded to MR and SF Dynatron achieved a rating of MRMS.

TT hybrids continued to out-yield OP varieties in the Mid series. The highest yielding hybrids (see above) achieved yields 11-21% higher than ATR Bonito.

For varieties with combination tolerance, the new TruFlex® variety Hyola 530XT achieved yields 5% higher than BASF 3000TR while the new TT+CL variety Hyola Enforcer CT achieved yields 6% higher than Hyola 580CT in 2019 (Table 4).

The highest yielding glyphosate-tolerant varieties in the Mid series were InVigor R4022P, Xseed Condor, Pioneer 45Y28 RR, Xseed Raptor, InVigor R 4022P, Pioneer 43Y29 RR and Pioneer 44Y27 RR. Their yields were within a 6% range each year, except the high InVigor R 4520P yields in 2019 (Table 4). Pioneer 44Y27 has been in the NVT for the past four years, while only 2019 data is available for the new varieties InVigor R 4520P, Xseed Condor and InVigor R 4022P. InVigor R 4520P and Xseed

Condor had high predicted yields across the yield spectrum, from 1-3.5t/ha (data not shown). Pioneer 45Y28 RR and Xseed Raptor achieved their highest relative yields in trials over 2t/ha, while InVigor R 4022P and Pioneer 44Y27 delivered their highest relative yields in trials less than 2t/ha (data not shown).

The new GT+CL combination variety Hyola Garrison XC had a 10% higher predicted yield than Hyola 540XC in the WA 2019 trials, with the greatest difference in Agzone 2 (13%).

In the CL trials, the new CL variety Pioneer 44Y94 CL delivered the highest predicted yields for 2019, with Pioneer 45Y93 CL closely behind. These results relate to the overall WA average and for the high rainfall Agzones 3 and 6. Pioneer 43Y92 CL and Pioneer 44Y90 CL were the highest yielding varieties in Agzone 2.

TABLE 9. Yield of canola varieties in AGZONE 2 MID series NVT expressed as percentage of site mean yield for each trial year (2015-2019)

TRIAZINE TOLERANT (TT), TT+GT and TT+CL				2015	2016	2017	2018	2019
Site mean yield (t/ha)				1.43	2.65	2.04	2.10	1.58
Variety	Herbicide tolerance	Harvest maturity	No. trials	(3)	(5)	(4)	(4)	(5)
HyTTec Trident	TT	3	(10)	122 *	119 *	115	123	117
HyTTec Trifecta	TT	5	(8)	119 *	121 *	118 *	116	117
HyTTec Trophy	TT	4	(13)	115 *	117 *	113	115	113
InVigor T 4510	TT	4	(18)	113 *	114	112	110	112
SF Dynatron TT	TT	5	(5)	108 *	116 *	114 *	108 *	110
Hyola Enforcer CT	TT+CL	4	(3)	118 *	110 *	107 *	110 *	111
Hyola 350TT	TT	3	(10)	114 *	108 *	106	107	109
InVigor T 3510	TT	3	(4)	113 *	108 *	107 *	105	108 *
Pioneer 44T02 TT	TT	4	(16)	113	106	104	110	108 *
Hyola 559TT	TT	5	(21)	110	106	104	111	106
SF Turbine TT	TT	4	(21)	108	107	106	106	106
DG 670TT	TT	6	(14)	102 *	109	108 *	103	104
SF Ignite TT	TT	5	(17)	97 *	108	108	103	102
SF Spark TT	TT	3	(5)	104 *	102 *	102 *	102	103
Hyola 530XT	TT+GT (TF)	5	(4)	102 *	101 *	101 *	102 *	101
BASF 3000TR	TT+GT (RR)	3	(10)	107 *	97 *	97	101	102
Hyola 580CT	TT+CL	5	(11)	95 *	99 *	99	101	98
ATR Mako	TT (OP)	4	(14)	96	96	96	96	97 *
ATR Bonito	TT (OP)	4	(16)	94	96	97	94	96 *
ATR Gem	TT (OP)	4	(3)	90	94 *	95 *	93 *	94 *
ATR Stingray	TT (OP)	3	(14)	93	93	95	88	94 *
Hyola 530XT	TT+GT (TF)	5	(4)	102 *	101 *	101 *	102 *	101
BASF 3000TR	TT+GT (RR)	3	(10)	107 *	97 *	97	101	102
Hyola Enforcer CT	TT+CL	4	(3)	118 *	110 *	107 *	110 *	111

[Table 9. continued following page...]

TABLE 9. Yield of canola varieties in AGZONE 2 MID series NVT expressed as percentage of site mean yield for each trial year (2015-2019) (cont'd)

GLYPHOSATE TOLERANT (GT) and GT+CL				2015	2016	2017	2018	2019
Site mean yield (t/ha)				1.43	2.73	1.86	2.17	1.67
Variety	Herbicide tolerance	Harvest maturity	No. trials	(3)	(4)	(3)	(3)	(4)
InVigor R 4520P	GT (TF)	4	(4)	117 *	118 *	119 *	102 *	114
Xseed Condor	GT (TF)	5	(4)	112 *	115 *	113 *	109 *	111
InVigor R 4022P	GT (TF)	4	(4)	114 *	111 *	113 *	96 *	109
Xseed Raptor	GT (TF)	4	(4)	108 *	109 *	106 *	111 *	107
Pioneer 44Y27 RR	GT (RR)	4	(14)	-	108	108	107	108
Pioneer 45Y28 RR	GT (RR)	5	(4)	105 *	109 *	108	106	106 *
Pioneer 43Y29 RR	GT (RR)	3	(5)	108 *	109 *	110	100 *	107
Nuseed GT-53	GT (RR)	5	(17)	103	106	103	111	104
Hyola 410XX	GT (TF)	4	(4)	107 *	104 *	102 *	108 *	104
DG 408RR	GT (RR)	4	(14)	105 *	104	103	105	104
Pioneer 43Y23 RR	GT (RR)	3	(13)	107	102	103	101	104 *
InVigor R 3520	GT (RR)	3	(11)	114 *	99	100 *	102	105
Pioneer 45Y25 RR	GT (RR)	5	(10)	94	105	103	101	100 *
InVigor R 5520P	GT (RR)	5	(10)	103 *	102	104	96	102
Nuseed GT-42	GT (RR)	4	(13)	98	97	96	102	98 *
Hyola 404RR	GT (RR)	4	(13)	103	94	95	99	99 *
Hyola 540XC	GT (TF)+CL	5	(4)	90 *	93 *	93 *	98 *	93
Hyola Garrison XC	GT (TF)+CL	4	(4)	108 *	107 *	106 *	108 *	106
CLEARFIELD (CL)				**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)				**1.56**	**3.23**	**1.81**	**2.02**	**1.25**
Variety	**Herbicide tolerance**	**Harvest maturity**	**No. trials**	**(2)**	**(2)**	**(2)**	**(2)**	**(1)**
Pioneer 43Y92 CL	CL	3	(5)	118 *	108	109	105	114 *
Pioneer 44Y90 CL	CL	4	(9)	111	111	111	105	107
Pioneer 45Y93 CL	CL	5	(3)	107 *	112 *	113	103 *	104
Banker CL	CL	6	(7)	105	107 *	108	98	104
Pioneer 45Y91 CL	CL	5	(2)	102 *	104 *	104	99 *	101 *

Varieties listed in decreasing yield, within each herbicide tolerance group. Source: NVT Online, **nvtonline.com.au**

MID series trials are sown in longer season environments that may suit mid-maturity varieties (see Figure 1)

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

***** = show predicted yield from MET analysis, where a variety was NOT present in trials.

TABLE 10. Yield of canola varieties in AGZONE 3 MID series NVT expressed as percentage of site mean yield for each trial year (2015-2019)

TRIAZINE TOLERANT (TT), TT+GT and TT+CL				2015	2016	2017	2018	2019
Site mean yield (t/ha)				2.14	3.28	2.23	2.59	2.68
Variety	Herbicide tolerance	Harvest maturity	No. trials	(3)	(2)	(3)	(3)	(3)
HyTTec Trifecta	TT	5	(6)	124 *	130 *	127 *	123	120
InVigor T 6010	TT	6	(3)	118 *	126 *	125 *	118 *	119
HyTTec Trident	TT	3	(3)	121 *	125 *	119 *	125	115 *
SF Dynatron TT	TT	5	(1)	117 *	124 *	125 *	116 *	119
HyTTec Trophy	TT	4	(7)	118 *	123 *	120	119	115
InVigor T 4510	TT	4	(11)	119 *	119	117	114	113
SF Ignite TT	TT	5	(11)	105 *	116	118	110	114
DG 670TT	TT	6	(11)	108 *	114	116	108	112
Hyola 350TT	TT	3	(5)	113 *	109 *	106	107	104 *
SF Turbine TT	TT	4	(14)	109	109	107	107	105
Hyola 559TT	TT	5	(11)	106	105	102	109	101 *
Pioneer 44T02 TT	TT	4	(8)	108	105	101	108 *	100 *
SF Spark TT	TT	3	(3)	104 *	103 *	102 *	102 *	101
Pioneer 45T03 TT	TT	5	(5)	101 *	101 *	103 *	99	102
ATR Wahoo	TT (OP)	6	(9)	90	98	102	96	102 *
ATR Bonito	TT (OP)	4	(13)	95	95	97	95	97
ATR Mako	TT (OP)	4	(11)	95	94	94	95	96 *
ATR Gem	TT (OP)	4	(3)	92	93 *	95 *	93 *	97 *
ATR Stingray	TT (OP)	3	(5)	95	91	94 *	89 *	95 *
Hyola 530XT	TT+GT (TF)	5	(4)	102 *	101 *	101	101 *	100
Hyola 580CT	TT+CL	5	(9)	96 *	100 *	101	101	101
Hyola Enforcer CT	TT+CL	4	(3)	115 *	110 *	106 *	109 *	104
GLYPHOSATE TOLERANT (GT) and GT+CL				**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)				2.04	3.19	2.26	2.46	2.69
Variety	Herbicide tolerance	Harvest maturity	No. trials	(2)	(1)	(2)	(2)	(3)
InVigor R 4520P	GT (TF)	4	(3)	126 *	122 *	121 *	111 *	117
Xseed Condor	GT (TF)	5	(3)	116 *	120 *	118 *	114 *	113
Pioneer 45Y28 RR	GT (RR)	5	(3)	108 *	114 *	113	110	110 *
Pioneer 43Y29 RR	GT (RR)	3	(4)	113 *	112 *	111	106 *	109
InVigor R 4022P	GT (TF)	4	(3)	120 *	110 *	110 *	103 *	108
Xseed Raptor	GT (TF)	4	(4)	107 *	113 *	110	112 *	107
Pioneer 44Y27 RR	GT (RR)	4	(7)	111 *	110	108	108	105
Pioneer 45Y25 RR	GT (RR)	5	(9)	100	110	111	105	110
Nuseed GT-53	GT (RR)	5	(10)	102	111	109	111	106
Hyola 410XX	GT (TF)	4	(4)	104 *	105 *	103	107 *	101
InVigor R 5520P	GT (RR)	5	(9)	106	101	102	98	102
Pioneer 43Y23 RR	GT (RR)	3	(2)	106	100 *	99	101 *	99 *
Nuseed GT-42	GT (RR)	4	(7)	95	97	97	100	97 *
Hyola 404RR	GT (RR)	4	(6)	97	89 *	88	95 *	90
Hyola 540XC	GT (TF)+CL	5	(4)	88 *	93 *	95	96 *	96
Hyola Garrison XC	GT (TF)+CL	4	(3)	108 *	109 *	107 *	108 *	104
CLEARFIELD (CL)				**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)				2.39	1.84	1.81	1.51	2.37
Variety	Herbicide tolerance	Harvest maturity	No. trials	(2)	(1)	(2)	(1)	(2)
Pioneer 44Y94 CL	CL	4	(2)	119 *	121 *	120 *	119 *	115
Pioneer 45Y93 CL	CL	5	(4)	110 *	117 *	118	110 *	115
Pioneer 44Y90 CL	CL	4	(11)	112	114	113	109	109
Banker CL	CL	6	(8)	108	112 *	113	104 *	110
Pioneer 43Y92 CL	CL	3	(3)	117 *	111	107	106 *	101 *
Pioneer 45Y91 CL	CL	5	(8)	104 *	107	108	103	106

Varieties listed in decreasing yield, within each herbicide tolerance group. Source: NVT Online, **nvtonline.com.au**

MID series trials are sown in longer season environments that may suit mid-maturity varieties (see Figure 1)

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

* = show predicted yield from MET analysis, where a variety was NOT present in trials.

TABLE 11. Yield of canola varieties in AGZONE 6 MID series NVT expressed as percentage of site mean yield for each trial year (2015-2019)

TRIAZINE TOLERANT (TT), TT+GT and TT+CL				2015	2016	2017	2018	2019
Site mean yield (t/ha)				2.50	1.84	1.73	2.01	2.60
Variety	Herbicide tolerance	Harvest maturity	No. trials	(3)	(1)	(4)	(2)	(3)
HyTTec Trifecta	TT	5	(5)	122 *	124 *	119 *	126	117
InVigor T 6010	TT	6	(3)	120 *	121 *	118 *	119 *	115
HyTTec Trident	TT	3	(3)	127 *	121 *	111 *	126 *	112
HyTTec Trophy	TT	4	(5)	118 *	121 *	113	121	112
InVigor T 4510	TT	4	(10)	112 *	114	112	119	110
SF Ignite TT	TT	5	(10)	116 *	113	114	106	111
DG 670TT	TT	6	(10)	112 *	110	112	108	109
SF Turbine TT	TT	4	(2)	105	107 *	105	109 *	104 *
Hyola 350TT	TT	3	(8)	103 *	106 *	104	113	104
Hyola 559TT	TT	5	(10)	105	109	99	109	102 *
Pioneer 44T02 TT	TT	4	(3)	103	107 *	99 *	110 *	101 *
Pioneer 45T03 TT	TT	5	(5)	100 *	99 *	103 *	100	101
ATR Wahoo	TT (OP)	6	(8)	103	99	103	90	101 *
ATR Bonito	TT (OP)	4	(13)	96	94	99	94	98
ATR Gem	TT (OP)	4	(3)	96	93 *	98 *	91 *	97 *
ATR Mako	TT (OP)	4	(9)	95	94	96	95	97 *
ATR Stingray	TT (OP)	3	(3)	90	97 *	98 *	91 *	96 *
Hyola 530XT	TT+GT (TF)	5	(3)	101 *	101 *	100 *	102 *	100
Hyola 580CT	TT+CL	5	(9)	103 *	103 *	100	98	101
Hyola Enforcer CT	TT+CL	4	(2)	104 *	108 *	103 *	116 *	104
GLYPHOSATE TOLERANT (GT) and GT+CL				**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)				2.50	1.84	2.22	2.52	2.61
Variety	Herbicide tolerance	Harvest maturity	No. trials	(3)	(1)	(3)	(1)	(3)
InVigor R 4520P	GT (TF)	4	(3)	111 *	111 *	117 *	121 *	113
Xseed Condor	GT (TF)	5	(3)	114 *	116 *	111 *	117 *	111
Pioneer 45Y28 RR	GT (RR)	5	(2)	112 *	112 *	108	110	108 *
Pioneer 45Y25 RR	GT (RR)	5	(11)	112	109	108	104	107
Pioneer 43Y29 RR	GT (RR)	3	(1)	106 *	106 *	109	111 *	107 *
Xseed Raptor	GT (TF)	4	(3)	110 *	113 *	103 *	110 *	106
Nuseed GT-53	GT (RR)	5	(11)	111	113	102	107	105
InVigor R 4022P	GT (TF)	4	(3)	101 *	100 *	111 *	113 *	107
Pioneer 44Y27 RR	GT (RR)	4	(4)	105 *	107	103	110	104 *
Hyola 410XX	GT (TF)	4	(3)	104 *	107 *	98 *	95 *	101
InVigor R 5520P	GT (RR)	5	(9)	99	97	104	103	102
Nuseed GT-42	GT (RR)	4	(8)	99	100	96	97	98 *
Hyola 404RR	GT (RR)	4	(6)	89	92 *	91	95 *	93 *
Hyola 540XC	GT (TF)+CL	5	(3)	99 *	97 *	96 *	92 *	97
Hyola Garrison XC	GT (TF)+CL	4	(3)	106 *	108 *	102 *	108 *	104
CLEARFIELD (CL)				**2015**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)				2.39	1.84	1.81	1.51	2.37
Variety	Herbicide tolerance	Harvest maturity	No. trials	(2)	(1)	(2)	(1)	(2)
Pioneer 44Y94 CL	CL	4	(2)	116 *	121 *	116 *	123 *	113
Pioneer 45Y93 CL	CL	5	(5)	112 *	111 *	118	108	113
Pioneer 44Y90 CL	CL	4	(6)	108	109	113	112	108 *
Banker CL	CL	6	(7)	107	105 *	115	105	109
Pioneer 45Y91 CL	CL	5	(6)	104 *	103	109	102	106

Varieties listed in decreasing yield, within each herbicide tolerance group. Source: NVT Online, **nvtonline.com.au**

MID series trials are sown in longer season environments that may suit mid-maturity varieties (see Figure 1)

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

***** = show predicted yield from MET analysis, where a variety was NOT present in trials.

PHENOLOGY AND DEVELOPMENT SPEED TRIALS

The variety maturities listed in Table 2 relate to the harvest maturity, as provided by the seed companies. However, the development speed, indicated by the start of flowering, should also be considered especially with early sowing, where the greatest differences between varieties is expressed.

Development speed was assessed in two DPIRD trials at South Perth. The date flowering started (50% plants with at least one flower) was recorded for early sowing (10-11 April) and compared with the traditional sowing date (27 April in 2018 and 3 May in 2019) (see Figures 2-4).

The variety development speed was generally in line with harvest maturity. Notable exceptions were the fast development speed (early flowering) of Hyola 580CT when sown early (Figure 2). Although Hyola 580CT has a mid harvest maturity, it may not be suited to early sowing. The mid maturity Hyola 540XC also had a fast development speed with early sowing, aligned with early maturity varieties (Figure 3). Conversely, Pioneer 43Y29 RR had a slower development speed (with early and traditional sowing dates) aligning with early-mid varieties (Figure 3).

The optimal start of flowering in South Perth is 21 June – 16 Aug (predicted from simulation model by Imma Farre, DPIRD). All varieties started to flower within the optimal period when sown around Anzac Day. However, with early sowing varieties with a fast development speed started flowering before the optimal time.

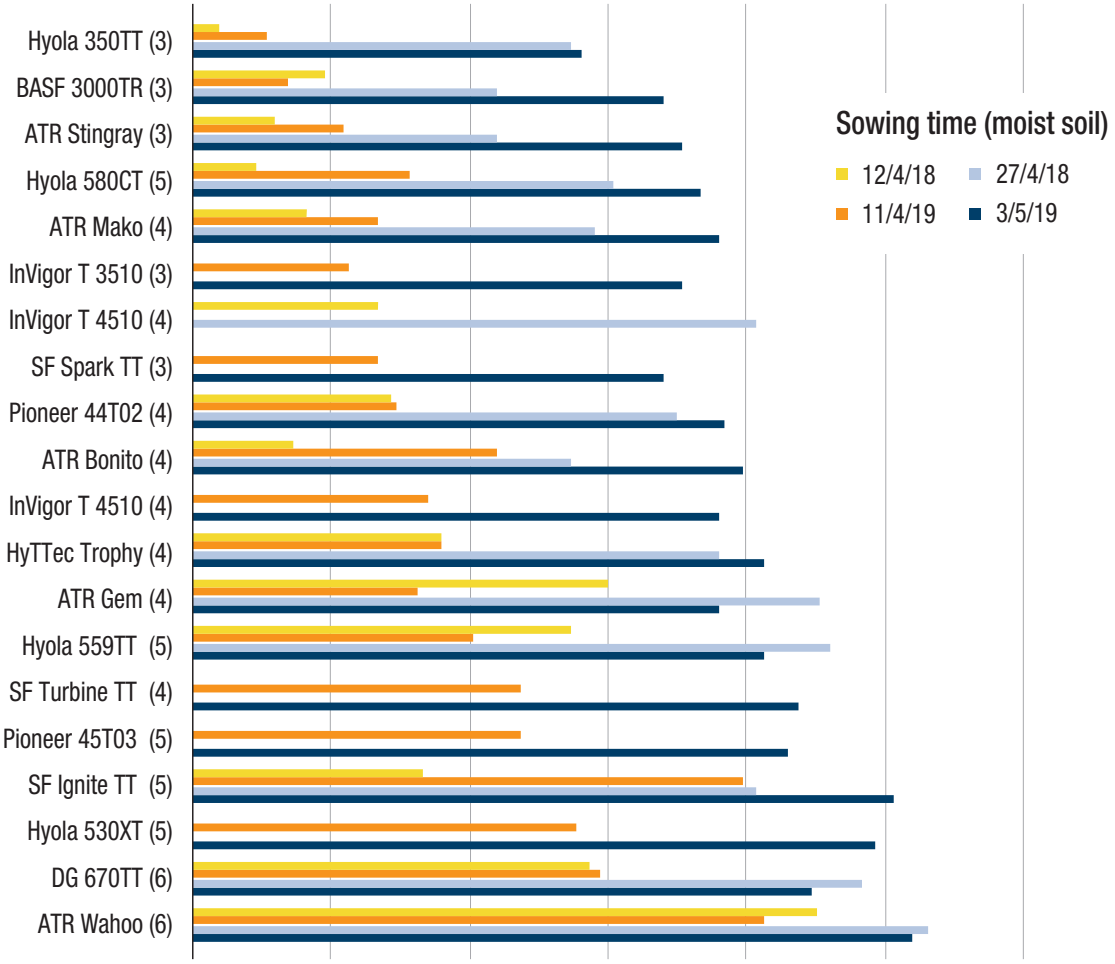


FIGURE 2. Start of flowering for TT, TT+CL and TT+GT canola varieties at South Perth, with a mid-April sowing compared to traditional sowing time around Anzac Day.

Varieties ordered by average time to start flowering with mid-April sowing. Harvest maturity key: (3) = early, (4) = early-mid, (5) = mid, (6) = mid-late (information provided by seed companies). Source: J Bucat and I Farre, DPIRD

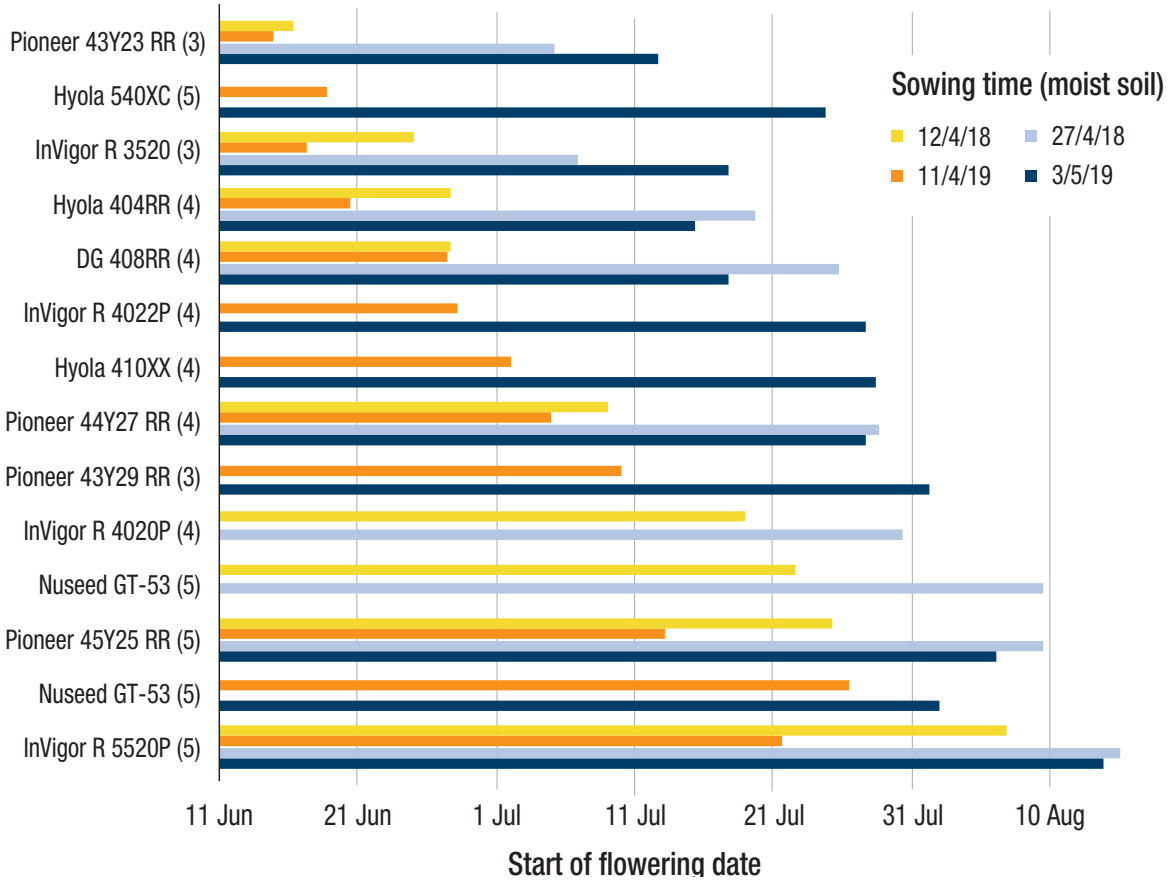


FIGURE 3. Start of flowering for GT and GT+CL canola varieties at South Perth, with a mid-April sowing compared to traditional sowing time around Anzac Day.

Varieties ordered by average time to start flowering with mid-April sowing. Harvest maturity key: (3) = early, (4) = early-mid, (5) = mid, (6) = mid-late (information provided by seed companies). Source: J Bucat and I Farre, DPIRD

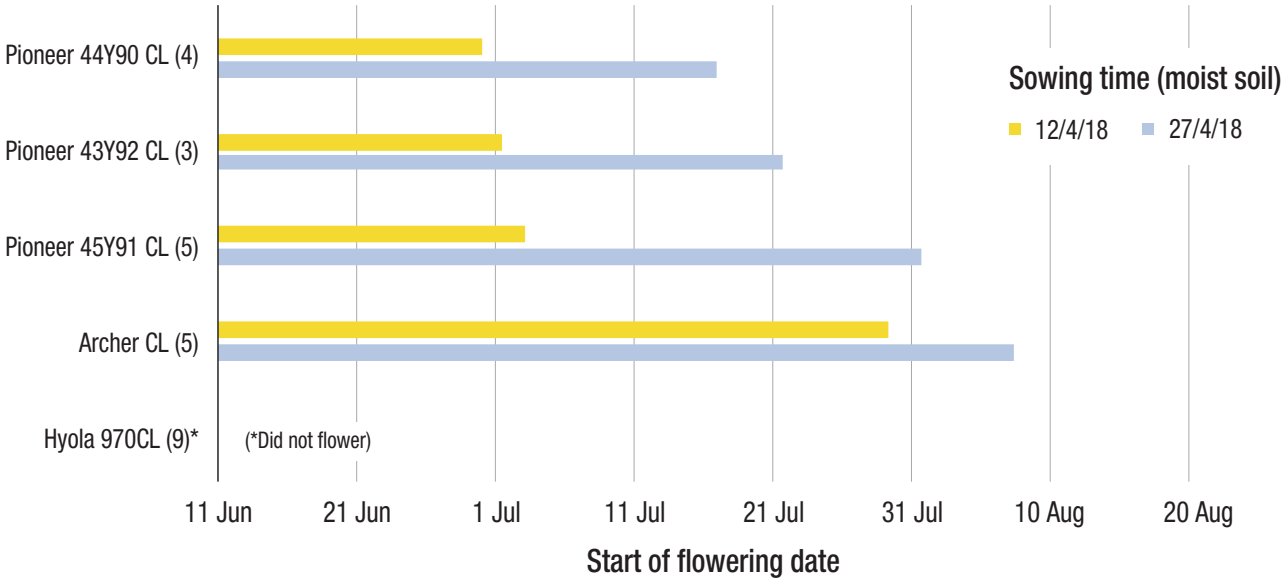


FIGURE 4. Start of flowering for CL canola varieties at South Perth, with a mid-April sowing compared to traditional sowing time around Anzac Day.

Varieties ordered by average time to start flowering with mid-April sowing. Harvest maturity key: (3) = early, (4) = early-mid, (5) = mid, (6) = mid-late (information provided by seed companies). Source: J Bucat and I Farre, DPIRD

CALCULATING CANOLA SEEDING RATE

Calculating canola seeding rate requires:

- Seed size, in seeds/kg (available from seed supplier)
- Germination % (available from seed supplier)
- Target density (see Table 12) and
- An estimate of field establishment (FE) (see Table 13)

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, for example 0.75) or use the online DPIRD seeding rate calculator at agric.wa.gov.au/n/4319

Target density

The optimum canola density varies with rainfall zone and canola type. The optimum density for the medium rainfall zone is 25-40 plants/m² for hybrid seed and 40-50 plants/m² for OP varieties (Table 12). The optimum canola density is lower for hybrid seed, compared with OP seed, largely due to the higher cost of hybrid seed.

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 (Table 13). Hybrids generally have better establishment than open pollinated varieties. Under reasonable seeding conditions hybrid seed can be expected to achieve 65% field emergence while open pollinated seed will likely achieve 50% field establishment under the same conditions (Table 13). DPIRD research has shown that seed size explains part of this difference as hybrid seed is often larger than open pollinated seed. Seeding rates may need to be increased during poor seeding conditions.

Seed size and seeding rates

Canola seed size varies with variety and season. Generally, hybrids have larger seed than open pollinated varieties. The common range of canola seed sizes is shown in Table 14, as well as example seeding rates for reasonable seeding conditions in the medium rainfall zone.

It is recommended that harvested open pollinated 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.

TABLE 12. 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)

TABLE 13. 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

TABLE 14. Hybrid and open pollinated 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 10cm of ruler length.

Check field establishment

Check your 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 15 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/m row is 9, then there are 30 plants/m² (3.3 x 9).

TABLE 15. Multiplication factors required to convert canola plants/m row to plants/m² for a range of row spacing

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

CANOLA SEED COMMERCIALISATION COMPANIES

Pacific Seeds

pacificseeds.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

David Peake +61 (0)408 780 577

Barenbrug Australia Pty Ltd

barenbrug.com.au

Steve Amery +61 (0)409 000 398
Tim O'Dea +61 (0) 429 203 505

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

Seednet

seednet.com.au

David Clegg +61 (0)408 630 641

Seed Force

seedforce.com

Tim Wilmshurst +61 (0)467 770 353
David Leah +61 (0)447 565 457

REGISTERED TRADEMARKS

- Roundup Ready® and TruFlex® are registered trademarks of Monsanto Technology LLC, Monsanto Australia Pty Ltd.
- Hyola® is registered trademark of Pacific Seeds Pty Limited. CT®, XX® and XC® are registered trademarks of Advanta Seeds Pty Ltd.
- Clearfield®, InVigor® and Podguard® are registered trademarks of BASF Agricultural Solutions Seed US LLC.
- HyTTec® and Xseed™ are published trademarks of Nuseed Pty Ltd.

ACKNOWLEDGEMENTS AND INFORMATION SOURCES

The information contained in this guide is based on the work conducted by many research scientists, technical officers, and service providers. The author would like to thank the following groups and staff:

- GRDC: Yield and oil data were generated from the NVT scheme and accessed from NVT Online (accessed 7/8/2020) and from Neale Sutton.
- DPIRD: The canola NVT oil data analysis was done by Andrew van Burgel.
- Blackleg information was reproduced from the GRDC Fact Sheet, 2020 Spring Blackleg Management Guide. Acknowledgement to the team at Marcroft Grains Pathology.
- DPIRD: The phenology data was generated from trials managed by Jackie Bucat, Imma Farre and Ghazwan Al Yaseri.
- 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.

Oat

By Georgie Troup, Helene Metzinger and Blakely Paynter, DPIRD

Introduction

This guide is designed to help you determine which milling oat or export hay variety to grow in your region. The guide provides variety characteristics, disease ratings and agronomic information for oat varieties that offer the best opportunity to meet market requirements.

This guide should be read in conjunction with industry information provided in the Grains Industry Association of Western Australia (GIWA) 'Oat variety and grade update' (available at www.giwa.org.au/oat-council).

GIWA collaborates with Western Australian bulk handlers to review grain standards as needed to ensure that WA grain standards match customer requirements and to maximise returns to the WA grain value chain.

There are several oat grain varieties available for delivery into the CBH system. CBH delivery grades are Oat1, Oat2 and OWAN, which is an exclusive segregation for Wandering oats. Each variety has its own strengths and weaknesses and their characteristics will determine their suitability for your area. Because no single oat variety is likely to provide optimum agronomic traits, disease resistance, yield and quality in any one year, most successful oat growers choose to grow more than one variety. The strengths and weaknesses of each oat variety are detailed in the variety description section of this sowing guide.

WHAT IS NEW?

Kingbale is a new oat hay variety released in 2020, for commercial production in 2021. While it has not been evaluated for commercial hay production, Kingbale is expected to perform similarly to its parent, Wintaroo, which has been accepted as a suitable export hay variety.

Kingbale is derived from Wintaroo, through a process of mutagenesis, and has a single gene trait tolerance to imidazolinone (IMI). Kingbale is a mid-maturity oaten hay variety with tolerance to imidazolinone residues present in the soil. Kingbale is suitable where there are IMI residue concerns from previous crops. A Sentry® registration for pre-emergent use only has been submitted to the Australian Pesticides and Veterinary Medicines Authority (APVMA), with March 2021 the earliest potential registration for its use in oaten hay production.

Seed of Kingbale is available through Intergrain and PBR and EPR are yet to be determined.

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

AgriFutures Australia

OAT VARIETY CHOICE IN 2021 – WHAT SHOULD I GROW?

Figure 1 outlines the change in oat variety popularity from 2018 to 2019 and highlights the subtle shift in the popularity of Williams and Carrolup and the increase in popularity of the short-season variety Durack.

Varieties have been suggested for the high, medium and low rainfall areas based on their performance in the NVT and agronomy trials. Deciding whether to grow milling oats depends on three main factors:

1. Profitability of Oat1 and Oat2 grain production.
2. Likelihood that grain will meet Oat1 or Oat2 receival specifications.
3. Location of receival segregations for Oat1 and Oat2 varieties.

Grain

If targeting the Oat1 market and septoria risk is low-moderate, then Bannister is suggested. In high rainfall areas, with low risk of drought stress during grain filling, Bilby and Williams are suggested.

If targeting the OWAN or Oat2 market, then Wandering is suggested.

Hay

High-yielding, high-quality hay varieties Brusher and Forester are suggested for the far southwest (in high yielding areas only) while Mulgara and Wintaroo are suggested for medium to high yielding areas. For high disease-risk areas the new variety Koorabup and Williams are suggested. For growers wanting a dual-purpose variety (milling oat and export hay eligible) Carrolup, Williams and Yallara are suggested.

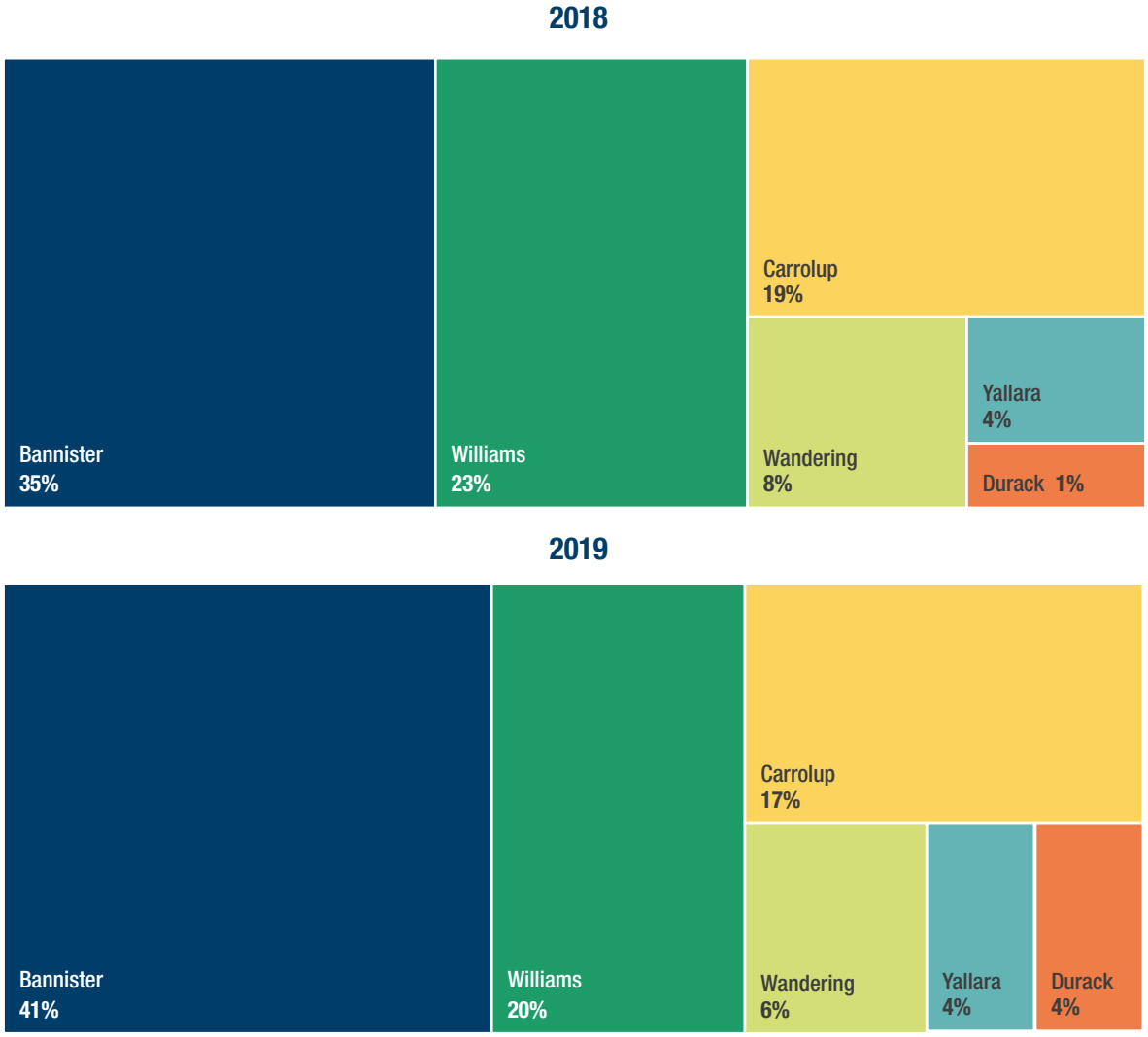


FIGURE 1. Popularity (percentage of oat area) of the top six oat varieties delivered in WA in 2018 and 2019. The top six varieties occupied about 90% of the area planted to oats in both years.

Source: grower estimates as provided to CBH for 2018 and 2019

Eligibility of oat varieties for delivery

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

Variety	Oat1	Oat2	OWAN	Hay
Bannister	✓	✓		✓
Bilby	✓	✓		
Brusher				✓
Carrolup	✓	✓		✓
Coomallo	✓	✓		
Durack		✓		✓
Forester				✓
Hotham	✓	✓		
*Kingbale				✓
Kojonup	✓	✓		✓
Koorabup				✓
Kowari	✓	✓		
Mitika	✓	✓		
Mortlock	✓	✓		
Mulgara				✓
Pallinup	✓	✓		
Tammar				✓
Tungoo				✓
Wandering		✓	✓	
Williams	✓	✓		✓
Winjardie				✓
Wintaroo				✓
Vasse				✓
Yallara	✓	✓		✓

*Released in 2020

OTHER CONSIDERATIONS FOR OAT GROWERS

Nitrogen management

When making decisions regarding the amount of nitrogen to apply to oat crops during the growing season the following points should be considered:

- Target market for crop – grain or hay?
- Nitrogen application strategies differ for grain vs hay.
- Seasonal rainfall to date – if the season is dry the positive impact of applied nitrogen on yield will be less.
- High nitrogen increases risk of screenings, low hectolitre weights and reduced hay quality. Williams and Carrolup are more sensitive to increasing nitrogen than Bannister.

Target plant density

Growers have traditionally sown oats at a set seeding rate, however this approach can mean target plant density is not reached which, in turn, can compromise yield and/or quality.

Suggested target plant density:

Crop purpose	Lower rainfall zone (e.g. Agzone 4)	Higher rainfall zone (e.g. Agzone 3)
Grain	160 plants/m²	240 plants/m²
Export hay	240 plants/m²	320 plants/m²

Differences in seed size, germination percentage and sowing conditions can result in variable plant densities at establishment and it is recommended that growers determine the 1000-grain weight of their seed to determine target seed rate (kg/ha):

$$\text{Seed rate (kg/ha)} = \frac{[\ \text{Target plant density (plants/m}^2) \times \text{Average grain weight (mg)}\ ]}{\text{Expected establishment (\%)}}$$

For example, if the desired plant population is 240 plants/m², the average grain weight is 40mg and expected establishment is 80% the calculation is: (240 x 40) / 80 = 120kg/ha

Impact of delayed harvest on grain shedding

In 2019, a trial was established in a high rainfall environment (Gibson) to compare the influence of a three, six or nine-week week delay in harvest date on grain yield and quality. Seven milling oat varieties and five breeding lines were evaluated, including Bannister, Bilby, Carrolup, Kowari, Wandering, Williams, Yallara, 09143-21, 09143-35, 09036-3, 11018-17 and 11022-82. The four harvest date treatments were (H1): at the first sign of physical maturity – when the peduncle had lost greenness, (H2): three weeks after physical maturity, (H3): six weeks after physical maturity, and (H4) nine weeks after physical maturity.

Delaying harvest by three weeks reduced grain yield by 13%. Grain yield loss increased to 23% when harvest was delayed by six weeks and to 38% when harvest was delayed by nine weeks. All varieties suffered similar grain yield loss when harvest was delayed. Grain quality was unaffected by delays in harvest date and consistently met Oat1 requirements (for hectolitre weight and screenings). While grain loss can be minimised by selecting varieties of differing maturities, the limited difference in physiological maturity between oat varieties makes this difficult. Yield remains the highest priority when selecting an oat variety, however a delayed harvest will reduce oat yields in general so harvesting on time is important.

Management of grain staining

Bannister is one of the top three oat varieties grown in WA for grain due to its yield advantage over Carrolup and its higher grain quality than Williams. However, Bannister is susceptible to septoria and, in higher rainfall areas where septoria is more prevalent, there is a greater risk of grain being downgraded at harvest due to grain staining.

In scenarios of high disease pressure such as growing a susceptible variety, oat-on-oat rotation and regions of high rainfall, our research suggests that if disease pressure becomes evident at stem elongation a two-spray regime at stem elongation and flag emergence should be implemented to achieve the greatest benefit.

Where disease pressure is lower, or when disease enters the canopy later in the season, a single application at flag leaf emergence was the best strategy.

Rainfall between grain-fill and harvest can also result in grain staining in Bannister but applying late fungicides has proved unreliable.

GRAIN YIELD

The National Variety Trials (NVT) compare current and new crop varieties in trials run across Australia. Each year, the NVT program coordinates about 31 oat variety trials with thirteen of these located in Western Australia. Grain yield comparisons (based on trials from 2015 to 2019 or 2015 to 2018 for Agzone 6) for current milling oat varieties are presented in Tables 2 to 7.

To find the latest NVT data (both long-term and seasonal) visit **www.nvtonline.com.au** or download the NVT yield app.

Grain yield data are presented in five WA Agzones, which group together environmental regions that give similar crop performance.

TABLE 2. Grain yield of oat varieties in AGZONE 2 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.33	4.11	3.15	3.46	2.67	
Variety	(No. trials)	(6)	(6)	(7)	(6)	(7)	(32)
Deliverable as Oat1							
Bannister	(32)	113	120	117	116	111	115
Bilby	(32)	109	107	111	111	110	110
Carrolup	(32)	91	93	97	98	93	94
Kojonup	(32)	99	103	101	99	95	99
Kowari	(32)	103	98	105	104	105	103
Mitika	(32)	98	94	101	100	100	99
Williams	(32)	112	111	111	112	110	111
Yallara	(32)	94	92	90	93	95	93
Deliverable as Oat2							
Durack	(32)	96	85	94	95	99	94
Wandering	(32)	111	121	111	113	111	113

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

TABLE 3. Grain yield of oat varieties in AGZONE 3 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.03	4.11	4.07	3.02	2.93	
Variety	(No. trials)	(3)	(4)	(4)	(4)	(3)	(18)
Deliverable as Oat1							
Bannister	(18)	111	113	115	113	110	113
Bilby	(18)	106	103	103	103	96	102
Carrolup	(18)	90	100	102	98	93	97
Kojonup	(18)	102	102	107	103	111	105
Kowari	(18)	99	97	96	97	90	96
Mitika	(18)	96	94	95	94	90	94
Williams	(18)	114	111	114	111	110	112
Yallara	(18)	96	100	98	98	98	98
Deliverable as Oat2							
Durack	(18)	96	91	91	91	87	91
Wandering	(18)	108	115	109	113	108	111

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

TABLE 4. Grain yield of oat varieties in AGZONE 4 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		2.19	3.72	3.43	2.06	1.11	
Variety	(No. trials)	(1)	(1)	(1)	(1)	(1)	(5)
Deliverable as Oat1							
Bannister	(5)	112	115	121	116	112	115
Bilby	(5)	113	107	110	116	112	112
Carrolup	(5)	95	96	87	99	105	96
Kojonup	(5)	98	97	104	88	83	94
Kowari	(5)	109	100	101	110	105	105
Mitika	(5)	106	96	98	102	96	100
Williams	(5)	104	110	104	115	118	110
Yallara	(5)	88	98	84	98	110	96
Deliverable as Oat2							
Durack	(5)	97	92	80	103	107	96
Wandering	(5)	106	119	122	119	123	118

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

TABLE 5. Grain yield of oat varieties in AGZONE 5 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.17	2.79	2.84	3.05	1.77	
Variety	(No. trials)	(2)	(1)	(2)	(1)	(2)	(8)
Deliverable as Oat1							
Bannister	(8)	111	128	128	116	102	116
Bilby	(8)	107	109	115	110	108	110
Carrolup	(8)	90	96	95	98	94	94
Kojonup	(8)	95	111	107	97	87	98
Kowari	(8)	100	97	104	102	106	102
Mitika	(8)	96	92	100	97	100	98
Williams	(8)	107	126	116	116	108	113
Yallara	(8)	97	91	83	98	104	95
Deliverable as Oat2							
Durack	(8)	93	85	83	97	109	94
Wandering	(8)	118	118	119	116	109	116

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

TABLE 6. Grain yield of oat varieties in AGZONE 6 expressed as a percentage of site mean yield for each trial year (2015-2018) and the weighted average over the four-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2015-2019
Site mean yield (t/ha)		3.73	1.82	3.56	4.82	
Variety	(No. trials)	(1)	(1)	(1)	(1)	(4)
Deliverable as Oat1						
Bannister	(4)	130	156	120	128	134
Bilby	(4)	127	121	109	107	116
Carrolup	(4)	85	93	100	104	96
Kojonup	(4)	106	136	115	111	117
Kowari	(4)	118	99	103	95	104
Mitika	(4)	114	91	102	91	100
Williams	(4)	105	170	113	124	128
Yallara	(4)	63	75	84	95	79
Deliverable as Oat2						
Durack	(4)	83	82	88	83	84
Wandering	(4)	112	103	101	120	109

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

TABLE 7. Grain yield of oat varieties in AGZONE 2 to 6 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.18	3.80	3.40	3.29	2.47	
Variety	(No. trials)	(13)	(13)	(15)	(13)	(13)	(67)
Deliverable as Oat1							
Bannister	(67)	114	119	118	117	110	116
Bilby	(67)	110	106	109	108	106	108
Carrolup	(67)	90	96	98	99	93	95
Kojonup	(67)	99	104	105	101	98	102
Kowari	(67)	103	98	102	101	101	101
Mitika	(67)	99	94	99	97	97	97
Williams	(67)	110	114	112	113	110	112
Yallara	(67)	92	94	91	95	97	94
Deliverable as Oat2							
Durack	(67)	94	87	91	93	97	92
Wandering	(67)	111	118	111	114	111	113

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

GRAIN YIELD – COMPARISONS

The highest yielding oat varieties in WA are Bannister and Williams (Figures 2 to 3, Tables 2, 3, 5 to 7). Newly released variety Bilby appears to be close to Williams in yield in the 3t/ha growing environment. Bannister appears to have the highest yield at sites with a potential above 2.5t/ha.

Bilby has an advantage below 2t/ha. Carrolup, Durack, Kojonup, Kowari, Mitika and Yallara are other milling oat options, none of which are yield competitive with Bannister.

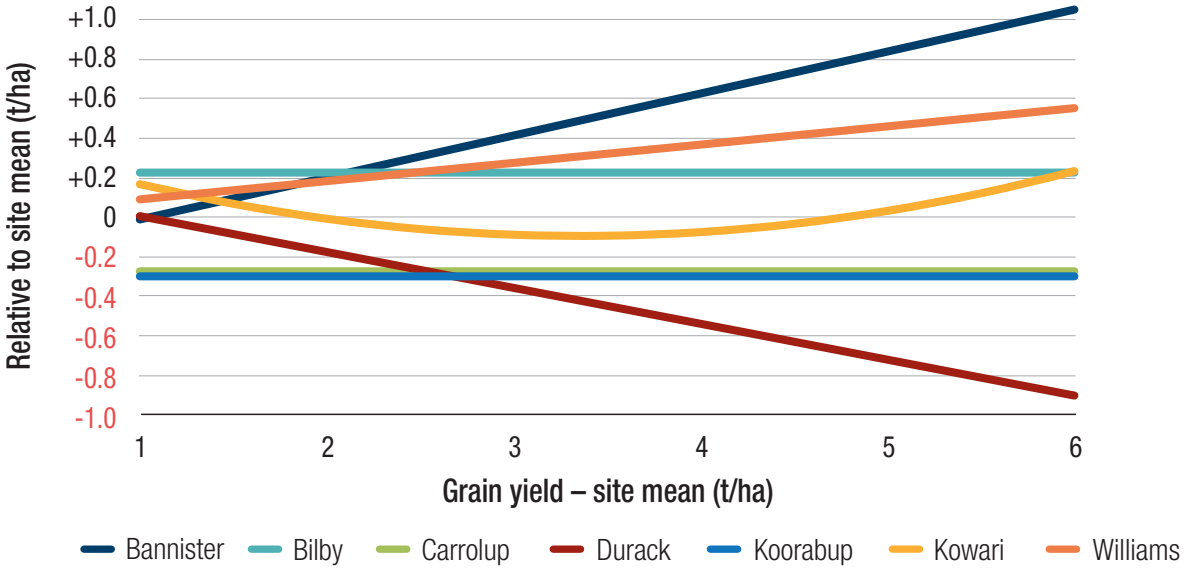


FIGURE 2. Fitted grain yield of Bannister, Bilby, Carrolup, Durack, Koorabup, Kowari and Williams at different site mean yields.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 47 trial-years of data.

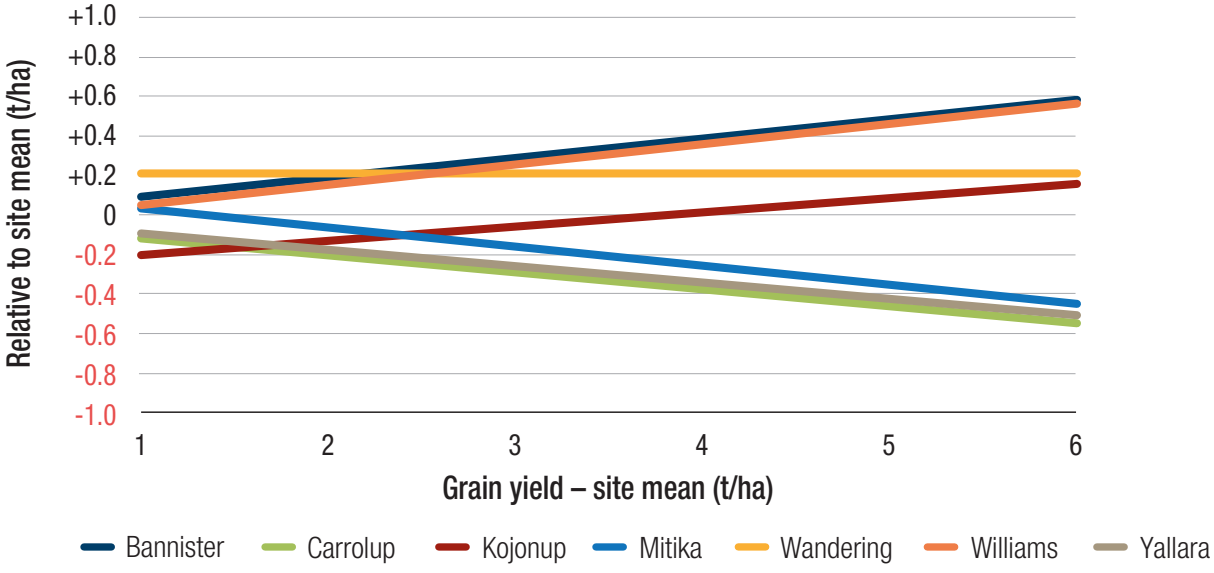


FIGURE 3. Fitted grain yield of Bannister, Carrolup, Kojonup, Mitika, Wandering, Williams and Yallara at different site mean yields.

Source: based on NVT state-wide tables of yields and grain quality (2018-2019), **nvtonline.com.au**. Each variety sown in all 101 trial-years of data.

GRAIN QUALITY

When comparing milling oat varieties, grain quality is an essential trait to consider – including the hectolitre weight and percentage of screenings compared to known benchmark varieties. Physical grain quality (hectolitre weight and screenings through a 2.0mm slotted sieve) of milling oat varieties have been plotted relative to the site mean in Figures 4 to 7. 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 have been extracted from the NVT document 'State-wide tables of yield and grain quality' available at nvtonline.com.au.

Figures 4 to 5 compare the hectolitre weight of varieties suitable for delivery into the Oat1 or Oat2 segregations in WA. Figures 6 to 7 present grain plumpness comparisons (percentage through a 2.0mm sieve).

Grain quality – hectolitre weight comparisons

Of the nine varieties segregated for milling in WA, Carrolup continues to be the benchmark variety for hectolitre weight. Durack and Yallara displayed a similar hectolitre weight to Carrolup over the years they were evaluated together (eight years for Carrolup vs Yallara and four years for Carrolup vs Durack) (Figure 4 and Figure 5). The hectolitre

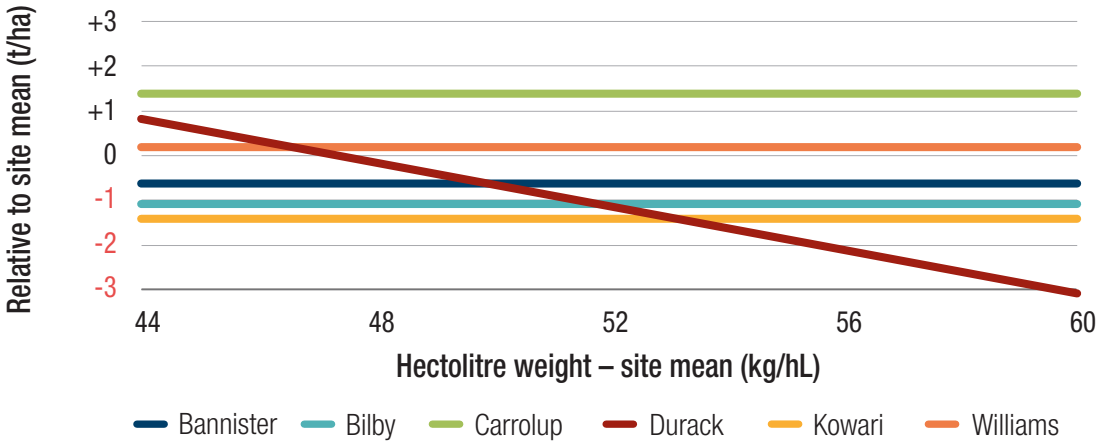


FIGURE 4. Fitted hectolitre weight of Bannister, Bilby, Carrolup, Durack, Kowari and Williams at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 47 trial-years of data.

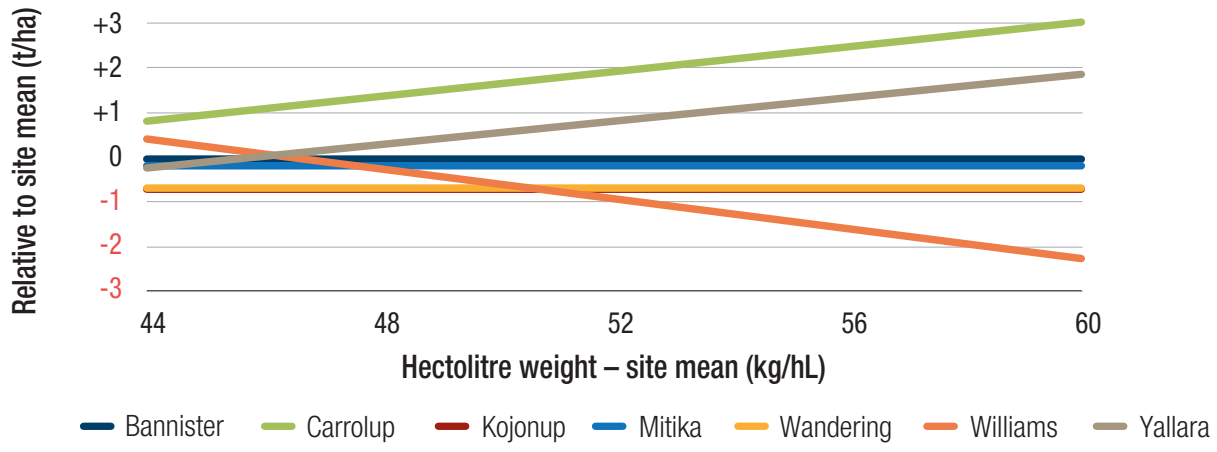


FIGURE 5. Fitted hectolitre weight of Bannister, Carrolup, Kojonup, Mitika, Wandering, Williams and Yallara at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2018-2019), **nvtonline.com.au**. Each variety sown in all 101 trial-years of data.

weights of Bilby, Kowari, Mitika, Wandering and Williams were ~2kg/hL lower than Carrolup ($p<0.05$).

Grain quality – grain plumpness comparisons

The benchmark oat variety for grain plumpness is Mitika (Figure 7), which has lower screenings than the other varieties segregated for milling in WA. Yallara appears to behave similarly to Mitika, while Carrolup behaves similarly to Williams, with screenings percentage increasing as the site mean increased. At very low screenings, most varieties have similar values. Around the Oat1 limit of 10% screenings, genetic differences are notable, and this will likely influence variety selection in different environments. Of the newer varieties, Bilby has similar grain plumpness to Bannister, while Kowari and Durack are plumper than Bannister.

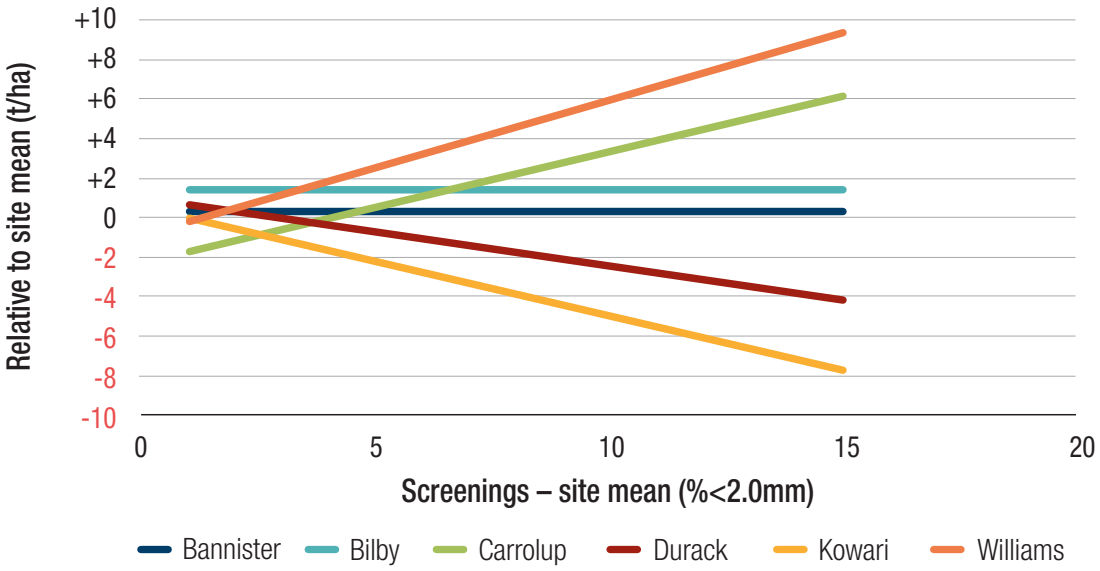


FIGURE 6. Fitted grain plumpness of Bannister, Bilby, Carrolup, Durack, Kowari and Williams at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 47 trial-years of data.

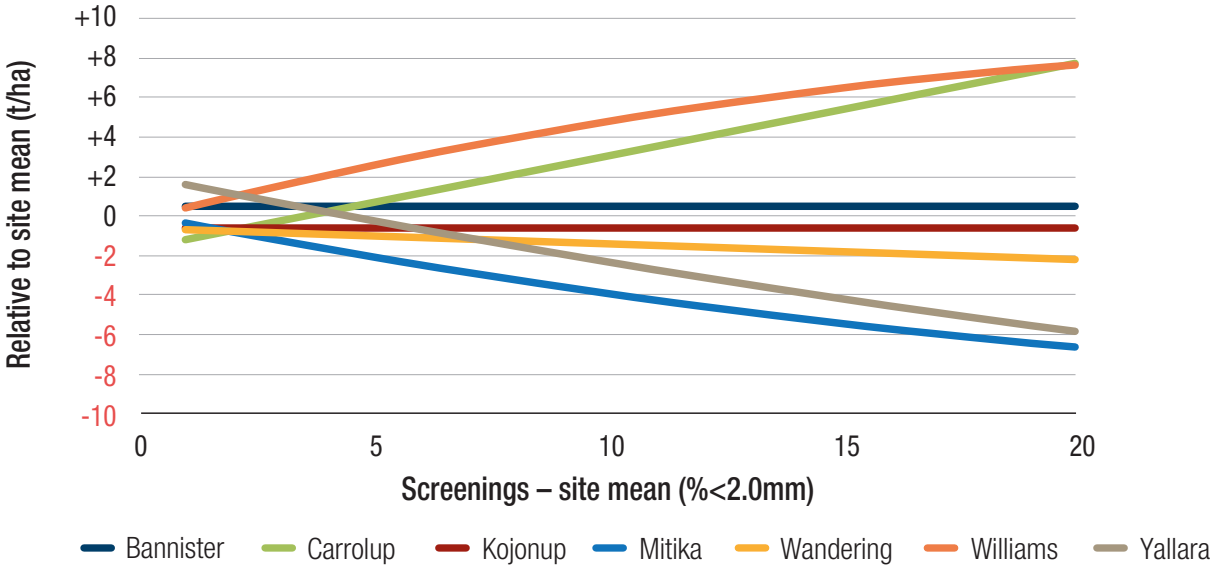


FIGURE 7. Fitted grain plumpness of Bannister, Carrolup, Kojonup, Mitika, Wandering, Williams and Yallara at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2012-2019), **nvtonline.com.au**. Each variety sown in all 101 trial-years of data..

DISEASE RESISTANCE RATING

Rust and BYDV reactions may vary in different regions and with different seasonal conditions depending on the prevalent pathotype/serotype. Crop monitoring is essential.

TABLE 8. Disease and virus resistance ratings of oat varieties in 2020

Variety	Septoria	Rust		BYDV
		Leaf rust	Stem rust	
Bannister	MSS	R	MS	MRMS
Bilby	S	MR	S	MRMS
Brusher*	SVS	R-MS	MR-S	MRMS
Carrolup	S	VS	SVS	MSS
Durack	SVS	MRMS*p*	S	MSS
Forester*	MSS	R-MS	R-MS	MS
Kojonup	SVS	SVS	MSS	MS
Koorabup	MRMS	MRMS	MSS	MSS
Kowari	SVS	R	S	MS
Mitika	SVS	MR	MSS	S
Mulgara*	MR-S	MR	MRMS	MSS
Wandering	MSS	VS	SVS	MS
Williams	MRMS	MR	MS	MRMS
Winjardie*	SVS	SVS	MR-S	MSS
Wintaroo*	MSS	SVS	MR	MS
Yallara	S	MRMS*p*	MSS	MS

Source: DPIRD and National Oat Breeding Program (*)

VS = very susceptible, S = susceptible, MS = moderately susceptible,
MR = moderately resistant, R = resistant, - = range in disease resistance, *p* = provisional rating

HAY YIELD AND QUALITY

The National Oat Breeding Program (NOBP) compares current and new hay varieties in trials across Australia. The South Australian Research and Development Institute (SARDI) leads the National Oat Breeding program, working closely with DPIRD to develop high quality export hay varieties, along with improved milling oats. The NOBP is supported by the Australian Government and growers through the Grains Research and Development Corporation (GRDC) and AgriFutures Australia, along with investment from DPIRD, South Australian Grain Industry Trust (SAGIT), and commercial partners AEXCO and Barenbrug.

Each year, the NOBP program coordinates about eight oat hay variety trials, with two of these located in Western Australia. Hay yield comparisons (based on trials from 2014 to 2019) for current oat hay varieties are presented in Table 9. Quality performance is also included in Table 9, with the parameters of digestibility, water soluble carbohydrates, acid detergent fibre, neutral detergent fibre and the neutral detergent fibre digestibility after 30 hours presented.

The suggested quality specifications that growers need to achieve to meet export hay requirements are given in Table 10.

Hay yield and quality performance is also included in the variety snapshots, as a comparison with the benchmark variety Carrolup.

TABLE 9. Average hay yield (t/ha) and quality for sixteen oat varieties in WA (2014-2019, with NDFDom30 2017-2019)

Variety	Hay yield (t/ha)	Digestibility (% dm)	WSC[1] (% dm)	ADF[2] (% dm)	NDF[3] (% dm)	NDFDom30[4] (% dm)
Early-mid varieties						
Bannister	6.6	69.6	32.6	27.1	47.6	59.2
Brusher	7.2	68.4	32.8	28	48.2	57
Carrolup	6.3	66.9	31.7	28.8	49	55.4
Durack	6.2	66.7	30.2	28.6	49.4	53
Koorabup	6.5	67.1	29.1	29	50.8	56
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
Wandering	6.8	69	32.9	27.3	48	58.4
Williams	6.3	67.3	30.7	28.5	49.6	56.1
Winjardie	7	66.9	31.3	28.7	49.8	55.7
Wintaroo	7.1	67.4	30.6	29	50	56.6
Yallara	6.8	67.9	32	28.2	48.4	54.6
Mid-late to very late varieties						
Forester	6.4	70.3	34.2	28.1	46.3	-
Kangaroo	6.8	66.3	29.9	29.3	51	-
Tammar	6.2	68	30.6	28.8	49.7	-
Tungoo	6.7	68.2	31.9	28.4	48.7	-
No. sites	*13*	*9*	*11*	*10*	*11*	*5*

Source: National Oat Breeding Program. Analysis by Chris Lisle, BBAGI, University of Woollongong.

WSC[1]= Water soluble carbohydrates, ADF[2] = Acid detergent fibre, NDF[3] = Neutral detergent fibre, NDFDom30[4] = Neutral detergent fibre digestibility after 30 hours.

TABLE 10. Quality standards to meet export hay requirements in WA

Parameter	Grade 1	Grade 2	Grade 3	Grade 4
Crude protein (% CP)	>4	<4	<4	<4
Estimated metabolisable energy (est. ME MJ/kg DM)	>9.5	<9.5	<9.5	<9.5
In vitro digestibility (% DMD)	>60	>58	>56	>53
Water soluble carbohydrates (% WSC)	>22	>18	>14	>14
Acid detergent fibre (% ADF)	<30-32	>32-35	>35-37	>37-40
Stem thickness (mm)	<6	<8	<9	>9-12

Variety snapshots

Variety snapshots are presented for:

- seven dual-purpose varieties (Bannister, Carrolup, Durack, Kojonup, Wandering, Williams and Yallara) that can be delivered as either milling grain (Oat1 or Oat2) or hay into the export or domestic market when they meet receival requirements.
- three milling oat varieties (Bilby, Kowari and Mitika) that are not suitable for hay production, and
- eight hay varieties (Brusher, Forester, Kingbale, Koorabup, Mulgara, Swan, Winjardie and Wintaroo) that can only be delivered as hay varieties and which are not suitable for milling.

The comment section in each snapshot describes essential characteristics of a variety including their yield relative to another variety, key weaknesses and strengths (including where appropriate disease resistance) and relevant market information.

Grain yield data extracted from the Long Term MET Yield Reporter (available at NVT online, nvtonline.com.au) are presented as a percentage of the site mean yield. Hay yield data are presented relative to a control variety (Carrolup) from data provided by the National Oat Breeding Program trials 2015-19.

Disease resistance ratings are sourced from Table 8 within this guide.

The phenology data presented in the snapshots are the median predicted date to Z71 (date predicted for 50% of 'normal' seasons) based on performance when sown at four sowing dates from late-April to early-July in hill plot trials located at Northam and Katanning in 2015-19.

Agronomic traits are tabulated based on published data, data collected by DPIRD, data generated from the DPIRD-GRDC co-funded projects DAW00227 and the National Oat Breeding Program.

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).

ACKNOWLEDGEMENTS

The information contained in this bulletin is based on work conducted by many research scientists and technical officers from the Department of Primary Industries and Regional Development (DPIRD), plant breeders from the National Oat Breeding Program and Consultants.

The authors would like to thank the following groups of people:

- Plant pathology staff and RSUs involved under the NVT Services Agreement: Manisha Shankar, Geoff Thomas, Pip Payne, Ryan Varischetti, Carnarvan RSU and Manjimup RSU.
- Biometrics: Andrew Van Burgel.
- Oat agronomy: Kimberly Arnold and Michelle Sampson.
- Research support units: Esperance, Katanning, Merredin, Northam and Wongan Hills.

Thank you to National Variety Trials, trial co-operators and the National Oat Breeding Program for their cooperation in providing data and Co-operative Bulk Handling for providing data on sowing area by variety information.

This publication presents data and information developed from research supported by the Department of Primary Industries and Regional Development, Western Australia, AgriFutures Australia and the Grains Research and Development Corporation (GRDC).

BANNISTER(Þ)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Bannister is a medium spring, tall milling variety with a high grain yield (~15% higher than Carrolup). It is 15cm shorter than Carrolup and heads about 4 days later than Carrolup, Yallara and Williams. Its suitability for the lower rainfall regions is supported by robust hectolitre weight and moderate screening percentages. Bannister is susceptible to grain staining (both septoria and alternaria have been isolated). 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. Bannister is not recommended as an export hay variety.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	113	120	117	116	111
Agzone 3	111	113	115	113	110
Agzone 4	112	115	121	116	112
Agzone 5	111	128	128	116	102
Agzone 6	130	156	120	128	-
Statewide	114	119	118	117	110
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	R				
Stem rust	MS				
BYDV	MRMS				
Agronomic traits					
Plant height	Tall				
Coleoptile length (mm)	110.3				
Growth habit	Medium spring				
Stem diameter	-				
Variety information					
Pedigree	Dumont/Echidna Mortlock//75Q:198 Swan Fulmark/Newton				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Seednet				
EPR ($/t, excl. GST)	$2.30				

CARROLUP

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Carrolup is a medium spring, mid-tall, dual purpose (milling grain and hay) variety. It has a similar height and maturity to Yallara. Carrolup has lower yields than the new milling varieties Bannister and Williams. With a consistently high hectolitre weight, screenings tend to be high, similar to Williams. Carrolup is suitable for export hay.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	91	93	97	98	93
Agzone 3	90	100	102	98	93
Agzone 4	95	96	87	99	105
Agzone 5	90	96	95	98	94
Agzone 6	85	93	100	104	-
Statewide	90	96	98	99	93
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	VS				
Stem rust	SVS				
BYDV	MSS				
Agronomic traits					
Plant height	Mid-tall				
Coleoptile length (mm)	104.7				
Growth habit	Medium spring				
Stem diameter	Medium				
Variety information					
Pedigree	Mortlock/5/Kent/Ballidu/Curt/3/Cortez/ 4/TAMO-312/2.2*West				
Breeder / Seed licensee	Dept. of Agriculture, WA				
Access to seed	Free to trade				
EPR ($/t, excl. GST)	No EPR				

DURACK

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Durack is an early spring, mid-tall, milling variety that was accredited as OAT2 only. It is similar in height and yield to Carrolup and Yallara, but with improved hectolitre weight. Screenings are low due to its plump grain shape compared to Carrolup and Williams. Durack is the earliest maturing oat variety of any current milling or hay variety. Whilst earlier flowering helps to 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. While Durack is suitable for export hay, its hay yields are generally lower yielding than Carrolup and Williams.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	96	85	94	95	99
Agzone 3	96	91	91	91	87
Agzone 4	97	92	80	103	107
Agzone 5	93	85	83	97	109
Agzone 6	83	82	88	83	-
Statewide	94	87	91	93	97
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	MRMS*p*				
Stem rust	S				
BYDV	MSS				
Agronomic traits					
Plant height	Mid-tall				
Coleoptile length (mm)	112.2				
Growth habit	Early spring				
Stem diameter	Medium				
Variety information					
Pedigree	01Q211/94Q601-45-28				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.30				

p = provisional assessment

KOJONUP

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Kojonup is a medium spring, medium height, dual purpose (milling grain and hay) variety. Grain yield is less competitive than Bannister and Williams, and similar to Wandering. It has good grain quality, large seed size, high hectolitre weight and low screenings. Kojonup is not suitable 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.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	99	103	101	99	95
Agzone 3	102	102	107	103	111
Agzone 4	98	97	104	88	83
Agzone 5	95	111	107	97	87
Agzone 6	106	136	115	111	-
Statewide	99	104	105	101	98
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	SVS				
Stem rust	MSS				
BYDV	MS				
Agronomic traits					
Plant height	Medium				
Coleoptile length (mm)	-				
Growth habit	Medium spring				
Stem diameter	-				
Variety information					
Pedigree	83Q:384/Coomallo				
Breeder / Seed licensee	Dept. of Agriculture, WA				
Access to seed	Free to trade				
EPR ($/t, excl. GST)	$2.25				

WANDERING(b)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Wandering is a medium spring, medium height feed variety that is received as Oat2 and OWAN only. Wandering has comparable yields to Bannister and Williams. Wandering is suitable for export hay, its hay yields are generally higher than Carrolup and Williams.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	111	121	111	113	111
Agzone 3	108	115	109	113	108
Agzone 4	106	119	122	119	123
Agzone 5	118	118	119	116	109
Agzone 6	112	103	101	120	-
Statewide	111	118	111	114	111
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	VS				
Stem rust	SVS				
BYDV	MS				
Agronomic traits					
Plant height	Medium				
Coleoptile length (mm)	106.6				
Growth habit	Medium spring				
Stem diameter	Medium				
Variety information					
Pedigree	SA Seln 41/75Q36-144-31				
Breeder / Seed licensee	Dept. of Agriculture, WA				
Access to seed	Free to trade				
EPR ($/t, excl. GST)	No EPR				

WILLIAMS(b)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Williams is an early spring, mid-tall dual purpose (milling grain and hay) variety. Williams has the best overall foliar disease resistance of milling and dual purpose varieties. Williams has a similar grain yield to Bannister and Wandering. Williams has lower hectolitre weight and higher screenings than Bannister, Mitika and Yallara, especially in lower rainfall regions. Williams may lodge in high yielding environments. Williams is suitable for export hay and 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. The main issue with Williams hay is stem thickness, so a target density of 320 plants/m2 is required when grown for export hay.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	112	111	111	112	110
Agzone 3	114	111	114	111	110
Agzone 4	104	110	104	115	118
Agzone 5	107	126	116	116	108
Agzone 6	105	170	113	124	-
Statewide	110	114	112	113	110
Disease resistance	**Rating**				
Septoria	MRMS				
Leaf rust	MR				
Stem rust	MS				
BYDV	MRMS				
Agronomic traits					
Plant height	Mid-tall				
Coleoptile length (mm)	109.8				
Growth habit	Early spring				
Stem diameter	Moderately thick				
Variety information					
Pedigree	Pennlo/Murray//Carrolup/3/ TAM386/Carrolup				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.30				

YALLARA(þ)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Yallara is a medium spring, mid-tall dual purpose (milling grain and hay) variety. Yallara grain has a similar grain quality to Carrolup but the variety is not susceptible to stem and leaf rust. It has good hectolitre weight, low screenings and high groat percent. Yallara is suitable for export hay, slightly higher hay yield than Williams and a comparable hay quality to the specialist hay variety Brusher. Yallara is replacing Winjardie as a hay variety in the northern half of Agzone 2.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	94	92	90	93	95
Agzone 3	96	100	98	98	98
Agzone 4	88	98	84	98	110
Agzone 5	97	91	83	98	104
Agzone 6	63	75	84	95	-
Statewide	92	94	91	95	97
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	MRMS*p*				
Stem rust	MSS				
BYDV	MS				
Agronomic traits					
Plant height	Erect mid tall				
Coleoptile length (mm)	121.4				
Growth habit	Medium spring				
Stem diameter	Moderately fine				
Variety information					
Pedigree	Euro*2/ND931075				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Seednet				
EPR ($/t, excl. GST)	$2.00				

p = provisional assessment

BILBY(þ)

MILLING VARIETY

Comments

Bilby is a cross between two breeding lines, 98011-6 and 98240-19. Bilby is a dwarf, early-mid season variety. Its grain yield and quality is between that of Kojonup and the higher yielding varieties Bannister and Williams (based on data from NVT 2016-19, and DPIRD oat agronomy 2017-19). Without a yield advantage over Bannister or Wandering, it is not expected that Bilby will displace these dominating varieties in the WA oat growing environment. The National Oat Breeding Program has developed this variety, along with Kowari, to have high ß-glucan, an important nutritional quality trait, which is valued by oat markets worldwide.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	109	107	111	111	110
Agzone 3	106	103	103	103	96
Agzone 4	113	107	110	116	112
Agzone 5	107	109	115	110	108
Agzone 6	127	121	109	107	-
Statewide	110	106	109	108	106
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	MR				
Stem rust	S				
BYDV	MRMS				
Agronomic traits					
Plant height	Dwarf				
Coleoptile length (mm)	-				
Growth habit	Early - Mid spring				
Stem diameter	-				
Variety information					
Pedigree	98011-6/98240-19				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.50				

KOWARI(ϕ)

MILLING VARIETY

Comments

Kowari is a newly released, medium spring, medium height milling variety. Kowari has improved green leaf retention relative to Mitika. Kowari has similar yields and slightly lower hectolitre weight than Mitika, but it has higher 1000 grain weight compared to Mitika. It combines high ß-glucan with low screenings.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	103	98	105	104	105
Agzone 3	99	97	96	97	90
Agzone 4	109	100	101	110	105
Agzone 5	100	97	104	102	106
Agzone 6	118	99	103	95	-
Statewide	103	98	102	101	101
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	R				
Stem rust	S				
BYDV	MS				
Agronomic traits					
Plant height	Medium				
Coleoptile length (mm)	-				
Growth habit	Medium spring				
Stem diameter	-				
Variety information					
Pedigree	Mitika/WAOAT2099				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.50				

MITIKA(ϕ)

MILLING VARIETY

Comments

Mitika is a medium spring, short height milling variety. Yield of Mitika is an improvement on Carrolup, but less competitive with Bannister and Williams. Mitika has high hectolitre weight, low screenings and high groat percent. Mitika like Kowari has higher levels of ß-glucan than current milling and dual purpose varieties. Mitika has improved feed quality due to low husk lignin and high grain digestibility. Mitika is not recommended as an export hay variety.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	98	94	101	100	100
Agzone 3	96	94	95	94	90
Agzone 4	106	96	98	102	96
Agzone 5	96	92	100	97	100
Agzone 6	114	91	102	91	-
Statewide	99	94	99	97	97
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	MR				
Stem rust	MSS				
BYDV	S				
Agronomic traits					
Plant height	Short				
Coleoptile length (mm)	133.2				
Growth habit	Medium spring				
Stem diameter	-				
Variety information					
Pedigree	0X87;072-13/0X87;080-1// 0X88;045-12				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.00				

BRUSHER(b)

HAY VARIETY

Comments

Brusher is a tall, medium spring hay variety. In phenology trials (2015-17) located at Northam, Brusher reached watery ripe (Z71) 4 days later than Carrolup when sown in late May.

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
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		

Disease resistance	Rating
Septoria	SVS
Leaf rust	RM-S
Stem rust	MR-S
BYDV	MRMS

Agronomic traits	
Plant height	Tall
Coleoptile length (mm)	114.2
Growth habit	Medium spring
Stem diameter	Medium

Variety information	
Pedigree	Dumont/Wallaroo//Bandicoot
Breeder / Seed licensee	National Oat Breeding Program
Access to seed	AEXCO Seed distributor
EPR ($/t, excl. GST)	$2.00

FORESTER(b)

HAY VARIETY

Comments

Forester is a tall, very late spring hay variety adapted to high rainfall areas. In phenology trials (2015-17) located at Northam, Forester reached watery ripe (Z71) 25 days later than Carrolup when sown in late May, indicating it does not have a fit in this region of export hay production (similar to Tammar and Tungoo which are not listed in this guide).

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
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		

Disease resistance	Rating
Septoria	MSS
Leaf rust	R-MS
Stem rust	R-MS
BYDV	MS

Agronomic traits	
Plant height	Tall
Coleoptile length (mm)	99.1
Growth habit	Very late spring
Stem diameter	Moderately thick

Variety information	
Pedigree	OT285/OX92;056-4
Breeder / Seed licensee	National Oat Breeding Program
Access to seed	AEXCO Seed distributor
EPR ($/t, excl. GST)	$2.00

KINGBALE(b)

HAY VARIETY

Comments

Kingbale is an imidazolinone tolerant variety. Kingbale has a single gene trait tolerance to imidazolinone (pre-sowing and plant-back residue tolerance only), and is very similar to its parent – Wintaroo.

Hay yield and quality	Kingbale	Carrolup
Hay Yield (t/ha)	No data currently available	6.3
Digestibility (% dm)		66.9
WSC (% dm)		31.7
ADF (% dm)		28.8
NDF (% dm)		49.0
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		

Disease resistance	Rating
Septoria	No current rating available
Leaf rust	
Stem rust	
BYDV	

Agronomic traits	
Plant height	Tall
Coleoptile length (mm)	-
Growth habit	Medium spring
Stem diameter	-

Variety information	
Pedigree	Wintaroo
Breeder / Seed licensee	GIA/Intergrain
Access to seed	Intergrain in 2021- pending registration
EPR ($/t, excl. GST)	TBC

KOORABUP(b)

HAY VARIETY

Comments

Koorabup is a tall, medium spring hay variety. In phenology trials , Koorabup had similar maturity to Wintaroo and Vasse, about 4-5 days later than Carroulp when sown in mid-May and early-June. Koorabup produces slightly higher hay yield than Carrolup (Muresk, May sown, 2019 National Hay Agronomy trial), with similar hay quality. Koorabup has similar septoria resistance to Williams (MRMS).

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
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		

Disease resistance	Rating
Septoria	MRMS
Leaf rust	MRMS
Stem rust	MSS
BYDV	MSS

Agronomic traits	
Plant height	Tall
Coleoptile length (mm)	95.8
Growth habit	Medium spring
Stem diameter	Moderately fine

Variety information	
Pedigree	WAOAT2282/WAOAT223
Breeder / Seed licensee	National Oat Breeding Program
Access to seed	AEXCO Seed distributor
EPR ($/t, excl. GST)	$2.00

MULGARA

HAY VARIETY

Comments

Mulgara is a tall, medium spring hay variety. In phenology trials (2015-17) located at Northam, Mulgara reached watery ripe (Z71) 3 days later than Carrolup when sown in late May. Mulgara is resistant to stem nematode (not listed in table below).

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
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		

Disease resistance	Rating
Septoria	MR-S
Leaf rust	MR
Stem rust	MRMS
BYDV	MSS

Agronomic traits	
Plant height	Tall
Coleoptile length (mm)	121.7
Growth habit	Medium spring
Stem diameter	Medium

Variety information	
Pedigree	OX89;030-26/93-112
Breeder / Seed licensee	National Oat Breeding Program
Access to seed	AEXCO Seed distributor
EPR ($/t, excl. GST)	$2.00

SWAN

HAY VARIETY

Comments

Swan was is a tall, medium spring variety which was released in 1967. In trials conducted in 2004 and 2005, Swan outyielded Carrolup by 900kg/ha. Due to its tendency to produce thick stems, and its lodging susceptibility it is only suited to lower rainfall environments where these quality constraints are limited by rainfall.

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
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		

Disease resistance	Rating
Septoria	No current rating available
Leaf rust	
Stem rust	
BYDV	

Agronomic traits	
Plant height	Tall
Coleoptile length (mm)	-
Growth habit	Medium spring
Stem diameter	-

Variety information	
Pedigree	Kent/Ballidu
Breeder / Seed licensee	Dept. of Agriculture, WA
Access to seed	Free to trade
EPR ($/t, excl. GST)	No EPR

WINJARDIE

HAY VARIETY

Comments

Winjardie is a tall, medium spring variety which was released in 1985. Its low disease resistance 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.

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
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	SVS	
Leaf rust	SVS	
Stem rust	MR-S	
BYDV	MSS	
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	-	
Growth habit	Medium spring	
Stem diameter	Medium	
Variety information		
Pedigree	Fulmark/Newton//Swan /3/Kent/ Ballidu//Curt	
Breeder / Seed licensee	Dept. of Agriculture, WA	
Access to seed	Free to trade	
EPR ($/t, excl. GST)	No EPR	

WINTAROO(ϕ)

HAY VARIETY

Comments

Wintaroo is a tall, medium spring variety. It resists brown leaf tipping by hot winds and maintains good colour longer than most varieties. In phenology trials (2015-17) located at Northam, Wintaroo reached watery ripe (Z71) 8 days later than Carrolup when sown in late May.

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
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	MSS	
Leaf rust	SVS	
Stem rust	MR	
BYDV	MS	
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	-	
Growth habit	Medium spring	
Stem diameter	Medium	
Variety information		
Pedigree	MIOLRP-86-3/Echidna//Wallaroo	
Breeder / Seed licensee	National Oat Breeding Program	
Access to seed	AEXCO Seed distributor	
EPR ($/t, excl. GST)	$2.00	

PULSE GUIDE

By Mark Seymour, Andrew Blake, Martin Harries, Harmohinder Dhammu, Stacey Power, Geoff Thomas and Jean Galloway (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 a peak in the 1990s, pulse crop areas declined due to an expansion in canola area as well as 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. Yield of crops in NVT experiments conducted in the past six years 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	0.5	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	0.6	1	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	0.6	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 • Very high prices in 2018 around $1,000/t – better to use long term price of $330/t • 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
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 which 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. Fungicides for pulse crops in WA

Active ingredient		carbendazim (500g/L)	chlorothalonil (720g/L)	chlorothalonil (900g/kg)	mancozeb (750g/kg)	procymidone (500g/L)	prothioconazole (150g/L) + bixafen (75g/L)	tebuconazole (430g/L)	tebuconazole (200g/L) + azoxystrobin (100g/L)
Example product		Spin Flo® – Nufarm	Bravo® Weather Stik® Barrack Betterstick® Nufarm Unite® 720	Sipcam Echo® 900 WDG	Dithane® Rainshield® Neo Tec®	Fortress® 500, Sumisclex® 500	Aviator® Xpro®	Orius® 430 SC	Veritas®
Crop	**Disease**								
Chickpea	Ascochyta blight		1.0-2.0L	0.8-1.6kg	1.0–2.2kg		400–600mL		0.75-1.0L
	Botrytis grey mould	500mL			1.0–2.2kg				0.75-1.0L
	Sclerotinia								
Field pea	Blackspot		1.1-1.8L		1.0–2.2kg		600mL		0.75-1.0L
	Downy mildew/BGM		1.1-1.8L	0.9-1.5kg	1.0–2.2kg				0.75-1.0L
	Powdery mildew							145 mL	
Faba bean	Ascochyta				1.0–2.2kg	500mL	400-600mL		0.75-1.0L
	Cercospora				1.0–2.2kg	500mL	400-600mL	145 mL#	300mL
	Chocolate spot	500mL	1.4–2.3L	1.2-1.9kg	1.0–2.2kg	500mL	600mL		0.75-1.0L
	Rust		1.4–2.3L	1.2-1.9kg	1.0–2.2kg		600mL	145 mL#	300mL
Lentil	Ascochyta blight		1.4–2.3L	0.8-1.6kg	1.0–2.2kg		400-600mL		0.75-1.0L
	Botrytis grey mould	500mL	1.4–2.3L	0.8-1.6kg	1.0–2.2kg	500mL	400-600mL		0.75-1.0L
	Sclerotinia								
Lupin	Anthracnose				1.0–2.2kg				
	Botrytis grey mould								0.75-1.0L
Vetch	Ascochyta blight				1.0–2.2kg				
	Botrytis grey mould	500mL			1.0–2.2kg				0.75-1.0L
	Rust				1.0–2.2kg				
WHP harvest		28 days	14 days	14 days	28 days	Faba bean 9 days, lentil 21 days	Not required	3 days	28 days
WHP graze		28 days	14 days	14 days	14 days	Lentil 21 days	35 days	3 days	28 days
Group		Group 1	Group M5	Group M5	Group M3	Group 2	Group 3 and 7	Group 3	Group 3 and 11
Special comments					Less effective on botrytis grey mould and chocolate spot than alternative products		DO NOT apply after early flowering in faba, field pea and lentil or after late flowering in chickpea		

WHP=withholding period, # refer to permit PER13752

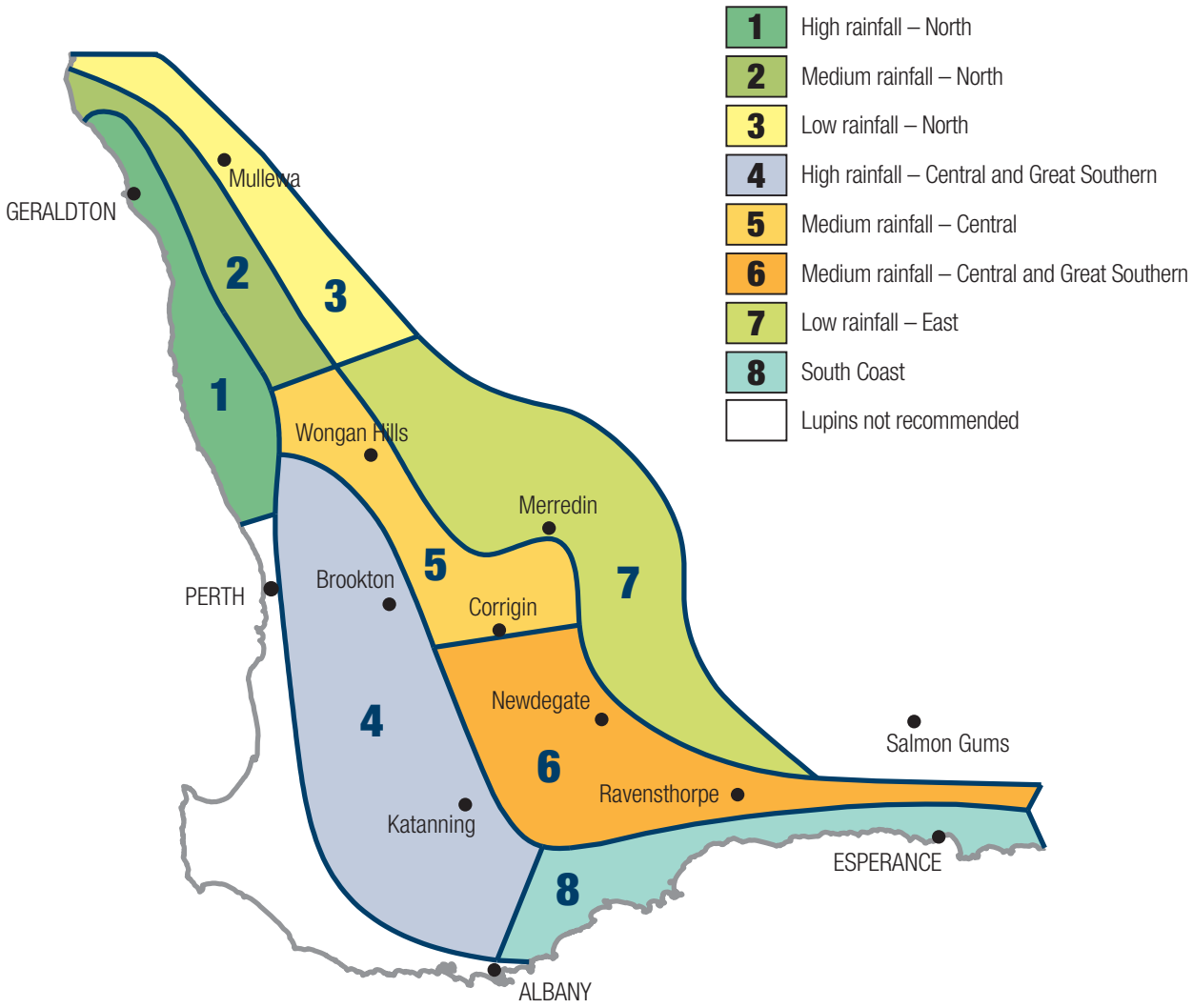


FIGURE 1 Lupin Agzones in Western Australia

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 moderately 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 varieties have been PBA Jurien and Mandelup.

Please refer to Figure 1 for the lupin Agzone key, which has eight zones compared with six for the other major crops.

TABLE 1. Grain yield of narrow-leaf lupin varieties in AGZONE 1 expressed as percentage of site mean yield for each trial year (2015-2019)

Year	2015	2016	2017	2018*	2019
Site mean yield (t/ha)	4.05	3.12	1.64	2.18	1.48
No. of trials	(2)	(4)	(3)	(4)	(4)
Coromup	97	98	95	91	103
Coyote	107	106	115	103	112
Danja	94	76	78	-	-
Jenabillup	103	91	90	92	-
Mandelup	104	108	104	-	97
PBA Barlock	105	118	101	-	96
PBA Bateman	106	100	-	95	110
PBA Gunyidi	104	102	101	-	105
PBA Jurien	107	127	107	-	106
PBA Leeman	97	95	-	96	100
Tanjil	98	97	89	-	-
Wonga	-	-	-	-	78

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 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 (2015, 2018-2019)

Year	2015	2018*	2019
Site mean yield (t/ha)	2.59	3.21	1.00
No. of trials	(2)	(4)	(3)
Coromup	97	91	101
Coyote	108	109	113
Danja	84	-	-
Jenabillup	92	94	-
Mandelup	105	-	100
PBA Barlock	107	-	102
PBA Bateman	102	100	106
PBA Gunyidi	100	-	102
PBA Jurien	112	-	115
PBA Leeman	98	94	100
Tanjil	95	-	-
Wonga	-	-	76

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 analysis. Use 2018 data with caution.

TABLE 3. Grain yield of narrow-leaf lupin varieties in AGZONE 3 expressed as percentage of site mean yield for each trial year (2016-2019)

Year	2016	2017	2018*	2019
Site mean yield (t/ha)	2.57	1.90	1.95	0.73
No. of trials	(1)	(1)	(1)	(1)
Coromup	102	99	91	104
Coyote	92	111	111	110
Danja	90	88	-	-
Jenabillup	89	100	102	-
Mandelup	104	100	-	101
PBA Barlock	115	98	-	106
PBA Bateman	88	-	106	108
PBA Gunyidi	96	104	-	106
PBA Jurien	119	102	-	120
PBA Leeman	98	-	96	98
Tanjil	103	93	-	-
Wonga	-	-	-	79

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 analysis. Use 2018 data with caution.

TABLE 4. Grain yield of narrow-leaf lupin varieties in AGZONE 4 expressed as percentage of site mean yield for each trial year (2015-2019)

Year	2015	2016	2017	2018*	2019
Site mean yield (t/ha)	1.20	1.67	3.14	2.40	2.49
No. of trials	(2)	(1)	(1)	(1)	(2)
Coromup	92	94	104	94	102
Coyote	119	111	106	118	105
Danja	95	90	81	-	-
Jenabillup	117	97	98	95	-
Mandelup	110	105	99	-	99
PBA Barlock	111	104	102	-	101
PBA Bateman	120	106	-	111	103
PBA Gunyidi	113	102	105	-	102
PBA Jurien	112	106	111	-	108
PBA Leeman	93	98	-	97	100
Tanjil	98	95	93	-	-
Wonga	-	-	-	-	88

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

*NOTE: For all Agzones in 2018, Mandelup, PBA Barlock, PBA Gunyidi and PBA Jurien establishment was poor and these varieties were not included in analysis. Use 2018 data with caution.

TABLE 5. Grain yield of narrow-leaf lupin varieties in AGZONE 5 expressed as percentage of site mean yield for each trial year (2015-2019)

Year	2015	2016	2017	2018*	2019
Site mean yield (t/ha)	2.00	2.52	1.73	1.97	1.08
No. of trials	(3)	(2)	(3)	(3)	(2)
Coromup	95	96	93	100	108
Coyote	111	116	116	103	108
Danja	93	80	78	-	-
Jenabillup	105	101	86	98	-
Mandelup	107	106	103	-	92
PBA Barlock	109	107	98	-	92
PBA Bateman	109	113	-	100	112
PBA Gunyidi	106	108	99	-	108
PBA Jurien	111	114	104	-	103
PBA Leeman	96	96	-	93	101
Tanjil	98	92	87	-	-
Wonga	-	-	-	-	76

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 analysis. Use 2018 data with caution.

TABLE 6. Grain yield of narrow leaf lupin varieties in AGZONE 6 expressed as percentage of site mean yield for each trial year (2015-2017)

Year	2015	2016	2017
Site mean yield (t/ha)	2.14	0.89	3.02
No. of trials	(1)	(1)	(1)
Coromup	95	101	92
Coyote	111	106	105
Danja	92	74	97
Jenabillup	100	90	91
Mandelup	105	104	106
PBA Barlock	103	111	103
PBA Bateman	108	101	-
PBA Gunyidi	103	102	95
PBA Jurien	105	122	101
PBA Leeman	98	97	-
Tanjil	95	93	98
Wonga	-	-	-

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

TABLE 7. Grain yield of narrow leaf lupin varieties in AGZONE 7 expressed as percentage of site mean yield for each trial year (2015-2019)

Year	2015	2016	2017	2018*	2019
Site mean yield (t/ha)	1.09	1.80	0.33	1.74	0.73
No. of trials	(2)	(3)	(1)	(2)	(3)
Coromup	93	97	128	113	102
Coyote	117	108	52	119	107
Danja	88	85	125	-	-
Jenabillup	103	96	91	111	-
Mandelup	107	106	72	-	100
PBA Barlock	105	109	74	-	102
PBA Bateman	114	104	-	124	106
PBA Gunyidi	107	103	84	-	104
PBA Jurien	108	114	70	-	110
PBA Leeman	96	97	-	92	99
Tanjil	94	96	112	-	-
Wonga	-	-	-	-	87

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 analysis. Use 2018 data with caution.

TABLE 8. Grain yield of narrow leaf lupin varieties in AGZONE 8 expressed as percentage of site mean yield for each trial year (2017-2019)

Year	2017	2018*	2019
Site mean yield (t/ha)	**1.85**	**1.13**	**1.98**
No. of trials	**(1)**	**(1)**	**(1)**
Coromup	92	110	83
Coyote	126	189	119
Danja	82	-	-
Jenabillup	106	142	-
Mandelup	106	-	114
PBA Barlock	101	-	109
PBA Bateman	-	198	97
PBA Gunyidi	111	-	89
PBA Jurien	106	-	114
PBA Leeman	-	-	98
Tanjil	88	-	-
Wonga	-	-	92

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 analysis. Use 2018 data with caution.

TABLE 9. Lupin variety disease, insect and lodging rating

Variety	Lodging (high rainfall)	Brown leaf spot	Phomposis (stem)	Anthracnose	Grey spot	CMV (seed)	BYMV	Aphid
Coromup	MRMS	MS	R	MR	R	RMR	MS	R
Coyote	-	MS*p*	MR*p*	MRMS*p*	R	MR	MRMS	-
Jenabillup	MRMS	MRMS	MS	MS	R	MR	MR	R
Mandelup	MS	MS	RMR	MR	R	MRMS	S	R
PBA Barlock	MR	MS	MR	RMR	R	RMR	MS	R
PBA Bateman	MRMS	MS	RMR	MRMS	R	MRMS	MR	R
PBA Gunyidi	MR	MS	RMR	MR	S	MR	MS	R
PBA Jurien	MRMS	MS	RMR	RMR	R	MRMS	MR	R
PBA Leeman	MRMS	MS	R	MR	R	MS	MS	R
Tanjil	MR	MS	R	R	R	R	MS	R

Source: Pulse Breeding Australia (PBA) trials program 2008-2014, NVT and AGT data

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 10. 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	**14.7**	**32%**	**0.017**
Coromup	14.5	-	-
Coyote^	14.7	Similar to Mandelup	Similar to Mandelup and PBA Jurien
Jenabillup	15.6	103	67
PBA Barlock	13.9	97	115
PBA Bateman	15	-	-
PBA Gunyidi	13.3	102	100
PBA Jurien	14.7	102	105
PBA Leeman	15	-	-
Tanjil	13.3	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 the northern area.
- Ideally paddocks with good stubble from previous year 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
Agzone 2	Medium	Late April to mid-May
Agzone 3	Low	Mid-April to early May
Agzone 4	High	Early May to early June
Agzone 5	Medium	Late April to mid-May
Agzone 6	Medium	Late April to mid-May
Agzone 7	Low	Mid-April to early May
Agzone 8	Medium	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 (for example, Rovral®) or procymidone (for example, 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 potentially manganese deficient soils, 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).
- Significantly, there is no yield penalty going wider.
- 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.

HERBICIDE OPTIONS

The following herbicides are registered on lupins 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

- 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
- *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 (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

* expected to be registered before the start of 2021 crop season

Post-sowing pre-emergent (PSPE) herbicides

- Diuron 900g/kg (e.g. Diurex® WG) at 1.1kg/ha (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.

* expected to be registered before the start of 2021 crop season

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 1.1–1.6kg/ha is registered for use on gravelly loam soils.
- Do not apply simazine, atrazine and diuron on deep white or grey sands.
- Due to a different sub-group within Group C herbicides, adding 0.55–1.1kg/ha of diuron (900g a.i./kg) will help manage wild radish resistant to simazine/atrazine. It will also improve the control of capeweed and doublegee. Crop damage may occur if diuron is added to high rates of simazine or/and 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 the 3-4 leaves until bud emergence stage.
- Picolinafen 750g/kg (e.g. Conquest Glocker® 750 WG Herbicide, Sniper®) at 33–50g/ha. Apply at 2-6 crop 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. Rhino®) 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.
- Sethoxydim 186g/L (e.g. Sertin®) at 0.5–1L/ha + crop oil (e.g. D-C-Trate® or Ulvapron®) at 1-2L/ha. When applying less than 100L/ha of spray volume, use the 1L/ha rate of spray oil. Do not apply after the start of main stem flowering (big bud stage).

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 eight-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. Sniper®) alone, or in combination with other herbicides, causes bleaching/leaf spotting on most of the 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 of the lupin varieties. Plants typically recover rapidly in normal growing conditions. It is advised not to use oils and wetters with metosulam and to apply 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 at the likely onset of moisture stress 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 the 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®) is registered for crop-topping at 400 or 800mL/ha for ground application only. Current use of paraquat for crop-topping may alter access to markets and prices.
- Crop-top when 80% of leaves have fallen off the lupin plants and ryegrass should be at flowering to soft dough stage for best results.
- If the target lupin and ryegrass windows are not going to match up and weed control is your highest priority, then you may need to consider sacrificing some lupin yield (which could be more than 25%) and spray before 80% leaf drop. 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®) 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 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.
- On old lupin country seed should be treated with either iprodione (for example, Rovral®) or procymidone (for example, Sumisclex® Broadacre Fungicide) to reduce the risk of brown spot and pleiochaeta root rot.

- Where possible, choose seed with low risk of anthracnose or CMV infection. 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.

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 been 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, ensure to select a variety with tolerance to ascochyta, have a disease management plan, use an inoculant and a seed dressing at sowing and sow into a relatively clean paddock as post-emergent broadleaf herbicides can be ineffective. It is important to use good seed; growers have been caught out sowing ascochyta infected seed and not knowing the germination rate of chickpeas, 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

PBA Striker and Neelam are the most consistent performers across WA.

Kabuli varieties

Genesis 090 is the most readily available variety of kabuli in WA. It can command a premium price to 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	Small		12–18	Gen508-510
	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 2016 (Pulse Australia)

WHAT IS NEW?

In October 2020, NSW DPI released CBA Captain (formerly CICA1521). CBA Captain is an erect desi chickpea with medium seed size and angular shape. CBA Captain has superior yields to Genesis 836, a current variety with a similar erect plant type, in all Agzones where NVT evaluation has been conducted. CBA Captain has yielded similar to PBA Striker, with CBA Captain offering excellent harvestability compared to PBA Striker through a greater height to lowest pod 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 a preliminary 2019 field trial at DPIRD, South Perth. They found CBA Captain showed no significant differences in ascochyta resistance to varieties Genesis 090, Genesis 836, Kalkee, PBA HatTrick and PBA Striker, but was significantly more resistant than varieties Jimbour, Kyabra, Moti and PBA Howzat, when inoculated with a mix of Western Australian ascochyta — these findings are being validated in a 2020 trial. 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 an opportunity to access established markets with a variety with the same grain type as eastern growers.

GRAIN YIELD

See Tables 2 to 5.

TABLE 2. Grain yield of chickpea varieties in AGZONE 1 expressed as percentage of site mean yield for each trial year (2015-2019)

Year	2015	2016	2017	2018	2019
Site mean yield (t/ha)	1.62	1.54	0.44	1.31	0.89
No. of trials	(3)	(2)	(2)	(2)	(1)
Desi type					
Ambar	89	103	90	106	-
CBA Captain	-	-	114	110	108
Genesis 836	89	92	92	95	95
Neelam	109	109	106	106	99
PBA Maiden	91	99	98	99	104
PBA Slasher	103	103	97	101	100
PBA Striker	99	109	106	110	111
Kabuli type					
Genesis 090	109	106	91	103	96

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 (2015-2019)

Year	2015	2016	2017	2018	2019
Site mean yield (t/ha)	1.28	0.97	1.00	0.58	0.42
No. of trials	(2)	(1)	(1)	(1)	(1)
Desi type					
Ambar	96	106	112	97	-
CBA Captain	-	-	106	99	108
Genesis 836	93	97	97	100	90
Neelam	103	109	101	101	94
PBA Maiden	95	110	97	102	111
PBA Slasher	100	105	101	98	114
PBA Striker	112	107	115	98	115
Kabuli type					
Genesis 090	109	97	114	90	114

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)	1.86
No. of trials	(1)
Desi type	
Ambar	94
CBA Captain	104
Genesis 836	99
Neelam	97
PBA Maiden	98
PBA Slasher	101
PBA Striker	106
Kabuli type	
Genesis 090	107

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 (2015-2019)

Year	2015	2016	2017	2018	2019
Site mean yield (t/ha)	1.45	1.82	0.59	1.36	0.85
No. of trials	(2)	(1)	(2)	(2)	(2)
Desi type					
Ambar	96	110	92	97	-
CBA Captain	-	-	115	99	109
Genesis 836	94	91	94	98	92
Neelam	106	116	104	105	97
PBA Maiden	95	110	88	105	105
PBA Slasher	100	108	92	103	103
PBA Striker	98	120	94	98	106
Kabuli type					
Genesis 090	102	-	90	95	95

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

DISEASE RATINGS FOR SELECTED CHICKPEA VARIETIES

TABLE 6. Disease ratings for selected chickpea varieties

	Ascochyta blight*	Botrytis grey mould (BGM)
Desi type		
Ambar	MS	S
CBA Captain	MS	S
Genesis 836	MS	S
Neelam	S	S
PBA Maiden	MS	S
PBA Slasher	MS	S
PBA Striker	S	S
Kabuli type		
Genesis 090	RMR	S

Source: National Pulse Disease Ratings (2019)

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

* 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.

VARIETY TRAITS

TABLE 7. Desi chickpea variety traits

Variety	Plant height (cm)[1]		Maturity[2]	Lodging resistance[2]
	Mingenew NVT 2019	Merredin NVT 2019		
Desi type				
Ambar	-	-	Early	Very good
CBA Captain	49	40	Mid*	Very good*
Genesis 836	51	37	-	-
Neelam	48	33	Mid	Very good
PBA Maiden	43	30	Mid	Moderate
PBA Slasher	45	31	Mid	Moderate
PBA Striker	46	31	Early	Moderate
Kabuli type				
Genesis 090	46	34	Mid-Late	Good

Source: [1]Merredin and Mingenew NVT trials Sept 2019, [2]NSW DPI Winter crop variety sowing guide (2020)

*Provisional classification

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.
- Avoid chickpea, faba, vetch, lentil or narbon bean stubble – at least 500 metres away from last year's 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-Pickle 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 a number of 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 approximately eight units of phosphorous to grow a chickpea crop that yields one tonne.
- 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/m^2
- Kabuli: 30–35 plants/m^2

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

SEEDING RATE

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

Calculate your own 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

*expected to be registered before the start of 2021 crop season

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. Stacato®) at 180–380g/ha
- Simazine 900g/kg (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

*expected to be registered before the start of 2021 crop season

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.
- Pyridate 600g/L (Tough® 600 EC) at 0.75-1.5L/ha. Do not apply when more than 20% of chickpea flowers are open.

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.
- Sethoxydim 186g/L (e.g. Sertin®) at 0.5–1L/ha + crop oil (e.g. D-C-Trate® or Ulvapron®) at 1-2L/ha. When applying less than 100L/ha of spray volume, use spray oil at 1L/ha rate. Do not apply after crop has started to flower.

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

BUDWORM THRESHOLD – VERY LOW

- Desi 1 caterpillar per 10 sweeps
- Kabuli 1 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-Pickle 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

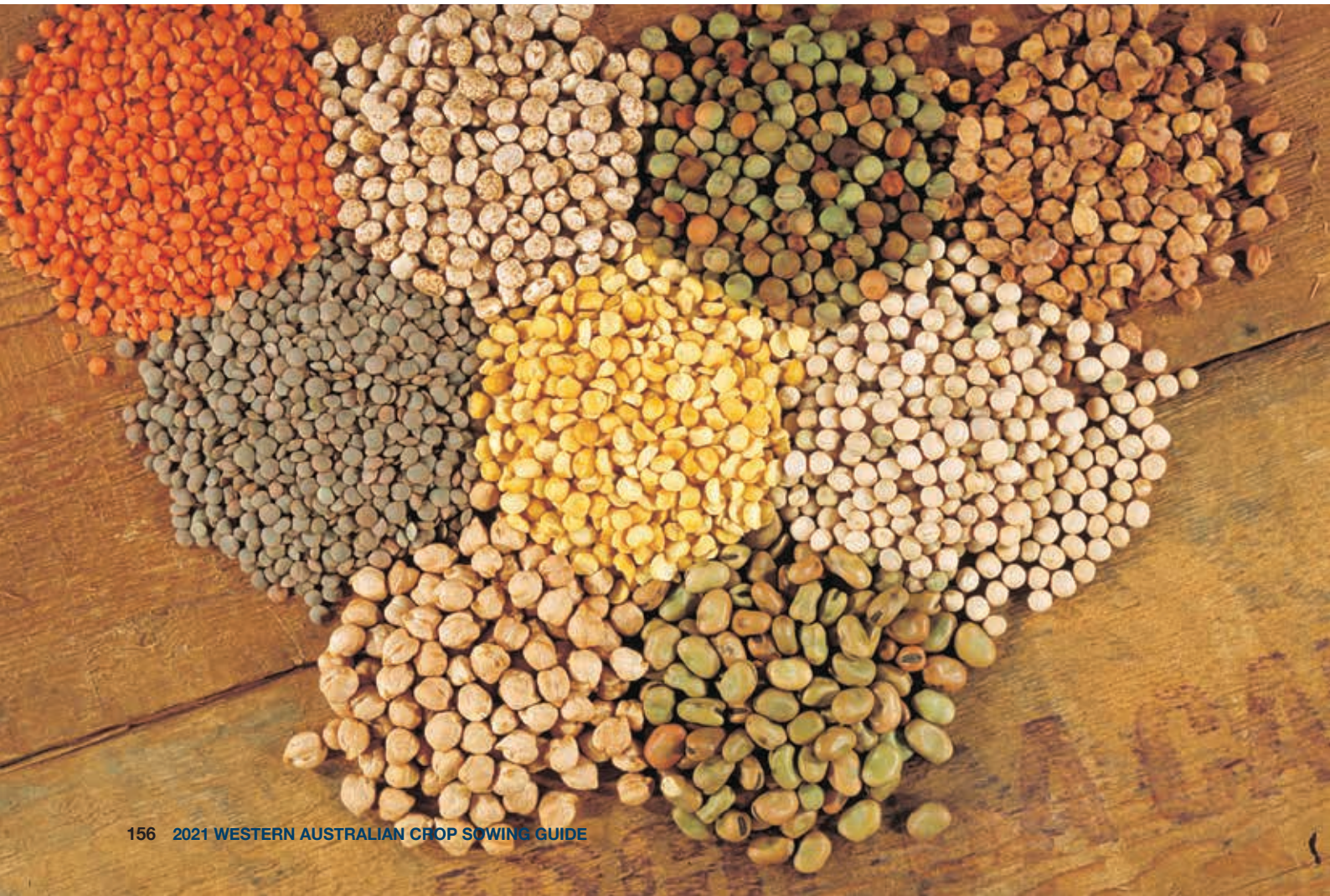
- To manage ascochyta, apply preventative fungicides. For example, apply chlorothalonil 720g/L product (1.0–2.0L/ha) or mancozeb 750g/kg product (1.0–2.0kg/ha) fungicides at four and seven weeks after emergence, then monitor regularly for disease. If disease is detected apply fungicide at three-week intervals before rain fronts.
- Veritas® fungicide (200g/L tebuconazole, 120g/L azoxystrobin) is registered for control of ascochyta blight and botrytis grey mould in chickpea crops at an application rate of 0.75–1.0L/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.
- 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. It helps overcome slow and uneven ripening of crop 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 the epidemics seen in the late 1990s are much lower these days.

WHAT IS NEW?

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 have 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 the 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.

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 both pathotypes 1 and 2 of 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.

WHAT VARIETY SHOULD I GROW?

PBA Samira is considered the benchmark variety for WA, and is the most widely grown variety. Growers who will 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 had high yields in the 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 (2016-2019)

	Agzone 3		Agzone 5			
Year	**2017**	**2019**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)	**0.70**	**1.69**	**3.82**	**1.40**	**3.09**	**1.28**
No. of trials	**(1)**	**(1)**	**(2)**	**(2)**	**(2)**	**(1)**
Farah	96	98	90	94	97	93
Nura	98	101	94	89	95	97
PBA Amberley	98	96	103	109	100	105
PBA Bendoc	92	88	96	116	97	92
PBA Marne	109	102	112	88	104	104
PBA Rana	94	108	84	98	95	85
PBA Samira	97	97	97	106	99	100
PBA Zahra	97	92	94	86	99	114

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	Ascochyta blight		Rust	Cercospora leaf spot	PSbMV seed stain
		Pathotype 1	Pathotype 2			
Farah	S	RMR	S	S	S	S
Fiesta VF	S	MS	S	S	S	S
Nura	MS	RMR	RMR	MS	S	VS
PBA Amberley	MR	RMR	RMR	S	S	-
PBA Bendoc	MS	RMR	RMR	S	S	S
PBA Marne	S	RMR	MRMS	MR	S	MR
PBA Rana	MS	R	MRMS	MS	S	MR
PBA Samira	MS	RMR	RMR	MS	S	S
PBA Zahra	MS	R	MRMS	MS	S	S

Source: National Pulse Disease Ratings (2019)

R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant, MRMS = moderately resistant to moderately susceptible, MS = moderately susceptible, S = susceptible. PSbMV = pea seedborne mosaic virus.

Faba bean agronomy guide

ROTATION

- Faba bean fixes large amounts of N, providing large rotation benefits for following crops.
- Grow no more often than one year in four in the same paddock to reduce disease risk.
- Avoid close rotations with vetch, narbon bean or 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, avoids spring drought, 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 in 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 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 the soils are not optimal for faba bean (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

*expected to be registered before the start of 2021 crop season

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.

*expected to be registered before the start of 2021 crop season

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.
- 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.
- Sethoxydim 186g/L (e.g. Sertin®) at 0.5–1L/ha + crop oil (e.g. D-C-Trate® or Ulvapron®) at 1-2L/ha. When applying less than 100L/ha of spray volume, use spray oil at 1L/ha rate. Do not apply after crop has started to flower.

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 seen in 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 your crop and fungicide mixes may be required.

Ascochyta

- Early vegetative stages – monitor to ensure disease is apparent.
- Suggested fungicides are mancozeb or Veritas® (tebuconazole + azoxystrobin) or Aviator® Xpro® (prothioconazole + bixafen).

Chocolate spot

- At canopy closure/flowering.
- Suggested fungicdes are carbendazim, procymidione, Veritas® (tebuconazole + azoxystrobin), or Aviator® Xpro® (prothioconazole + bixafen).

Cercospora

- Often seen 6-8 weeks after sowing.
- Suggested fungicides are Veritas® (tebuconazole + azoxystrobin) or Aviator® Xpro® (prothioconazole + bixafen) and tebuconazole (refer PER13752).

Rust

- Suggested fungicides are mancozeb, chlorothalonil, Veritas® (tebuconazole + azoxystrobin), or Aviator® Xpro® (prothioconazole + bixafen) and tebuconazole (refer PER13752).

CROP-TOPPING

- Paraquat 250g/L (e.g. Gramoxone®) at 400 or 800mL/ha.
- 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 a majority of 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. It 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 may 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 may 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 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 among growers and their 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.

The majority of 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?

PBA Butler was released in 2017. It is a mid-to-late flowering semi-dwarf with a semi-leafless canopy. In WA, it produces a noticeably taller and bulkier canopy than most other field pea varieties. PBA Butler produces Kaspa-type dun seeds. It has improved bacterial blight and downy mildew resistance compared with other Kaspa-types. PBA Butler is available from Seednet (EPR $2.70/t).

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 (2015-2019)

Year	2015	2016	2017	2018	2019
Site mean yield (t/ha)	2.33	1.99	0.60	1.48	1.18
No. of trials	(1)	(2)	(2)	(2)	(1)
Kaspa	97	70	98	105	105
Parafield	68	69	76	69	-
PBA Butler	98	105	98	110	99
PBA Gunyah	100	83	100	104	105
PBA Oura	87	92	89	96	101
PBA Pearl	81	101	76	110	99
PBA Percy	87	99	113	95	108
PBA Twilight	99	75	97	99	106
PBA Wharton	106	94	99	93	101

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 (2015-2019)

Year	2015	2016	2017	2018	2019
Site mean yield (t/ha)	1.71	1.93	1.52	1.37	0.86
No. of trials	(4)	(2)	(3)	(2)	(1)
Kaspa	89	62	97	99	97
Parafield	69	50	79	79	-
PBA Butler	95	106	102	117	108
PBA Gunyah	96	78	99	95	97
PBA Oura	93	85	92	81	84
PBA Pearl	92	107	91	102	86
PBA Percy	85	57	95	51	90
PBA Twilight	98	73	96	87	90
PBA Wharton	111	104	100	92	93

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 (2015-2019)

Year	2015	2016	2017	2018	2019
Site mean yield (t/ha)	0.45	0.46	1.65	1.10	2.14
No. of trials	(2)	(1)	(1)	(1)	(1)
Kaspa	69	48	97	73	95
Parafield	33	37	71	90	82
PBA Butler	83	109	129	100	105
PBA Gunyah	91	70	91	86	98
PBA Oura	97	87	72	107	98
PBA Pearl	98	128	96	112	102
PBA Percy	80	31	61	129	107
PBA Twilight	99	66	72	81	94
PBA Wharton	129	107	74	92	94

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 (2016-2019)

Year	2016	2017	2018	2019
Site mean yield (t/ha)	1.91	1.07	1.92	0.63
No. of trials	(1)	(1)	(1)	(1)
Kaspa	63	99	107	92
Parafield	61	62	59	-
PBA Butler	97	99	103	114
PBA Gunyah	81	102	107	94
PBA Oura	92	89	95	71
PBA Pearl	97	81	101	97
PBA Percy	92	103	90	21
PBA Twilight	77	99	107	89
PBA Wharton	104	102	104	106

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 (2015-2019)

Year	2015	2016	2017	2018	2019
Site mean yield (t/ha)	2.31	1.70	1.57	1.29	0.65
No. of trials	(5)	(3)	(7)	(5)	(6)
Excell	-	60	-	-	89
Kaspa	93	102	92	88	94
Parafield	81	82	86	72	89
PBA Butler	111	112	107	91	102
PBA Gunyah	95	100	94	96	98
PBA Oura	99	91	91	91	105
PBA Pearl	114	97	95	77	115
PBA Percy	103	100	94	103	105
PBA Twilight	88	91	88	97	97
PBA Wharton	88	87	93	109	98
Sturt	107	96	-	-	107

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
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 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
Sturt	White	C	High	Early-mid	Mid	Poor	MR: NSP	I	MI

Source: Victorian Winter Crop Summary 2020

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]
Excell	MS	S	-
Kaspa	MS	S	S
Parafield	MS	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 Twilight	MS	S	S
PBA Wharton	MS	S	R
Sturt	MS	S	-

Source: National Pulse Disease Ratings (2019)

[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.

TABLE 8. Resistance of field pea varieties to diseases rarely found in WA crops

Variety	Powdery mildew	Bacterial blight	Bean leafroll virus
Kaspa	S	S	S
Parafield	S	MS	-
PBA Butler	S	MS	S
PBA Gunyah	S	S	S
PBA Oura	S	MS	R
PBA Pearl	S	MS	R
PBA Percy	S	MRMS	S
PBA Twilight	S	S	-
PBA Wharton	R	S	R
Sturt	MS	S	-

Source: National Pulse Disease Ratings (2019)

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

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, it 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 it may 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 releases of spores that occur 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 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 partially burying 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.
- It 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 such as 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

*Expected to be registered before the start of 2021 crop season.

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.

*Expected to be registered before the start of 2021 crop season.

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.
- Picolinafen 750g/kg (e.g. Conquest Glocker® 750 WG, Sniper®) at 33–50g/ha. Apply from third-node to pre-flowering of 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. Rhino®) 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. BS-1000®) at 0.2% (v/v). Apply from 2nd node stage of crop to before flowering. Do not apply it in mixture with diflufenican (e.g. Brodal® Options) as crop yellowing may occur and separate applications are recommended. Apply from 2nd-node 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 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.
- Sethoxydim 186g/L (e.g. Sertin®) at 0.5–1L/ha + crop oil (e.g. D-C-Trate® or Ulvapron®) at 1-2L/ha. When applying less than 100L/ha of spray volume, use spray oil at 1L/ha rate. Do not apply after crop has stated to flower.

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/10 sweeps of a sweep net. Spray before the grubs grow to 1cm. Controlling large grubs (20–25mm) is costly as the majority 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 1 weevil/100 sweeps of a sweep net (human consumption) or one weevil/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. It can be minimised by:

- sowing field pea at least 500m from previous seasons' pea stubble;
- not sowing in paddocks where peas were grown in the past three years; and
- sowing crops after the majority of spores (60%) 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®) at 400 or 800mL/ha.
- 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 a majority of 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 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 may 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 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 may 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 that have 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 and 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?

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 IMI-tolerance 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 early 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.

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 the majority of experiments conducted in WA 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 growers talk to potential buyers prior to committing to a variety.

GRAIN YIELD OF LENTIL VARIETIES

Refer to Tables 1 and 2.

TABLE 1. Grain yield of lentil varieties in AGZONE 1 and AGZONE 2 expressed as percentage of site mean yield for each trial year (2017-2019)

Agzone	Agzone 1			Agzone 2	
Year	**2017**	**2018**	**2019**	**2018**	**2019**
Site mean yield (t/ha)	**1.16**	**1.33**	**0.51**	**1.63**	**0.75**
No. of trials	**(1)**	**(1)**	**(1)**	**(1)**	**(1)**
PBA Ace	94	102	120	98	114
PBA Blitz	105	103	-	91	-
PBA Bolt	95	98	111	93	110
PBA Flash	90	93	96	85	89
PBA Greenfield	111	82	87	94	79
PBA Hallmark XT	113	113	113	117	120
PBA Highland XT	-	110	123	117	131
PBA Hurricane XT	100	88	101	112	103
PBA Jumbo2	100	85	107	104	109
PBA Kelpie XT	-	-	-	101	-

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

TABLE 2. Grain yield of lentil varieties in AGZONE 4 and AGZONE 5 expressed as percentage of site mean yield for each trial year (2015-2019)

Agzone	Agzone 4		Agzone 5			
Year	**2015**	**2018**	**2016**	**2017**	**2018**	**2019**
Site mean yield (t/ha)	**0.53**	**1.94**	**1.74**	**1.31**	**1.34**	**0.64**
No. of trials	**(1)**	**(2)**	**(3)**	**(4)**	**(3)**	**(1)**
PBA Ace	135	102	105	108	105	91
PBA Blitz	104	109	96	92	94	83
PBA Bolt	109	92	104	108	115	107
PBA Flash	94	87	100	96	94	109
PBA Greenfield	102	-	-	91	73	91
PBA Hallmark XT	119	99	104	110	114	87
PBA Highland XT	123	117	111	115	126	91
PBA Hurricane XT	101	104	98	104	106	100
PBA Jumbo2	116	99	108	101	96	83
PBA Kelpie XT	-	-	-	-	95	102

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)#
PBA Ace	Medium red	Grey	Mid	132	Mid	MRMS	30
PBA Blitz	Medium red	Grey	Early	117	Early	MR	-
PBA Bolt	Medium red	Grey	Early-Mid	125	Early-Mid	R	29
PBA Flash	Medium red	Green	Early-Mid	131	Early-Mid	MR	26
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 may be required under severe disease pressure.

TABLE 4. Disease ratings for selected lentil varieties

Variety	Botrytis grey mould	Ascochyta blight
PBA Ace	MRMS	R
PBA Blitz	MR	MR
PBA Bolt	S	MRMS
PBA Hallmark XT	RMR	MRMS
PBA Highland XT	MRMS	MRMS
PBA Hurricane XT	MRMS	MRMS
PBA Jumbo2	RMR	R
PBA Kelpie XT	RMR	MRMS*p*

Source: National Pulse Disease Ratings (2019)
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.

TABLE 5. Lentil tolerance to soil conditions

Variety	Boron	Salinity
PBA Ace	I	I
PBA Blitz	I	I
PBA Bolt	MI	MI
PBA Flash	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

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-Pickle 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/m^2. Recommended plant density provides better competition with weeds than lower densities and aids efficient harvest.

SEEDING RATE

- Small-seeded varieties (PBA Hurricane XT) 35 to 40kg/ha.
- Medium-sized varieties (PBA Bolt, PBA Hallmark XT) 40 to 50kg/ha.
- Large-seeded varieties (PBA Jumbo2) 50+ kg/ha.

Always check seed size and germination percentage as both vary widely from year to year.

ROW SPACING

- Similar yield response on wide range of row spacing. Inter-row sowing between 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®) 2.0L/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%).

*Expected to be registered before the start of 2021 crop season.

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 100–380g/ha. Rolling prior to 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.

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

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.

- Sethoxydim 186g/L (e.g. Sertin®) at 0.5-1L/ha + crop oil (e.g. D-C-Trate® or Ulvapron®) at 1-2L/ha. When applying less than 100L/ha of spray volume, use spray oil at 1L/ha rate. Do not apply after crop has started to flower.

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 to be prevalent in WA lentil crops. Regular crop monitoring and protection will be required in high-risk situations – e.g. immediately adjacent to last year's crop; in bulky, dense canopies sown with narrow row spacing; non-optimal paddock selection (e.g. waterlogging); high disease pressure experienced last year; or a susceptible variety is planted; or lentil was 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 filling.

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®
- 0.75 to 1L/ha of Veritas® (200g/L tebuconazole +120 g/L azoxystrobin)
- 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®
- 0.75 to 1L/ha of Veritas® (200g/L tebuconazole +120g/L azoxystrobin)
- 400 to 600mL/ha of Aviator® xPro® (150g/L prothioconazole + 75g/L bixafen)
- 1 to 2.2kg/ha of mancozeb (750g a.i./kg) e.g. Dithane®

CROP-TOPPING

- Paraquat 250g/L (e.g. Gramoxone®) at 400 to 800mL/ha.
- 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 a majority of 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 colour change 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 in 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 likes 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 approximately 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 provided by 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 yields (t/ha) of current vetch varieties at Kingsford (450mm+) and Morchard (320-350mm) in South Australia

Variety	2014 Kingsford	2015 Kingsford	2015 Morchard	2016 Kingsford	2016 Morchard	Multi site 2014-2016
Studenica	3.03	2.19	2.04	2.86	3.25	2.67
Rasina	-	1.90	2.12	3.39	2.76	2.54
Timok	2.69	2.24	2.33	3.66	2.87	2.76
Volga	2.93	2.00	2.20	3.98	3.23	2.87

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. 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	0.6
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

*Expected to be registered before the start of 2021 crop season.

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

*Expected to be registered before the start of 2021 crop season.

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.

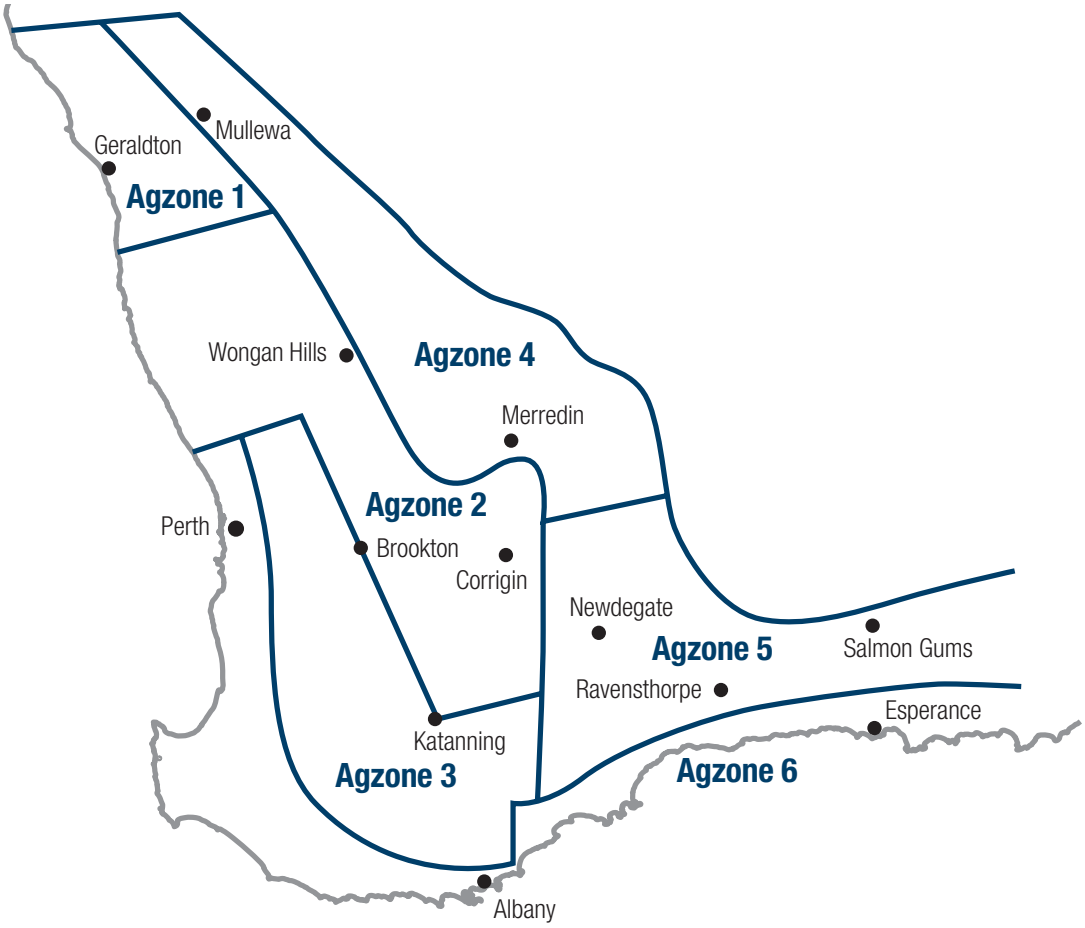
CROP-TOPPING

- Paraquat 250g/L (e.g. Gramoxone®) at 400 to 800mL/ha.
- 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 a majority of green immature pods. The higher label rate may also increase any yield reduction. DO NOT harvest within seven days of application.

PHOTO: Father of vetch breeding in Australia, Rade Matic in a crop of RM4.

Image courtesy of Stuart Nagel, SARDI

Notes



Agzones in Western Australia

Refer to page 90 for the distribution of Mid and Early Canola NVT's across Agzones.
Refer to page 138 for the Lupin Agzone map which has eight Agzones.