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2020 WESTERN AUSTRALIAN CROP SOWING GUIDE

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GRDC
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Service providers and the cooperation of growers prepared to contribute sites for NVT and DPIRD experiments are also gratefully acknowledged.

The information contained in this bulletin is based on work conducted by many research scientists, technical officers, breeding and seed companies. These groups of people are acknowledged by the authors in each crop section.

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This guide can be downloaded to your computer or tablet at:
www.grdc.com.au/NVT-WA-Sowing-Guide or www.agric.wa.gov.au
Remember to update it each November.

INTERPRETING CEREAL RESISTANCE CLASSIFICATIONS

Below is an explanation of the resistance ratings used in this guide for foliar diseases and how they should be interpreted.

R Resistant: the disease will not multiply or cause any damage on this variety.

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

MS Moderately susceptible: the disease may cause losses up to 15 per cent or more in very severe cases.

S Susceptible: the disease can be severe on this variety and losses of 15 to 50 per cent can occur.

VS Very susceptible: this variety should not be grown in areas where a disease is likely to be a problem. Losses greater than 50 per cent are possible and the build-up of inoculum will create problems for other growers.

INTERPRETING PULSE RESISTANCE CLASSIFICATIONS

No pulse crops or varieties are immune to disease and fungicide application may be required under severe disease pressure. Below is an explanation of the resistance ratings used in this guide for foliar diseases and how they should be interpreted.

R Resistant: the disease are unlikely to multiply or cause any damage on this variety. However, under severe disease pressure, fungicide applications may be required.

MR Moderately resistant: the disease may be visible and will multiply slightly, but it will not cause significant loss. However, under severe disease pressure, fungicide applications may be required.

MS Moderately susceptible: the disease will cause yield losses in conducive seasons.

S Susceptible: the disease will be severe on this variety and cause significant yield losses in conducive seasons.

VS Very susceptible: this variety should not be grown in areas where a disease is likely to be a problem. Significant yield losses can be expected without control and the increase in inoculum will create problems for other growers.

INTERPRETING NEMATODE RESISTANCE CLASSIFICATIONS

Below is an explanation of the resistance ratings used in this guide for **nematodes for both cereals and pulses** and how they should be interpreted.

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 in the presence of this variety.

VS Very susceptible: a large increase in nematode numbers can occur when this variety is grown and this will cause problems to a following intolerant crop.

These classifications are only a guide and yield losses will depend on the environment and seasonal conditions.

DISEASE RESISTANCE RATINGS

Colour range

VS	SVS	S	MSS	MS	MRMS	MR	RMR	R

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INTRODUCTION

THE CROP SOWING GUIDE FOR WESTERN AUSTRALIA

Welcome to the 2020 edition of the Crop Sowing Guide. The content and format of the WA variety guide has been changed, in line with recommendations from a Department of Primary Industries and Regional Development (DPIRD) review involving industry consultation and a workshop. Please direct feedback to the authors of this publication.

This edition includes the major crops grown in WA – wheat, barley, canola, oat and now a new section on lupins and pulses. The publication aims to provide information to support growers with decisions on the best choice of variety for each of the major crops for the upcoming season. The lupin and pulse sections also include an agronomy guide summary to support management decisions required for these high-value crops.

Not sure whether pulses are for your system? Yields and break-even yields are listed in the pulse section plus there is a guide on choosing a pulse that might be suitable for your property. Please also consult your local adviser for more specific information for your area.

The barley section includes market feedback from the Grain Industry Association of Western Australia (GIWA), as market demand, pricing signals and location of segregation sites should be considered along with the agronomic management required and the risk associated with delivering malt-grade barley.

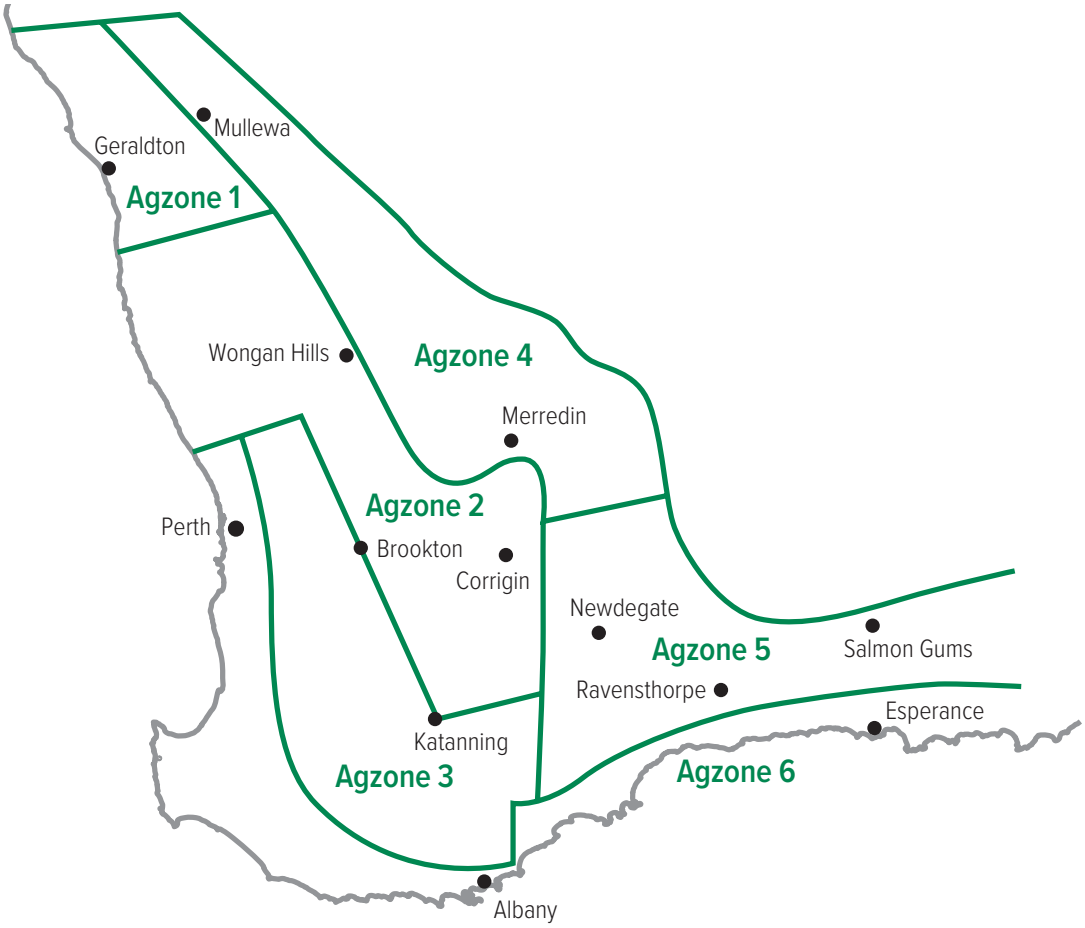
Although frost has a devastating effect on crop yields, it is acknowledged that variety choice and sowing time are still the most reliable ways of reducing yield losses. Key management strategies are available on the Grains Research and Development Corporation (GRDC) and DPIRD websites. Relative maturities of varieties are given in the wheat section to help growers decide the best variety choice for their sowing opportunities. All wheat and barley varieties are susceptible to frost; however, their risk profile during flowering can differ. Frost performance values provided on the NVT website give an indication of a variety's risk to frost damage during flowering.

Sources of additional information are listed in each section. Local advisers are also a key resource for information relevant to local areas. Growers are encouraged to use this publication as a guide to support discussions with consultants, advisers and marketing agents.

The spring release of this publication should assist growers with making variety choices for the 2020 season. It is important for growers and consultants to review disease resistance ratings in autumn 2020 to ensure current resistance ratings of varieties are known. The latest NVT data will also be available early in 2020 via the NVT website and the Long Term Yield Reporting tool. Updated barley and wheat snapshots will also be available on the DPIRD website by March 2020.

This edition of the *2020 Western Australian Crop Sowing Guide* has been compiled by officers in DPIRD with investment from GRDC and DPIRD.

FIGURE 1 Agzones in Western Australia.



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WHEAT

By Brenda Shackley, Christine Zaicou-Kunesch, Jeremy Curry, Dion Nicol, Manisha Shankar and Geoff Thomas, DPIRD

INTRODUCTION

The wheat section of this sowing guide provides information to support wheat growers with decisions on variety selection and management. It provides a summary of the yield performance of varieties in the National Variety Trials (NVT), disease resistance ratings and agronomic information. There is also a quick reference for 22 common and recently released varieties in snapshots at the end of the wheat section.

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:

- have better or equal yield, grain quality and/or disease traits
- provide diversity or risk mitigation
- suit current market requirements.

Reviewing available trial information (such as NVT and DPIRD trials) is highly recommended.

WHAT IS NEW?

CatapultΦ is an Australian Hard (AH) wheat variety with a mid-long maturity released by Australian Grains Technologies (AGT) (Table 17). CatapultΦ was included in the NVT for the first time in 2018, yielding higher than alternatives such as CutlassΦ, LRPB TrojanΦ and MagentaΦ, but lower than ScepterΦ and RockStarΦ in the main season trials. Provisional disease ratings suggest that CatapultΦ is moderately resistant to moderately susceptible to yellow spot, moderately resistant to stem rust and resistant to moderately resistant to stripe rust, but susceptible to leaf rust and powdery mildew.

RockStarΦ is an Australian Hard (AH) wheat variety with a mid-long maturity released by InterGrain (Table 17). RockStarΦ was included in the NVT for the first time in 2018, yielding similar to ScepterΦ and higher than the existing mid-long maturity alternatives such as CatapultΦ, CutlassΦ, LRPB TrojanΦ and MagentaΦ. Provisional disease ratings suggest that RockStarΦ is moderately resistant to moderately susceptible to yellow spot, moderately resistant to stem rust, resistant to moderately resistant to stripe rust, susceptible to leaf rust and moderately resistant to moderately susceptible to powdery mildew.

Sheriff CL PlusΦ is an imidazolinone herbicide tolerant Australian Premium White (APW) wheat released by InterGrain in 2018. Sheriff CL PlusΦ is a mid-season maturity wheat that can be sown slightly earlier than the other Clearfield® options (Table 17). NVT yield performance from 2016 and 2017 suggests Sheriff CL PlusΦ yields are similar to MaceΦ and other top-performing Clearfield® options, Chief CL PlusΦ and Razor CL PlusΦ. Sheriff CL PlusΦ was not sown in NVT in 2018. Sheriff CL PlusΦ is moderately resistant to moderately susceptible to yellow spot, moderately susceptible to stem rust, moderately susceptible to susceptible to stripe rust, susceptible to very susceptible to leaf rust and susceptible to powdery mildew.

VixenΦ is an Australian Hard (AH) wheat variety with a short season maturity released by InterGrain in 2018 (Table 17). VixenΦ has been tested in NVT since 2017, except for Agzones 3 and 6 (tested in 2018 only). NVT data suggests VixenΦ is similar yielding to ScepterΦ, but as for all short maturing varieties its performance is more variable across sites. VixenΦ is moderately resistant to moderately susceptible to yellow spot, moderately resistant to moderately susceptible to stem and stripe rust, susceptible to very susceptible to leaf rust and susceptible to powdery mildew.

VARIETY CLASSIFICATION

Source: Wheat Quality Australia (WQA).

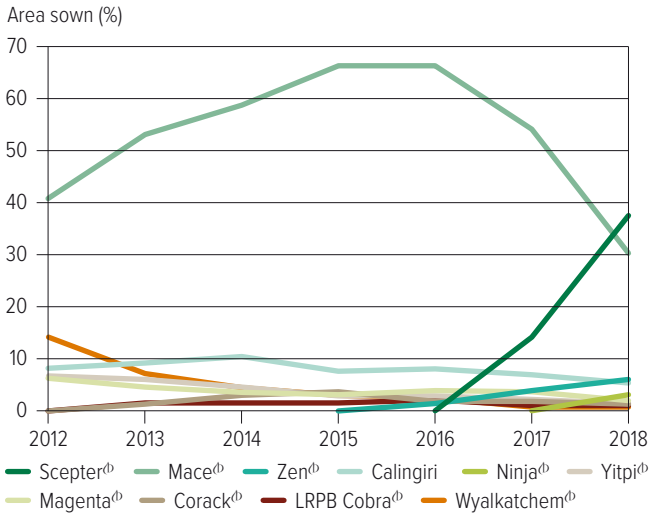
Wheat Quality Australia rationalises the Wheat Variety Master List through annual reviews of varieties that are more than 10 years old and are less than 0.1% of deliveries over the past four seasons. In 2021, the varieties Clearfield® JNZ, Clearfield® STL, Endure, Tammarin Rock^{Φ} and Zippy^{Φ} are to be removed from the Wheat Variety Master List. This means that they are no longer deliverable into their respective wheat classification segregations beyond 2021 and will only be deliverable as feed. These varieties have been surpassed in yield performance.

Australian Premium Noodle (APWN) is a quality class created to allow varietal control to optimise end-use quality in export blends with Australian Noodle (ANW), which primarily services the premium Japanese udon noodle market. APWN classification has been determined for the following AH and APW varieties:Chief CL Plus^{Φ}, Cutlass^{Φ}, Devil^{Φ}, EGA Bonnie Rock^{Φ}, LRPB Envoy^{Φ}, King Rock^{Φ}, LRPB Havoc^{Φ}, LRPB Trojan^{Φ}, LRPB Scout^{Φ}, Mace^{Φ}, Westonia and Wyalkatchem^{Φ}. Cutlass^{Φ}, Devil^{Φ}, LRPB Havoc^{Φ} and LRPB Trojan^{Φ} were additions to this list in 2019.

WHAT VARIETY SHOULD I GROW?

Variety choice is one of the easiest means to lift the profitability of wheat cropping. The opportunity to increase returns from the same input costs must surely motivate keen interest when new varieties can show consistent yield gains. As proof of this, Scepter^{Φ} has now replaced Mace^{Φ} as the most popular variety planted in Western Australia (Figure 1).

FIGURE 1 Popularity (per cent of wheat area) of the top 10 wheat varieties grown in WA over the past seven seasons.



SOURCE: FIGURE BASED ON GROWER ESTIMATES AS PROVIDED TO CBH FOR 2012–2018

There are now alternatives to Scepter^{Φ} for yield coming onto the market, but also a range of varieties that would complement Scepter^{Φ} very well. Many of these can provide a measurable change in risk or opportunity. It is important to consider several factors, including:

- its yield performance in your environment over multiple seasons;
- its maturity to ensure its life cycle is a fit for your targeted sowing time;
- its disease resistance ratings, particularly for prevalent diseases in your area and farming system. Due to the incursion of new strains or mutations of pathogens already present, it is essential to review existing varieties' disease ratings as these may have changed; and
- other quality requirements such as susceptibility to high grain screenings, low hectolitre weight, pre-harvest sprouting, black point and other quality defects.

Tables 1–4 compare notable varieties with Scepter^{Φ} to assist in variety selection. Preferred agronomic characteristics and disease traits will vary in priority based on the pressure in the target environment.

AH and APW short-mid season varieties

In 2018, two AH wheats were released by InterGrain. Devil^{Φ} is a short-mid maturity wheat and Vixen^{Φ} is a short maturity wheat (Table 1). While there is only two years of data available on these varieties, yield performances in the 2017 and 2018 NVT were similar to Scepter^{Φ}, although Vixen^{Φ} is more variable in yield than Scepter^{Φ} and Devil^{Φ}. As the table shows, all leading varieties competing in this maturity class are MRMS for yellow spot and most are susceptible for powdery mildew and the new strain of leaf rust. Neither Devil^{Φ} nor Vixen^{Φ} have improved powdery mildew resistance over Scepter^{Φ}, and they are also more susceptible for leaf rust. LRPB Havoc^{Φ} is slightly shorter in maturity than Mace^{Φ} and is moderately resistant to moderately susceptible for powdery mildew (see comment in Disease Resistance section, page 19), but is averaging approximately five per cent lower yield than Scepter^{Φ} and is susceptible for stem and leaf rust. Scepter^{Φ} has a higher falling number rating (equal to Mace^{Φ}) than Devil^{Φ}, Vixen^{Φ} (provisional ratings only) and LRPB Havoc^{Φ}.

CL Plus wheats

Wheat varieties denoted with 'CL Plus' identifies them as varieties with two resistance genes for imidazolinone herbicides and are registered for

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TABLE 1 Summary of wheat variety traits comparing Scepter(Ⓘ) with top yielding AH and APW short and short-mid maturity wheat varieties.

	Scepter(Ⓘ)	Devil(Ⓘ)	Vixen(Ⓘ)	LRPB Havoc(Ⓘ)	Corack(Ⓘ)	Mace(Ⓘ)	Emu Rock(Ⓘ)
Yield (% site mean)	111%	111%	110%	106%	103%	103%	97%
Maturity	Short-mid	Short-mid	Short	Short-mid	Short-mid	Short-mid	Short
Classification	AH	AH(N)	AH	AH(N)	APW	AH(N)	AH
Falling no. index	5	3*p*	3*p*	3	4	5	2
Stem rust	MRMS	MS	MRMS	S	MR	MRMS	MS
Stripe rust	MR*	MR	MRMS	MR	MS	RMR*	MRMS
Leaf rust	MSS	SVS	SVS	S	SVS	MSS	SVS
Powdery mildew	S	S*p*	S	MRMS	SVS	MSS	S
Yellow spot	MRMS	MRMS	MRMS	MRMS	MRMS	MRMS	MRMS

(N) = Denotes supplementary classification of APWN. * = Some races in eastern Australia can attack these varieties

TABLE 2 Summary of wheat variety traits comparing Scepter(Ⓘ) with CL Plus wheat varieties.

	Scepter(Ⓘ)	Chief CL Plus(Ⓘ)	Sheriff CL Plus(Ⓘ)	Razor CL Plus(Ⓘ)	Grenade CL Plus(Ⓘ)	Impress CL Plus(Ⓘ)
Yield (% site mean)	111%	102%	102%	102%	91%	88%
Maturity	Short-mid	Mid	Mid	Short-mid	Short-mid	Short-mid
Classification	AH	APW(N)	APW	ASW	APW	APW
Falling no. index	5	4	-	-	5	2
Stem rust	MRMS	MR	MS	MRMS	MR	MR
Stripe rust	MR*	S	MSS	RMR	RMR	MSS
Leaf rust	MSS	MR*	SVS	S	S	R*
Powdery mildew	S	S	S	S	MSS	SVS
Yellow spot	MRMS	MRMS	MRMS	MSS	S	MRMS

(N) = Denotes supplementary classification of APWN. * = Some races in eastern Australia can attack these varieties

TABLE 3 Summary of wheat variety traits comparing Scepter(Ⓘ) with mid-long maturity wheat varieties.

	Scepter(Ⓘ)	RockStar(Ⓘ)^	Catapult(Ⓘ)^	Kinsei(Ⓘ)	Cutlass(Ⓘ)	Magenta(Ⓘ)	LRPB Trojan(Ⓘ)	Yitpi(Ⓘ)
Yield (% site mean)	111%	111%	104%	104%	101%	99%	99%	95%
Maturity	Short-mid	Mid-long	Mid-long	Mid-long	Mid-long	Mid-long	Mid-long	Mid-long
Classification	AH	AH	AH	ANW	APW(N)	APW	APW(N)	AH
Falling no. index	5	-	-	4	4	3	5	5
Stem rust	MRMS	MR*p*	MR*p*	MS	RMR	RMR	MRMS	S
Stripe rust	MR*	RMR*p*	RMR*p*	MRMS	RMR*	MSS	MR	MRMS
Leaf rust	MSS	S*p*	S*p*	S	R*	RMR*	MR	S
Powdery mildew	S	MRMS*p*	S*p*	MSS	S	MRMS	S	MRMS
Yellow spot	MRMS	MRMS*p*	MRMS*p*	MS	MSS	(MR)	MSS	SVS

^ = Single year of NVT data. (N) = Denotes supplementary classification of APWN. * = Some races in eastern Australia can attack these varieties *p* = provisional assessment

TABLE 4 Summary of wheat variety traits comparing Scepter(Ⓘ) with noodle wheat varieties.

	Scepter(Ⓘ)	Ninja(Ⓘ)	Kinsei(Ⓘ)	Zen(Ⓘ)	Supreme(Ⓘ)	Calingiri(Ⓘ)
Yield (% site mean)	111%	107%	105%	102%	97%	95%
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	MS	S	MRMS	MSS
Stripe rust	MR*	MS	MRMS	MRMS	MR*	SVS
Leaf rust	MSS	SVS	S	S	RMR*	S
Powdery mildew	S	S	MSS	S	MSS	SVS
Yellow spot	MRMS	MRMS	MS	MRMS	MS	MSS

* = Some strains in eastern Australia can attack these varieties

spraying with label rates of Intervix®. Chief CL Plus$^{\Phi}$, Sheriff CL Plus$^{\Phi}$ and Razor CL Plus$^{\Phi}$ are competitive with Mace$^{\Phi}$ in the NVT and far out-yield previous CL Plus varieties; however, they are inferior in yield to some non-Imidazolinone resistant varieties such as Scepter$^{\Phi}$, Devil$^{\Phi}$ and Vixen$^{\Phi}$ (Table 2). Chief CL Plus$^{\Phi}$ is classified as APWN, Sheriff CL Plus$^{\Phi}$ was recently classified in WA as APW and Razor CL Plus$^{\Phi}$ is classified as ASW. With a decent overall agronomic package and APWN classification, it will be hard to see Chief CL Plus$^{\Phi}$ being displaced by Sheriff CL Plus$^{\Phi}$ or Razor CL Plus$^{\Phi}$, which have not achieved higher yields.

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

Mid-long maturity varieties

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

The benefits of their delayed maturity is realised by growers and is evident in the stability of the area sown to longer season varieties over the past five years (Figure 1). Although most NVT are sown in the second half of May, which suits short-mid and mid maturing wheats, several mid-long maturities are still yield competitive, with Cutlass$^{\Phi}$, Magenta$^{\Phi}$ LRPB Trojan$^{\Phi}$ yielding similarly to Mace$^{\Phi}$ in some environments.

The recently released AH varieties RockStar$^{\Phi}$ and Catapult$^{\Phi}$ have performed very well in the 2018 NVT, although more seasons are required to determine their yield stability. Kinsei$^{\Phi}$, an ANW released in 2018, showed superior yields to Cutlass$^{\Phi}$, Magenta$^{\Phi}$ and LRPB Trojan$^{\Phi}$ in 2017 and 2018.

Of the three newest mid-long varieties (Catapult$^{\Phi}$, RockStar$^{\Phi}$ and Kinsei$^{\Phi}$), Kinsei$^{\Phi}$ has inferior ratings to stem and stripe rust, with Catapult$^{\Phi}$ and RockStar$^{\Phi}$ both provisionally rated as moderately resistant to stem rust and resistant to moderately resistant to stripe rust. All three are susceptible to the new pathotype of leaf rust, which is inferior to Cutlass$^{\Phi}$, Magenta$^{\Phi}$ and LRPB Trojan$^{\Phi}$.

RockStar$^{\Phi}$ and Catapult$^{\Phi}$ are rated as moderately resistant to moderately susceptible to yellow spot and Kinsei$^{\Phi}$ is rated moderately susceptible. RockStar$^{\Phi}$ is provisionally rated as moderately resistant to moderately susceptible to powdery mildew while Catapult$^{\Phi}$ is provisionally susceptible like Cutlass$^{\Phi}$, LRPB Trojan$^{\Phi}$ and Scepter$^{\Phi}$. Yitpi$^{\Phi}$ is now inferior in both yield and disease package.

ANW

Ninja$^{\Phi}$ is one of the top five highest yielding milling wheats, yielding just below Scepter$^{\Phi}$ in the NVT over the past four years (Table 4). The longer maturing Kinsei$^{\Phi}$ has also performed well in 2017 and 2018 with both varieties having improved yields over all other ANW varieties. Ninja$^{\Phi}$ is marginally shorter in maturity than Zen$^{\Phi}$ and Calingiri, while Kinsei$^{\Phi}$ is slightly longer in maturity. Ninja$^{\Phi}$ is highly susceptibility to powdery mildew, stem rust and leaf rust and should be actively monitored and managed. Kinsei$^{\Phi}$'s disease ratings are marginally better than Zen$^{\Phi}$ and Ninja$^{\Phi}$, particularly for stem rust, stripe rust and powdery mildew.

Suggested sowing times

Suggested planting times for varieties have been developed (Table 5) to support variety decisions in response to sowing time preferences or opportunities. The suggestions are based on knowledge of the varieties and their performance in NVT and agronomy trials. The output was developed in consultation with breeding companies and researchers. Refer to the maturity class of a variety to assess the suggested sowing time for varieties not listed in the table. Note: spring wheats have a higher risk of yield loss if sown before late April in Western Australia.

Research findings on the flowering time of varieties relative to Mace$^{\Phi}$ can also assist with decisions on the planting order of wheat varieties. Number of days to flowering after/before Mace$^{\Phi}$ are provided in Tables 17 and 18.

GRAIN YIELD

National Variety Trials (NVT) provide an independent means of assessing varietal performance in WA. NVT results can be viewed as individual site reports or as multi-environment (MET) long-term summaries that can deliver an insight into a variety's yield performance across several environments and seasons. Tables 6–11 are outputs extracted from www.nvtonline.com.au. They provide the MET data for the six Agzones in WA between 2014 and 2018.

Visit https://app.nvtonline.com.au to assess the performance of varieties relative to the site mean at locations relevant to your business.

TABLE 5 Suggested sowing times of wheat varieties in WA.

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(Ф), Cutlass(Ф), Kinsei(Ф), LRPB Trojan(Ф), Magenta(Ф), RockStar(Ф), Yitpi(Ф), Zen(Ф), Ninja(Ф)												
Short-mid: Chief CL Plus(Ф), Corack(Ф), Devil(Ф), LRPB Cobra(Ф), LRPB Havoc(Ф), Mace(Ф), Scepter(Ф), Supreme(Ф)												
Short: Emu Rock(Ф), Vixen(Ф)												

Yellow = earlier than ideal.
Green = optimum sowing time.
Red = later than ideal but acceptable.

TABLE 6 Grain yield of wheat varieties in Agzone 1 expressed as a per cent of site mean yield for each trial year (2014–18).

Year			2014	2015	2016	2017	2018
Site mean yield (t/ha)			1.92	2.37	4.12	2.59	3.63
	Maturity	No. trials	(5)	(6)	(5)	(5)	(6)
AUSTRALIAN HARD							
Bremer(Ф)	mid	(27)	98	103	99	102	100
Catapult(Ф)	mid-long	(6)	-	-	-	-	102
Devil(Ф)#	short-mid	(11)	-	-	-	104	111
Emu Rock(Ф)	short	(27)	101	84	96	88	102
LRPB Cobra(Ф)	short-mid	(27)	100	101	101	98	100
LRPB Havoc(Ф)#	short-mid	(16)	-	-	106	97	113
Mace(Ф)#	short-mid	(27)	106	96	101	97	106
RockStar(Ф)	mid-long	(6)	-	-	-	-	109
Scepter(Ф)	short-mid	(22)	-	106	108	104	110
Tungsten(Ф)	mid-long	(16)	-	98	96	98	-
Vixen(Ф)	short	(11)	-	-	-	93	116
Yitpi(Ф)	mid-long	(27)	91	96	95	102	90
AUSTRALIAN PREMIUM WHITE							
Chief CL Plus(Ф)#	mid	(21)	105	-	101	103	104
Corack(Ф)	short-mid	(27)	107	93	101	95	108
Cutlass(Ф)#	mid-long	(22)	-	105	101	106	95
Grenade CL Plus(Ф)	short-mid	(27)	92	85	90	93	92
Hydra(Ф)	short-mid	(27)	102	104	103	102	103
Impress CL Plus(Ф)	short-mid	(27)	101	88	89	89	99
LRPB Scout(Ф)#	mid	(21)	98	97	100	98	-
LRPB Trojan(Ф)#	mid-long	(27)	96	103	101	100	96
Magenta(Ф)	mid-long	(27)	95	106	100	104	93
Sheriff CL Plus(Ф)	mid	(10)	-	-	100	102	-
Wyalkatchem(Ф)#	short-mid	(27)	102	98	98	100	101
AUSTRALIAN NOODLE WHEAT							
Calingiri	mid-long	(27)	91	100	95	104	92
Kinsei(Ф)	mid-long	(11)	-	-	-	108	102
Ninja(Ф)	mid	(22)	-	107	105	105	105
Supreme(Ф)	short-mid	(27)	99	92	97	93	98
Zen(Ф)	mid-long	(27)	101	104	102	104	103
AUSTRALIAN STANDARD WHITE							
Razor CL Plus(Ф)	short-mid	(11)	-	-	-	90	107
FEED							
Cobalt(Ф)		(16)	-	110	107	105	-
Tenfour(Ф)		(21)	105	99	106	95	-

= Denotes supplementary classification of APWN

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 7 Grain yield of wheat varieties in Agzone 2 expressed as a per cent of site mean yield for each trial year (2014–18).

Year			2014	2015	2016	2017	2018
Site mean yield (t/ha)			2.60	2.38	3.52	3.48	4.02
	Maturity	No. trials	(16)	(14)	(7)	(16)	(14)
AUSTRALIAN HARD							
Bremer(Φ)	mid	(67)	95	100	92	99	101
Catapult(Φ)	mid-long	(14)	-	-	-	-	104
Devil(Φ)#	short-mid	(30)	-	-	-	111	111
Emu Rock(Φ)	short	(67)	97	92	96	99	96
LRPB Cobra(Φ)	short-mid	(67)	101	101	101	97	97
LRPB Havoc(Φ)#	short-mid	(37)	-	-	100	108	106
Mace(Φ)#	short-mid	(67)	103	101	100	106	104
RockStar(Φ)	mid-long	(14)	-	-	-	-	113
Scepter(Φ)	short-mid	(51)	-	110	111	111	111
Tungsten(Φ)	mid-long	(37)	-	96	97	94	-
Vixen(Φ)	short	(30)	-	-	-	111	109
Yitpi(Φ)	mid-long	(67)	95	93	100	94	95
AUSTRALIAN PREMIUM WHITE							
Chief CL Plus(Φ)#	mid	(53)	102	-	96	104	103
Corack(Φ)	short-mid	(67)	102	100	99	108	105
Cutlass(Φ)#	mid-long	(51)	-	101	107	98	100
Grenade CL Plus(Φ)	short-mid	(67)	91	87	91	94	91
Harper(Φ)	mid-long	(66)	97	92	99	95	94
Hydra(Φ)	short-mid	(67)	103	104	105	102	103
Impress CL Plus(Φ)	short-mid	(67)	89	89	70	96	87
LRPB Scout(Φ)#	mid	(53)	101	98	105	97	-
LRPB Trojan(Φ)#	mid-long	(67)	100	100	103	95	96
Magenta(Φ)	mid-long	(67)	101	100	103	95	95
Sheriff CL Plus(Φ)	mid	(23)	-	-	101	104	-
Wyalkatchem(Φ)#	short-mid	(67)	100	98	95	103	100
AUSTRALIAN NOODLE WHEAT							
Calingiri	mid-long	(67)	94	95	95	95	97
Kinsei(Φ)	mid-long	(30)	-	-	-	104	108
Ninja(Φ)	mid	(51)	-	107	109	106	105
Supreme(Φ)	short-mid	(67)	98	95	98	96	95
Zen(Φ)	mid-long	(67)	99	103	98	104	106
AUSTRALIAN STANDARD WHITE							
Razor CL Plus(Φ)	short-mid	(30)	-	-	-	105	102
FEED							
Cobalt(Φ)		(38)	103	109	107	102	-

= Denotes supplementary classification of APWN

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

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TABLE 8 Grain yield of wheat varieties in Agzone 3 expressed as a per cent of site mean yield for each trial year (2014–18).

Year			2014	2015	2016	2017	2018
Site mean yield (t/ha)			4.56	3.70	3.17	4.25	2.96
	Maturity	No. trials	(5)	(6)	(3)	(4)	(3)
AUSTRALIAN HARD							
Bremer(Ф)	mid	(21)	98	99	94	97	104
Catapult(Ф)	mid-long	(3)	-	-	-	-	101
Devil(Ф)#	short-mid	(7)	-	-	-	114	111
Emu Rock(Ф)	short	(21)	94	102	95	93	97
LRPB Cobra(Ф)	short-mid	(21)	99	101	100	99	98
LRPB Havoc(Ф)#	short-mid	(10)	-	-	97	104	112
Mace(Ф)#	short-mid	(21)	102	106	99	102	104
RockStar(Ф)	mid-long	(3)	-	-	-	-	111
Scepter(Ф)	short-mid	(16)	-	109	109	113	109
Tungsten(Ф)	mid-long	(16)	-	95	96	94	91
Vixen(Ф)	short	(3)	-	-	-	-	110
Yitpi(Ф)	mid-long	(21)	97	89	102	96	90
AUSTRALIAN PREMIUM WHITE							
Chief CL Plus(Ф)#	mid	(15)	103	-	95	101	105
Corack(Ф)	short-mid	(21)	101	107	98	101	106
Cutlass(Ф)#	mid-long	(16)	-	94	108	104	96
DS Pascal(Ф)	mid-long	(10)	-	-	92	86	84
Grenade CL Plus(Ф)	short-mid	(21)	92	92	93	88	89
Harper(Ф)	mid-long	(21)	97	92	100	95	90
Hydra(Ф)	short-mid	(21)	103	102	105	105	103
Impress CL Plus(Ф)	short-mid	(15)	90	-	68	78	96
LRPB Scout(Ф)#	mid	(18)	99	97	105	100	-
LRPB Trojan(Ф)#	mid-long	(21)	99	97	103	100	96
Magenta(Ф)	mid-long	(21)	101	94	102	100	93
Sheriff CL Plus(Ф)	mid	(7)	-	-	101	102	-
Wyalkatchem(Ф)#	short-mid	(21)	101	102	94	98	101
AUSTRALIAN NOODLE WHEAT							
Calingiri(Ф)	mid-long	(21)	97	91	99	96	95
Kinsei(Ф)	mid-long	(7)	-	-	-	108	107
Ninja(Ф)	mid	(16)	-	104	107	109	104
Supreme(Ф)	short-mid	(21)	96	99	97	95	95
Zen(Ф)	mid-long	(21)	102	102	100	103	107
AUSTRALIAN STANDARD WHITE							
Razor CL Plus(Ф)	short-mid	(7)	-	-	-	100	101
FEED							
Cobalt(Ф)		(18)	104	103	109	109	-
Tenfour(Ф)		(18)	100	107	107	106	-

= Denotes supplementary classification of APWN

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 9 Grain yield of wheat varieties in Agzone 4 expressed as a per cent of site mean yield for each trial year (2014–18).

Year			2014	2015	2016	2017	2018
Site mean yield (t/ha)			1.38	2.14	3.06	2.16	3.26
	Maturity	No. trials	(9)	(8)	(4)	(9)	(9)
AUSTRALIAN HARD							
Bremer(Φ)	mid	(39)	86	98	96	97	101
Catapult(Φ)	mid-long	(9)	-	-	-	-	102
Devil(Φ)#	short-mid	(18)	-	-	-	110	111
Emu Rock(Φ)	short	(39)	111	93	100	97	100
LRPB Cobra(Φ)	short-mid	(39)	104	104	101	96	98
LRPB Havoc(Φ)#	short-mid	(22)	-	-	109	102	108
Mace(Φ)#	short-mid	(39)	107	98	104	105	105
RockStar(Φ)	mid-long	(9)	-	-	-	-	111
Scepter(Φ)	short-mid	(30)	-	107	112	112	110
Vixen(Φ)	short	(18)	-	-	-	108	112
Yitpi(Φ)	mid-long	(39)	94	94	93	98	94
AUSTRALIAN PREMIUM WHITE							
Chief CL Plus(Φ)#	mid	(31)	98	-	100	104	102
Corack(Φ)	short-mid	(39)	109	96	104	106	107
Cutlass(Φ)#	mid-long	(30)	-	102	100	102	98
Grenade CL Plus(Φ)	short-mid	(39)	98	87	90	96	92
Harper(Φ)	mid-long	(30)	-	94	94	99	94
Hydra(Φ)	short-mid	(38)	102	104	104	102	103
Impress CL Plus(Φ)	short-mid	(39)	92	87	84	93	90
LRPB Scout(Φ)#	mid	(30)	106	101	101	98	-
LRPB Trojan(Φ)#	mid-long	(39)	100	104	100	95	96
Magenta(Φ)	mid-long	(39)	99	104	97	98	93
Sheriff CL Plus(Φ)	mid	(4)	-	-	100	-	-
Wyalkatchem(Φ)#	short-mid	(39)	100	96	98	104	100
AUSTRALIAN NOODLE WHEAT							
Calingiri	mid-long	(39)	86	95	92	97	95
Kinsei(Φ)	mid-long	(18)	-	-	-	104	105
Ninja(Φ)	mid	(30)	-	106	107	108	104
Supreme(Φ)	short-mid	(39)	106	97	99	96	97
Zen(Φ)	mid-long	(39)	92	100	101	102	105
AUSTRALIAN STANDARD WHITE							
Razor CL Plus(Φ)	short-mid	(18)	-	-	-	105	105
FEED							
Cobalt(Φ)		(30)	95	108	107	99	-
Tenfour(Φ)		(30)	101	104	110	97	-

= Denotes supplementary classification of APWN

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

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TABLE 10 Grain yield of wheat varieties in Agzone 5 expressed as a per cent of site mean yield for each trial year (2014–18).

Year			2014	2015	2016	2017	2018
Site mean yield (t/ha)			2.61	3.09	2.97	3.20	2.44
	Maturity	No. trials	(6)	(6)	(3)	(5)	(4)
AUSTRALIAN HARD							
Bremer(Ф)	mid	(24)	94	97	91	92	94
Catapult(Ф)	mid-long	(4)	-	-	-	-	108
Devil(Ф)#	short-mid	(9)	-	-	-	115	115
Emu Rock(Ф)	short	(24)	98	102	96	97	99
LRPB Cobra(Ф)	short-mid	(24)	100	101	101	101	99
LRPB Havoc(Ф)#	short-mid	(12)	-	-	96	106	109
Mace(Ф)#	short-mid	(24)	103	108	100	104	107
RockStar(Ф)	mid-long	(4)	-	-	-	-	116
Scepter(Ф)	short-mid	(18)	-	114	111	115	116
Tungsten(Ф)	mid-long	(14)	-	94	98	97	-
Vixen(Ф)	short	(9)	-	-	-	115	117
Yitpi(Ф)	mid-long	(24)	98	88	103	95	93
AUSTRALIAN PREMIUM WHITE							
Chief CL Plus(Ф)#	mid	(18)	102	-	95	102	105
Corack(Ф)	short-mid	(24)	103	110	99	104	109
Cutlass(Ф)#	mid-long	(18)	-	95	109	103	100
Grenade CL Plus(Ф)	short-mid	(24)	95	89	93	90	92
Harper(Ф)	mid-long	(24)	100	92	102	97	96
Hydra(Ф)	short-mid	(24)	103	103	105	104	104
Impress CL Plus(Ф)	short-mid	(18)	89	-	67	84	92
LRPB Scout(Ф)#	mid	(20)	101	98	106	101	-
LRPB Trojan(Ф)#	mid-long	(24)	99	96	103	99	95
Magenta(Ф)	mid-long	(24)	101	94	104	101	97
Sheriff CL Plus(Ф)	mid	(8)	-	-	101	103	-
Wyalkatchem(Ф)#	short-mid	(24)	101	102	95	100	104
AUSTRALIAN NOODLE WHEAT							
Calingiri	mid-long	(24)	95	88	97	92	91
Kinsei(Ф)	mid-long	(9)	-	-	-	103	102
Ninja(Ф)	mid	(18)	-	108	109	111	110
Supreme(Ф)	short-mid	(24)	98	99	98	97	97
Zen(Ф)	mid-long	(24)	99	102	98	98	101
AUSTRALIAN STANDARD WHITE							
Razor CL Plus(Ф)	short-mid	(9)	-	-	-	105	108
FEED							
Cobalt(Ф)		(20)	100	104	106	102	-
Tenfour(Ф)		(20)	97	108	103	99	-

= Denotes supplementary classification of APWN

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 11 Grain yield of wheat varieties in Agzone 6 expressed as a per cent of site mean yield for each trial year (2014–18).

Year			2014	2015	2016	2017	2018
Site mean yield (t/ha)			2.75	4.20	4.01	4.16	3.75
	Maturity	No. trials	(3)	(3)	(2)	(1)	(2)
AUSTRALIAN HARD							
Bremer(Ф)	mid	(11)	104	99	96	94	98
Catapult(Ф)	mid-long	(2)	-	-	-	-	103
Devil(Ф)#	short-mid	(3)	-	-	-	111	110
Emu Rock(Ф)	short	(11)	90	93	95	95	93
LRPB Cobra(Ф)	short-mid	(11)	96	101	99	100	102
LRPB Havoc(Ф)#	short-mid	(5)	-	-	94	101	106
Mace(Ф)#	short-mid	(11)	104	102	99	101	100
RockStar(Ф)	mid-long	(2)	-	-	-	-	109
Scepter(Ф)	short-mid	(8)	-	114	106	111	108
Tungsten(Ф)	mid-long	(8)	-	93	96	97	97
Vixen(Ф)	short	(2)	-	-	-	-	106
Yitpi(Ф)	mid-long	(11)	92	90	105	99	95
AUSTRALIAN PREMIUM WHITE							
Chief CL Plus(Ф)#	mid	(8)	109	-	95	100	101
Corack(Ф)	short-mid	(11)	104	102	98	101	98
Cutlass(Ф)#	mid-long	(8)	-	100	108	105	102
DS Pascal(Ф)	mid-long	(5)	-	-	95	91	92
Grenade CL Plus(Ф)	short-mid	(11)	87	83	96	92	88
Harper(Ф)	mid-long	(11)	91	90	102	99	94
Hydra(Ф)	short-mid	(11)	103	106	104	104	104
Impress CL Plus(Ф)	short-mid	(8)	98	-	70	81	86
LRPB Scout(Ф)#	mid	(9)	93	98	104	102	-
LRPB Trojan(Ф)#	mid-long	(11)	94	100	102	100	102
Magenta(Ф)	mid-long	(11)	97	98	102	102	102
Sheriff CL Plus(Ф)	mid	(3)	-	-	101	102	-
Wyalkatchem(Ф)#	short-mid	(11)	104	97	95	98	97
AUSTRALIAN NOODLE WHEAT							
Calingiri	mid-long	(11)	97	92	101	96	96
Kinsei(Ф)	mid-long	(3)	-	-	-	105	105
Ninja(Ф)	mid	(5)	-	-	105	108	107
Supreme(Ф)	short-mid	(5)	-	-	97	97	96
Zen(Ф)	mid-long	(8)	-	104	101	100	101
AUSTRALIAN STANDARD WHITE							
Razor CL Plus(Ф)	short-mid	(3)	-	-	-	101	97
FEED							
Cobalt(Ф)		(9)	106	112	108	104	-
Tenfour(Ф)		(9)	100	112	106	101	-

= Denotes supplementary classification of APWN

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

DPIRD GRDC

Variety performance in early sown trials

Since 2017, NVT has conducted an 'early season' wheat series in WA. This series, along with the DPIRD trial series 'Capturing the best sowing opportunities for wheat in WA', aims to evaluate the performance of longer-maturing varieties in WA when sown early.

Early season NVT

In 2017 and 2018 the early season series was generally sown in late April. At these sowing dates the newly released Catapult[Φ] performed well in 2018, closely followed by other mid-long maturing varieties Cutlass[Φ], Kinsei[Φ] and LRPB Trojan[Φ] (Table 12). Scepter[Φ] was also included in 2018 and performed similarly to the mid-long maturing varieties. They were all higher yielding than the recently released winter wheats such as Illabo[Φ] and Longsword[Φ]. These releases are generally higher yielding than EGA Wedgetail[Φ], LRPB Kittyhawk[Φ] and Forrest[Φ]. RockStar[Φ] was not included in early sown NVT in 2017 or 2018.

DPIRD tactical wheat agronomy trials

DPIRD has conducted trials from 2015 to 2018 to determine optimum variety choice across sowing dates at multiple locations. In 2018, varieties were assessed across a broad range of sowing dates at four DPIRD sites, where irrigation was used when required to ensure timely germination. Catapult[Φ], Illabo[Φ] and RockStar[Φ] were not included in the DPIRD experiments.

At the early April sowing time in 2018, the top two yielding varieties were Ninja and Kinsei at Mullewa, LRPB Trojan[Φ] and Yitpi[Φ] at Merredin, Longsword and Kinsei[Φ] at Gibson, and LRPB Kittyhawk[Φ] and EGA Wedgetail[Φ] at the frosted Katanning site. For Anzac Day sowing, the top two yielding varieties were Kinsei[Φ] and LRPB Trojan[Φ] at Mullewa, Devil[Φ] and LRPB Havoc[Φ] at Merredin, Kinsei[Φ] and Cutlass[Φ] at Gibson, and EGA Wedgetail[Φ] and LRPB Kittyhawk[Φ] at Katanning (frosted).

Where frost was an issue, the winter wheats were the highest yielding varieties when sown in April. But overall the highest yield at the site was obtained by Cutlass[Φ], Kinsei[Φ] and Yitpi[Φ] when sown in early May. This indicates it is a better proposition to delay sowing wheat or use another crop species in frost-prone areas. Higher-yielding mid and short-mid season varieties are competitive with the mid-long varieties when sown late April to early May; however, there is more risk with frost and reduced growth and yield if earlier conditions are stressful.

Despite the early sowing dates tested, winter wheats were generally uncompetitive with spring wheats except for Longsword[Φ] at Gibson or the longer maturing types at the frosted Katanning sites. For more information on these results, as well as long term results (2015–2018) at these sites, contact Brenda Shackley at: brenda.shackley@dpird.wa.gov.au.

TABLE 12 Early season NVT in 2017 and 2018, expressed as per cent of site mean yield.

Site			York	Eneabba	Ogilvie	Ogilvie	Gibson	Bencubbin
Year			2017	2017	2017	2018	2018	2018
Sowing date			24 April	20 April	23 April	20 April	2 May	30 April
Trial mean (t/ha)			4.07	2.84	3.47	4.02	3.11	2.93
Variety (order of maturity)	Classification	Maturity						
Scepter[Φ]	AH	Short-mid	-	-	-	100	108	115
LRPB Trojan[Φ]	APWN	Mid-long	121	122	110	103	110	117
Magenta[Φ]	APW	Mid-long	114	114	103	101	104	111
Kinsei[Φ]	ANW	Mid-long	118	125	111	107	119	117
DS Pascal[Φ]	APW	Mid-long	98	110	103	109	114	108
Catapult[Φ]	AH	Mid-long	-	-	-	111	122	126
Yitpi[Φ]	AH	Mid-long	111	109	98	100	98	109
Cutlass[Φ]	APWN	Mid-long	112	117	109	106	110	114
Longsword[Φ]	Feed	Fast winter	99	103	113	98	122	88
Forrest[Φ]	ASW	Long spring	-	-	-	105	93	97
LRPB Kittyhawk[Φ]	Feed	Mid winter	79	84	97	100	104	83
EGA Wedgetail[Φ]	APW	Mid winter	78	82	97	101	100	85
Illabo[Φ]	AH	Mid winter	91	102	114	104	128	88

TABLE 13 Performance of varieties expressed as a percentage of sowing time mean yield, sown early April to early May at four DPIRD sites in 2018.

	Mullewa[1]			Merredin[2]			Gibson			Katanning[3] (frosted)		
Variety (order of maturity)	10 April	24 April	8 May	12 April	26 April	15 May	10 April	24 April	8 May	10 April	24 April	8 May
Emu Rock(Φ)	79	91	97	85	105	111	81	94	87	34	18	30
Vixen(Φ)	91	111	129	92	116	116	75	91	96	23	53	41
Devil(Φ)	107	113	128	93	126	127	88	107	111	10	73	104
LRPB Havoc(Φ)	99	107	117	91	124	124	76	91	102	13	7	32
Mace(Φ)	96	98	108	100	113	110	86	94	96	16	44	78
Scepter(Φ)	106	107	111	114	121	128	99	109	100	10	34	108
Chief CL Plus(Φ)	113	104	109	101	102	108	73	76	92	28	46	83
Ninja(Φ)	129	115	111	95	118	107	106	105	115	23	50	101
Zen(Φ)	105	104	111	111	122	121	85	93	97	16	53	92
LRPB Trojan(Φ)	116	116	121	129	109	99	99	102	104	23	80	104
Magenta(Φ)	104	111	108	101	98	103	108	107	102	45	79	107
Kinsei(Φ)	125	121	109	115	111	123	117	115	115	38	81	135
DS Pascal(Φ)	115	110	104	95	83	92	110	100	106	95	120	107
Yitpi(Φ)	95	98	96	117	111	118	104	93	100	79	160	133
Cutlass(Φ)	104	110	110	114	110	117	115	115	115	69	118	130
Longsword(Φ)	85	87	71	106	80	77	125	108	108	48	78	92
Forrest(Φ)	88	93	94	92	60	73	110	95	81	263	125	91
LRPB Kittyhawk(Φ)	94	81	67	90	92	79	93	95	83	303	164	120
EGA Wedgetail(Φ)	70	63	53	79	66	51	99	96	82	299	174	104
Mean yield (t/ha)	2.78	2.76	2.79	2.78	3.03	2.90	3.94	4.69	4.79	0.80	1.55	2.32
lsd (%) within TOS	10			20			11			29		

1. To ensure germination 21mm of irrigation was applied prior to each seeding.
2. A total of 50mm was applied to the trial in 10mm allotments across the sowing period, some establishment issues with April sowings.
3. A total of 10mm was applied before and after seeding.

DPIRD GRDC

DISEASE RESISTANCE

Plan ahead:

- 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. Do not 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 the disease resistance of each variety (Table 16). Higher resistance ratings reduce disease severity and subsequent yield losses. Avoiding susceptible or very susceptible varieties, where possible, 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 that is usually carried over from last season; favourable weather conditions; 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 soil borne** (Table 14).

TABLE 14 Examples of wheat diseases carried over from different inoculum sources.

Inoculum carryover source	Disease
Infested stubble or trash	Yellow spot, nodorum blotch (syn. 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

TABLE 15 Suggested minimum resistance for wheat varieties in different disease risk areas to common 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 taking into account factors such as disease history in previous years, presence and amount of primary inoculum and prevailing weather conditions (temperature, rainfall and relative humidity).

Choose your variety for each paddock based on its disease 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(ϕ), which is rated susceptible to very susceptible to yellow spot, onto wheat stubble.

Planning ahead and understanding the disease strengths and weaknesses of your variety will allow for more effective disease management during the season. For example, Scepter(ϕ) is susceptible to powdery mildew. In a season or environment conducive to powdery mildew it may be prudent to use a seed dressing or in-furrow fungicide and to proactively monitor for the presence of disease to ensure a rapid and appropriate response if disease is detected.

Diversification of varieties reduces the risk of whole farm infection requiring management at the same time in the case of disease outbreaks. 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 16) are for the pathotype that was an incursion in WA in 2015 (104-1,3,4,6,7,8,10,12 +Lr37). These are based on 2017 eastern states' consensus ratings and on testing done on inoculated nurseries at Carnarvon in 2018.

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 where a more virulent isolate occurs.

For more information

- Crop diseases – forecasts and management at www.agric.wa.gov.au/n/2319
- Wheat disease ratings at www.agric.wa.gov.au
- Download the Australian Field Crop Disease Guide app

TABLE 16 Disease resistance ratings for wheat varieties grown in Western Australia.

Variety	Grade	Nodorum blotch	Septoria tritici blotch	Yellow spot	Rust			Powdery mildew	Flag smut	Common bunt	Root lesion nematodes		CCN	Crown rot
					Stem	Stripe	Leaf				*P. quasitereoides*	*P. neglectus*		
Arrino	ANW	MS	MSS	MS	VS	MSS	VS	MRMS	MSS	MS	S	S	–	–
Bremer(Φ)	AH	MS	S	MSS	MR	MR*	MR*	S	MSS	RMR	–	SVS	MRMS	S
Calingiri	ANW	MSS	MSS	MSS	MSS	SVS	S	SVS	RMR	MRMS	S	SVS	–	S
Carnamah	APW	MSS	SVS	MSS	MRMS	SVS	MSS	S	MSS	MS	SVS	VS	S	–
Catapult(Φ)	tbd	–	–	MRMS*p*	MR*p*	RMR*p*	S*p*	S*p*	–	–	–	–	–	–
Chief CL Plus(Φ)	APW	MS	S	MRMS	MR	S	MR*	S	SVS	MR*p*	–	MRMS	–	MSS
Clearfield WHT STL(Φ)	APW	MRMS	MSS	S	MR	MSS	VS	S	MS	MS	–	S	–	–
Corack(Φ)	APW	MSS	S	MRMS	MR	MS	SVS	SVS	MRMS	MSS	MSS	MSS	RMR	S
Cutlass(Φ)	APW	MRMS	MSS	MSS	RMR	RMR*	R*	S	MS	S	–	MSS	MSS	S
Devil(Φ)	AH	MS*p*	S*p*	MRMS	MS	MR	SVS	S*p*	SVS	R*p*	–	S	–	MSS*p*
DS Pascal(Φ)	APW	MRMS	MS	MS	MSS	RMR	MS	RMR	S	SVS	–	S	MS	S
EGA Bonnie Rock(Φ)	AH	MSS	S	MRMS	MSS	VS	SVS	S	S	MS	S	SVS	S	–
EGA Eagle Rock(Φ)	AH	MRMS	MSS	MSS	MRMS	MS	MR	MSS	S	MRMS	S	S	S	–
EGA Wedgetail(Φ)	APW	MRMS	MSS	MSS	MRMS	MS	S	–	–	–	–	–	–	–
Emu Rock(Φ)	AH	SVS	S	MRMS	MS	MRMS	SVS	S	R	S	MS	MSS	S	MSS
Fortune(Φ)	ANW	MS	MS	MRMS	MS	MRMS	MRMS	MS	R	MR	S*p*	S	–	S
Grenade CL Plus(Φ)	APW	MSS	S	S	MR	RMR	S	MSS	MR	SVS	–	MSS	R	S
Harper(Φ)	APW	MS	MSS	MSS	MS	RMR	S	MSS	RMR	MSS	–	S	MRMS	S
Hydra(Φ)	APW	MSS	MS	MRMS	MS	MS	SVS	S	VS	VS	–	S	S	S
Illabo(Φ)	AH	MR	MR	MS	MS	RMR	S	RMR	R	MS	–	S	MS	S*p*
Impress CL Plus(Φ)	APW	MSS	MSS	MRMS	MR	MSS	R*	SVS	MSS	RMR	–	MRMS	MS	S
Justica CL Plus(Φ)	APW	MRMS	S	SVS	MR	RMR*	SVS	MSS	RMR	VS	S*p*	S	MS	S
King Rock(Φ)	AH	MSS	S	MRMS	MSS	RMR*	S	S	SVS	MSS	–	MSS	MS	S
Kinsei(Φ)	ANW	MRMS*p*	SVS*p*	MS	MS	MRMS	S	MSS	RMR	RMR*p*	–	S	–	MSS*p*
Longsword(Φ)	Feed	MR	MRMS	MRMS	MR	RMR	MSS	MRMS	R	RMR	–	MRMS	–	S
LRPB Cobra(Φ)	AH	MRMS	MSS	MRMS	MR	MSS	MR	MSS	MS	SVS	MS	MSS	MS	S
LRPB Havoc(Φ)	AH	MS	MRMS	MRMS	S	MR	S	MRMS	MS	R	–	S	–	S
LRPB Trojan(Φ)	APW	MS	MSS	MSS	MRMS	MR	MR	S	SVS	SVS	MRMS*p*	MSS	MS	MS
Mace(Φ)	AH	MS	S	MRMS	MRMS	RMR*	MSS	MSS	S	MR	MRMS	MS	MRMS	S
Magenta(Φ)	APW	MRMS	MRMS	MR	RMR	MSS	RMR*	MRMS	MSS	S	MSS	MSS	S	MSS
Ninja(Φ)	ANW	MRMS	MSS	MRMS	SVS	MS	SVS	S	MR	RMR	–	S	MS	S
Razor CL Plus(Φ)	ASW	MS	SVS	MSS	MRMS	RMR	S	S	R	RMR	–	S	–	S
RockStar(Φ)	tbd	–	–	MRMS*p*	MR*p*	RMR*p*	S*p*	MRMS*p*	–	–	–	–	–	–
Scepter(Φ)	AH	MRMS	S	MRMS	MRMS	MR*	MSS	S	MSS	MSS	MS*p*	S	MRMS	S
Sheriff CL Plus(Φ)	APW	MSS	S	MRMS	MS	MSS	SVS	S	S	RMR	–	MRMS	–	S*p*
Stiletto	APW	MS	MSS	S	RMR	MSS	VS	MSS	MS	MS	MRMS	MS	S	–
Supreme(Φ)	ANW	S	MSS	MS	MRMS	MR*	RMR*	MSS	MSS	SVS	–	MSS	S	MSS
Tungsten(Φ)	AH	MS	MSS	MSS	MSS	RMR	MS	MSS	MR	S	–	MSS	–	S
Vixen(Φ)	AH	S	MSS	MRMS	MRMS	MRMS	SVS	S	SVS	RMR	–	MRMS	–	S
Westonia	APW	MS	SVS	MS	VS	VS	MS	SVS	SVS	S	S	SVS	S	S*p*
Wyalkatchem(Φ)	APW	MSS	S	MR	MSS	S	S	SVS	SVS	RMR	MSS	MRMS	S	S
Yitpi(Φ)	AH	MS	MRMS	SVS	S	MRMS	S	MRMS	MR	S	MS	MSS	MR	S
Zen(Φ)	ANW	MRMS	S	MRMS	S	MRMS	S	S	MS	MR	–	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. These include races with Yr17 virulence for stripe rust and races with Lr24 virulence for leaf rust. 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.

TABLE 17 Number of days to flowering compared with Mace(Ф) on selected NVT trials in 2016, 2017 and 2018.

Variety	Maturity	2016	2017	2018	Average
Emu Rock(Ф)	Short	-7	-7	-9	**-8**
Vixen(Ф)	Short	-	-	-7	**-7**
Supreme(Ф)	Short-mid	-1	0	-3	**-1**
Razor CL Plus(Ф)	Short-mid	-	-	-1	**-1**
Grenade CL Plus(Ф)	Short-mid	1	2	-1	**0**
Hydra(Ф)	Short-mid	0	-1	-1	**-1**
Corack(Ф)	Short-mid	-3	-2	-1	**-2**
Impress CL Plus(Ф)	Short-mid	-1	1	-1	**0**
Devil(Ф)	Short-mid	-	-	-1	**-1**
LRPB Havoc(Ф)	Short-mid	-1	1	0	**0**
LRPB Cobra(Ф)	Short-mid	-1	0	0	**0**
Mace(Ф)	Short-mid	0	0	0	**0**
Wyalkatchem(Ф)	Short-mid	2	2	0	**1**
Scepter(Ф)	Short-mid	3	2	1	**2**
Chief CL Plus(Ф)	Mid	0	4	3	**2**
Sheriff CL Plus(Ф)	Mid	5	3	-	**4**
Ninja(Ф)	Mid	6	1	4	**4**
Bremer(Ф)	Mid	4	6	5	**5**
RockStar(Ф)	Mid-long	-	-	5	**5**
Calingiri	Mid-long	7	6	5	**6**
LRPB Trojan(Ф)	Mid-long	7	5	5	**6**
Zen(Ф)	Mid-long	7	5	5	**6**
Kinsei(Ф)	Mid-long	-	5	7	**6**
Harper(Ф)	Mid-long	9	6	5	**6**
Magenta(Ф)	Mid-long	9	5	7	**7**
Tungsten(Ф)	Mid-long	9	7	8	**8**
DS Pascal(Ф)	Mid-long	12	8	7	**9**
Catapult(Ф)	Mid-long	-	-	8	**8**
Yitpi(Ф)	Mid-long	11	7	9	**9**
Cutlass(Ф)	Mid-long	14	9	10	**11**

TABLE 18 Number of days to flowering compared with Mace(Ф) for selected varieties over five sowing dates, averaged from four DPIRD sites in 2018.

Variety	Maturity	Sowing time				
		10 Apr	24 Apr	8 May	22 May	20 June
Emu Rock(Ф)	Short	-12	-13	-12	-7	-3
Vixen(Ф)	Short	-15	-11	-10	-6	-2
Devil(Ф)	Short-mid	-8	-5	-3	-1	-1
LRBP Havoc(Ф)	Short-mid	-4	-7	-3	-1	-2
Mace(Ф)	Short-mid	0	0	0	0	0
Scepter(Ф)	Short-mid	3	1	3	2	1
Chief CL Plus(Ф)	Mid	7	3	4	4	3
Ninja(Ф)	Mid	11	6	6	4	3
Zen(Ф)	Mid-long	10	7	7	4	4
Magenta(Ф)	Mid-long	10	6	7	6	7
LRPB Trojan(Ф)	Mid-long	15	10	5	4	3
Kinsei(Ф)	Mid-long	16	11	10	6	5
DS Pascal(Ф)	Mid-long	21	17	11	8	7
Yitpi(Ф)	Mid-long	21	17	11	7	6
Cutlass(Ф)	Mid-long	26	20	13	10	6
Longsword(Ф)	Fast winter	57	36	21	15	8
Forrest(Ф)	Long	59	37	26	19	10
LRPB Kittyhawk(Ф)	Mid winter	65	39	28	20	13
EGA Wedgetail(Ф)	Mid winter	65	43	28	21	15

VARIETY TRAITS

Maturity

The majority of wheat varieties grown in WA have a very low response to vernalisation (an accumulation of cold temperatures) and photoperiod (a response to daylength), making them suitable for mid-May sowings. Varieties with a higher response to vernalisation (such as Magenta(Ф)) or photoperiod (such as Yitpi(Ф)) can be sown from late April as their maturity is delayed. Varieties are broadly classified into maturity categories of short, short-mid, mid and mid-long in WA based on their duration to flowering. There are longer-maturing spring wheats and winter wheats, but these are not commonly grown in WA.

Mace(Ф) is classified as short-mid maturity and Table 17 shows how other varieties compare over selected NVT locations between 2016 and 2018 sown mid to late May. In many cases, sowing spring wheats into April results 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 April sowing in WA, primarily due to their vernalisation requirement. Table 18 is a summary of DPIRD's experiments in 2018 with sowing times ranging from early April to mid June, showing the large spread in the number of days to flowering after Mace(Ф) that mid-long to mid-winter wheats can provide, particularly when sown in April and early May.

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 as the genetic control of flowering is complex.

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 will have inherently different coleoptile lengths and this is also affected by seed size with larger seeds increasing the coleoptile length. An index value for coleoptile length (Table 19) replaces reporting of a variety's 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$^{\Phi}$ (7.3), Harper$^{\Phi}$ (8.1), Magenta$^{\Phi}$ (7.5), Scout$^{\Phi}$ (7.3) and Yitpi$^{\Phi}$ (7.8).
- If dry seeding, increase the seed rate as there is the risk of staggered emergence with a false break.
- The impact of deep sowing on grain yield depends on growing season conditions and whether low crop 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; ensure depth is monitored as conditions change.
- Sowing deeper than 5cm where the 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 the guide. Details can be found at www.nvtonline.com.au.

TABLE 19 Black point ratings, falling number index and coleoptile index for wheat in 2020.

Variety	Black point	Falling number index	Coleoptile index (cm)
Arrino	MS	2	6.8
Bremer$^{\Phi}$	MRMS	5	6.8
Calingiri	MS	4	6.4
Carnamah	MS	2	7.4
Chief CL Plus$^{\Phi}$	MS	4	-
Clearfield WHT STL$^{\Phi}$	MRMS	6	6.8
Corack$^{\Phi}$	S	4	6.8
Cutlass$^{\Phi}$	MS	4	7.3
Devil$^{\Phi}$	MSS	3*p*	-
DS Pascal$^{\Phi}$	MS	7	6
EGA Bonnie Rock$^{\Phi}$	MR	4	6.6
EGA Eagle Rock$^{\Phi}$	MS	6	-
Emu Rock$^{\Phi}$	MSS	2	6.5
Fortune$^{\Phi}$	MS	2	6.4
Grenade CL Plus$^{\Phi}$	MSS	5	6.6
Harper$^{\Phi}$	MRMS	5	8.1
Hydra$^{\Phi}$	MS	3	6.9
Illabo$^{\Phi}$	MRMS	-	-
Impress CL Plus$^{\Phi}$	S	2	6.8
Justica CL Plus$^{\Phi}$	MSS	5	6.7
King Rock$^{\Phi}$	MRMS	4	6.3
Kinsei$^{\Phi}$	MSS	4	-
LRPB Cobra$^{\Phi}$	MSS	2	6.6
LRPB Havoc$^{\Phi}$	MS	3	-
LRPB Trojan$^{\Phi}$	MS	5	-
Mace$^{\Phi}$	MRMS	5	6.9
Magenta$^{\Phi}$	MSS	3	7.5
Ninja$^{\Phi}$	MRMS	4	-
Razor CL Plus$^{\Phi}$	MS	5	-
Scepter$^{\Phi}$	MS	5	6.6
Sheriff CL Plus$^{\Phi}$	MRMS	-	-
Supreme$^{\Phi}$	MSS	4	5.7
Tungsten$^{\Phi}$	MRMS	2	6.3
Vixen$^{\Phi}$	MS	3*p*	-
Westonia	MS	2	7
Wyalkatchem$^{\Phi}$	MS	3	6.4
Yitpi$^{\Phi}$	MS	5	7.8
Zen$^{\Phi}$	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 Hugh Wallwork at the Field Crop Pathology Unit (SARDI).

Falling number index

The falling number index (FNI) is a system of ratings that reflects the risk of a wheat variety exhibiting a low falling number at harvest (Table 19). The risk of a variety exhibiting a low falling number is associated with complex variety and environment interactions. 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. A wheat crop's risk of sprouting is affected by the variety's resistance to sprouting (including grain dormancy), the grains' maturity, and environmental conditions during growth and grain-filling stages, which all influence the overall impact of any rainfall that does occur.

Since 2013, DPIRD has conducted experiments* to 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.

DPIRD GRDC

The falling number index* is designed to inform growers of the relative differences between wheat varieties in their risk of exhibiting a low falling number at harvest. A higher FNI reflects a lower risk of downgrading.

The pre-harvest sprouting (PHS) tolerance of Mace(ф) has enabled its widespread adoption across WA, even into areas of high PHS risk; this is reflected in its FNI of 5. A variety with a FNI of less than 4 is not recommended for sowing into high-risk areas (such as the south coast), while the recently released DS Pascal(ф) has leading pre-harvest sprouting tolerance as reflected in its FNI of 7.

* Outcome of the co-investment by DPIRD and GRDC in the Tactical Wheat Agronomy Project (DAW00249)

VARIETY SNAPSHOTS

Variety snapshots are presented for 22 varieties. Varieties are presented in order of classification.

Each snapshot includes a general comment describing essential characteristics of the variety and highlighting key strengths and weaknesses. Grain yields relative to Mace(ф) for each year between 2014 and 2018 for each Agzone are presented. The data was extracted from www.nvtonline.com.au and disease ratings are sourced from Table 16.

Flowering information is sourced from DPIRD experiments in 2018 and NVT trials where data was not available from the DPIRD experiments and presented relative to Mace(ф).

Crown rot yield loss information was provided by Daniel Huberli, Miriam Connor and Kris Gajda from DPIRD with GRDC investment. Ratings were collected and provided as weighted yield loss to Fusarium crown rot in inoculated trials at Merredin and Wongan Hills between 2014–2016.

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

If you are seeking information for any varieties not included in the snapshots please consult www.varietycentral.com.au, www.nvtonline.com.au and breeding companies for the information.

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CHIEF CL PLUS(ᵖ)

APW(N)

Comments

Chief CL Plus(ᵖ) is an APW imidazolinone tolerant variety that was released in 2016. This variety was the highest-yielding APW imidazolinone tolerant variety in its four years of NVT data with yields that were competitive with Mace(ᵖ). Chief CL Plus(ᵖ) is resistant to both pathotypes of leaf rust, but susceptible to the Lr24 virulent pathotype that is not present in WA (*). Registered for label rate applications of Intervix® herbicide. Note: There are no grower-to-grower sales permitted for any CL Plus varieties.

Yield (% of Mace(ᵖ))	2014	2015	2016	2017	2018
Agzone 1	99	-	100	106	98
Agzone 2	99	-	96	98	99
Agzone 3	101	-	96	99	101
Agzone 4	92	-	96	99	97
Agzone 5	99	-	95	98	98
Agzone 6	105	-	96	99	101

Disease resistance	Adult rating
Nodorum blotch	MS
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*p*
RLN (*P. quasitereoides*)	-
RLN (*P. neglectus*)	MRMS
CCN	-
Crown rot	MSS

Flowering 2017 & 2018 DPIRD trials	Days after/before Mace(ᵖ)				
	11 Apr	25 Apr	8 May	24 May	20 Jun
Mullewa	+15	+7	+8	+7	+5
Merredin	+8	+0	+0	+1	+2
Katanning	+4	+2	+2	+2	+3
Gibson	+3	+7	+8	+4	+5

Agronomic traits	
Coleoptile length (cm)	-
Crown rot yield loss	-
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, exc. GST)	$4.25

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

* = Some races in eastern Australia can attack these varieties.

CORACK(ᵖ)

APW

Comments

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

Yield (% of Mace(ᵖ))	2014	2015	2016	2017	2018
Agzone 1	101	97	100	98	102
Agzone 2	99	99	99	102	101
Agzone 3	99	101	99	99	102
Agzone 4	102	98	100	101	102
Agzone 5	100	102	99	100	102
Agzone 6	100	100	99	100	98

Disease resistance	Adult rating
Nodorum blotch	MSS
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 Mace
2016 (av sowing date 8 May)	-3
2017 (av sowing date 24 May)	-2
2018 (av sowing date 28 May)	-1
Average	-2

Agronomic traits	
Coleoptile length (cm)	6.8
Crown rot yield loss	Moderate (10-20%)
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 s haring
EPR ($/t, excl GST)	$3.00

DPIRD GRDC

CUTLASS(Φ)

APW(N)

Comments

Cutlass(Φ) is a variety that provides growers with a longer-season APW option. Over the last three years, Cutlass(Φ) has outyielded Yitpi(Φ), another longer-maturing variety commonly grown in WA, and has yielded similar to Mace(Φ) in the NVT. Cutlass(Φ) has a very useful triple rust resistance rating, MSS to yellow spot and a poor powdery mildew rating (compared with Yitpi(Φ)'s SVS). DPIRD lead research has found that Cutlass(Φ) has less tolerance to sprouting than Yitpi(Φ).

Yield (% of Mace(Φ))	2014	2015	2016	2017	2018
Agzone 1	-	109	100	109	90
Agzone 2	-	100	107	92	96
Agzone 3	-	89	109	102	92
Agzone 4	-	104	96	97	93
Agzone 5	-	88	109	99	93
Agzone 6	-	98	109	104	102

Disease resistance	Adult rating
S. nodorum blotch	MRMS
S. tritici blotch	MSS
Yellow spot	MSS
Stem rust	RMR*
Stripe rust	RMR*
Leaf rust	R*
Powdery mildew	S
Flag smut	MS
Common bunt	S
RLN (*P. quasitereoides*)	-
RLN (*P. neglectus*)	MSS
CCN	MSS
Crown rot	S

Flowering 2017 & 2018 DPIRD trials	Days after/before Mace(Φ)				
	11 Apr	25 Apr	8 May	24 May	20 Jun
Mullewa	+22	+16	+15	+11	+8
Merredin	+19	+12	+5	+8	+6
Katanning	+20	+14	+6	+7	+8
Gibson	+29	+22	+18	+13	+10

Agronomic traits	
Coleoptile length (cm)	7.3
Crown rot yield loss	-
Black point	MS
Falling number index	4
Maturity	Mid-long

Variety information	
Pedigree	RAC1316/2*Fang
Breeder/seed licensee	AGT
Access to seed	AGT affiliates, retailers, or seed sharing
EPR ($/t, exc. GST)	$3.00

(N) denotes the supplementary classification of APWN

* = Some races in eastern Australia can attack these varieties.

DS PASCAL(Φ)

APW

Comments

DS Pascal(Φ) is a mid-long maturing APW wheat variety. The outstanding characteristic of DS Pascal(Φ) is its ability to maintain falling numbers after pre-harvest rain. It was the best performing variety in DPIRD's falling number index testing from 2014 to 2018. DS Pascal(Φ) is resistant to powdery mildew, moderately susceptible to leaf rust and resistant to moderately resistant to stripe rust. It was included in the 2016, 2017 and 2018 NVT in Agzone 3 and 6, but it generally yielded lower than Mace(Φ) and is susceptible to crown rot. Despite DS Pascal(Φ)'s generally lower yields, it may have a fit where sprouting and powdery mildew are an issue.

Yield (% of Mace(Φ))	2014	2015	2016	2017	2018
Agzone 1	-	-	-	-	-
Agzone 2	-	-	-	-	-
Agzone 3	-	-	93	84	81
Agzone 4	-	-	-	-	-
Agzone 5	-	-	-	-	-
Agzone 6	-	-	96	90	92

Disease resistance	Adult rating
Nodorum blotch	MRMS
S. tritici blotch	MS
Yellow spot	MS
Stem rust	MSS
Stripe rust	RMR
Leaf rust	MS
Powdery mildew	RMR
Flag smut	S
Common bunt	SVS
RLN (*P. quasitereoides*)	-
RLN (*P. neglectus*)	S
CCN	MS
Crown rot	*S*

Flowering 2017 & 2018 DPIRD trials	Days after/before Mace(Φ)				
	11 Apr	25 Apr	8 May	24 May	20 Jun
Mullewa	+21	+13	+15	+11	+5
Merredin	+19	+9	+3	+6	+7
Katanning	+17	+12	+7	+9	+10
Gibson	+20	+18	+15	+11	+10

Agronomic traits	
Coleoptile length (cm)	6.0
Crown rot yield loss	-
Black point	MS
Falling number index	7
Maturity	Mid-long

Variety information	
Pedigree	FAWWON105/CFR00-687-55
Breeder/seed licensee	Seednet/DOW Seeds
Access to seed	Seed retailers
EPR ($/t, exc. GST)	$4.25

LRPB TROJAN$^{\Phi}$

APW(N)

Comments

Trojan$^{\Phi}$ is an APW variety with a mid-long maturity. Trojan$^{\Phi}$ has a falling number rating with pre-harvest rain of 5, which is similar to Mace$^{\Phi}$. Trojan has a useful black point rating and is moderately resistant to both leaf rust strains and to stripe rust, but is susceptible to powdery mildew and moderately susceptible to susceptible to yellow spot.

Yield (% of Mace$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	91	107	100	103	91
Agzone 2	97	99	103	90	92
Agzone 3	97	92	104	98	92
Agzone 4	93	106	96	90	91
Agzone 5	96	89	103	95	89
Agzone 6	90	98	103	99	102
Disease resistance	**Adult rating**				
Nodorum blotch	MS				
S. tritici blotch	MSS				
Yellow spot	MSS				
Stem rust	MRMS				
Stripe rust	MR				
Leaf rust	MR				
Powdery mildew	S				
Flag smut	SVS				
Common bunt	S				
RLN (*P. quasitereoides*)	MRMS*p*				
RLN (*P. neglectus*)	MSS				
CCN	MS				
Crown rot	MS				
Flowering 2017 & 2018 DPIRD trials	**Days after/before Mace$^{\Phi}$**				
	11 Apr	**25 Apr**	**8 May**	**24 May**	**20 Jun**
Mullewa	+14	+11	+12	+6	+2
Merredin	+9	+4	+1	+3	+3
Katanning	+17	+9	+5	+6	+8
Gibson	+14	+12	+11	+6	+7
Agronomic traits					
Coleoptile length (cm)	-				
Crown rot yield loss	Moderate (10-20%)				
Black point	MS				
Falling number index	5				
Maturity	Mid-long				
Variety information					
Pedigree	LPB 00LR000041/Sentinel3R				
Breeder/seed licensee	LongReach Plant Breeders				
Access to seed	Free to trade grower to grower				
EPR ($/t, exc. GST)	$4.00				

p = provisional assessment.

MAGENTA$^{\Phi}$

APW

Comments

Magenta$^{\Phi}$ is an APW variety suitable for early to mid sowing opportunities. This variety has a good disease package so it is suitable for wheat-on-wheat situations and has a longer coleoptile. Magenta$^{\Phi}$ has a low falling number index and is susceptible to black point, so is not suited to the south coast or areas that experience pre-harvest rainfall.

Yield (% of Mace$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	90	110	99	107	88
Agzone 2	98	99	103	90	91
Agzone 3	99	89	103	98	89
Agzone 4	93	106	93	93	89
Agzone 5	98	87	104	97	91
Agzone 6	93	96	103	101	102
Disease resistance	**Adult rating**				
Nodorum blotch	MRMS				
S. tritici blotch	MRMS				
Yellow spot	MR				
Stem rust	RMR				
Stripe rust	MS				
Leaf rust	RMR*				
Powdery mildew	MRMS				
Flag smut	MSS				
Common bunt	S				
RLN (*P. quasitereoides*)	MSS				
RLN (*P. neglectus*)	MSS				
CCN	S				
Crown rot	MSS				
Flowering 2017 & 2018 DPIRD trials	**Days after/before Mace$^{\Phi}$**				
	11 Apr	**25 Apr**	**8 May**	**24 May**	**20 Jun**
Mullewa	+14	+11	+10	+8	+6
Merredin	+16	+7	+2	+9	+7
Katanning	+10	+10	+5	+8	+10
Gibson	na	na	na	na	na
Agronomic traits					
Coleoptile length (cm)	7.5				
Crown rot yield loss	High (>20%)				
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				

* = Some races in eastern Australia can attack these varieties.

DPIRD GRDC

WYALKATCHEM(Φ)

APW(N)

Comments

Wyalkatchem(Φ) is an APW variety with a Machete background. This variety has good resistance to yellow spot. Wyalkatchem(Φ) has tolerance to acidic soils and low screenings. It is susceptible to very susceptible to powdery mildew, susceptible to stripe and leaf rust and has a low falling number index rating. Now superceded by Scepter(Φ).

Yield (% of Mace(Φ))	2014	2015	2016	2017	2018
Agzone 1	96	102	97	103	95
Agzone 2	97	97	95	97	96
Agzone 3	99	96	95	96	97
Agzone 4	93	98	94	99	95
Agzone 5	98	94	95	96	97
Agzone 6	100	95	96	97	97

Disease resistance	Adult rating
Nodorum blotch	MSS
S. tritici blotch	S
Yellow spot	MR
Stem rust	MS
Stripe rust	S
Leaf rust	S
Powdery mildew	SVS
Flag smut	SVS
Common bunt	RMR
RLN (*P. quasitereoides*)	MSS
RLN (*P. neglectus*)	MRMS
CCN	S
Crown rot	S

Flowering selected NVT trials	Days after/before Mace(Φ)
2016 (av sowing date 8 May)	+2
2017 (av sowing date 24 May)	+2
2018 (av sowing date 28 May)	+0
Average	+1

Agronomic traits	
Coleoptile length (cm)	6.4
Crown rot yield loss	High (>20%)
Black point	MS
Falling number index	3
Maturity	Short-mid

Variety information	
Pedigree	Machete/W84-129*504
Breeder/seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, exc. GST)	$1.92

p = provisional assessment.

CATAPULT(Φ)

AH

Comments

Catapult(Φ) is a mid-long maturing AH variety released by AGT in 2019. Catapult(Φ) was included in the NVT for the first time in 2018, yielding higher than alternatives such as Cutlass(Φ), LRPB Trojan(Φ) and Magenta(Φ), but lower than Scepter(Φ) in the main season trials. In the 2018 early season NVT trials Catapult(Φ) was the highest yielding variety, highlighting its suitability for plantings towards the end of April. Catapult(Φ) is susceptible to leaf rust and powdery mildew.

Yield (% of Mace(Φ))	2014	2015	2016	2017	2018
Agzone 1	-	-	-	-	96
Agzone 2	-	-	-	-	100
Agzone 3	-	-	-	-	97
Agzone 4	-	-	-	-	97
Agzone 5	-	-	-	-	101
Agzone 6	-	-	-	-	103

Disease resistance	Adult rating
Nodorum blotch	-
S. tritici blotch	-
Yellow spot	MRMS*p*
Stem rust	MR*p*
Stripe rust	RMR*p*
Leaf rust	S*p*
Powdery mildew	S*p*
Flag smut	-
Common bunt	-
RLN (*P. quasitereoides*)	-
RLN (*P. neglectus*)	-
CCN	-
Crown rot	-

Flowering selected NVT trials	Days after/before Mace(Φ)
2016 (av sowing date 8 May)	-
2017 (av sowing date 24 May)	-
2018 (av sowing date 28 May)	+8

Agronomic traits	
Coleoptile length (cm)	-
Crown rot yield loss	-
Black point	-
Falling number index	-
Maturity	Mid-long

Variety information	
Pedigree	Mace/Corack
Breeder/seed licensee	AGT
Access to seed	AGT affiliates, retailers, or seed sharing
EPR ($/t, exc. GST)	$3.25

p = provisional assessment.

DEVIL$^{\Phi}$

AH(N)

Comments

Devil$^{\Phi}$ is a short-mid maturity AH (N) that was released in 2018. Devil$^{\Phi}$ was first included in the 2017 NVT and with two years of data its yields are very similar to Scepter$^{\Phi}$. Devil$^{\Phi}$ is susceptible to very susceptible to the latest leaf rust pathotype compared with Scepter$^{\Phi}$ as moderately susceptible to susceptible. For mid May sowings, Devil$^{\Phi}$ is similar to Mace$^{\Phi}$; however, has been observed to be faster when sown much earlier, especially in warmer conditions. It has a provisional falling number rating of 3 so is not recommended for areas prone to pre-harvest sprouting.

Yield (% of Mace$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	-	-	-	107	105
Agzone 2	-	-	-	105	107
Agzone 3	-	-	-	112	107
Agzone 4	-	-	-	105	106
Agzone 5	-	-	-	111	107
Agzone 6	-	-	-	110	110

Disease resistance	Adult rating
Nodorum blotch	MS*p*
S. tritici blotch	S*p*
Yellow spot	MRMS
Stem rust	MS
Stripe rust	MR
Leaf rust	SVS
Powdery mildew	S*p*
Flag smut	SVS
Common bunt	R*p*
RLN (*P. quasitereoides*)	-
RLN (*P. neglectus*)	S
CCN	-
Crown rot	MS*p*

Flowering 2018 DPIRD trials	Days after/before Mace$^{\Phi}$				
	10 Apr	24 Apr	08 May	22 May	21 Jun
Mullewa	-16	-3	-6	-1	-2
Merredin	-8	-9	-3	+0	-1
Katanning	-2	-6	-1	-1	+1
Gibson	-6	-4	-1	-1	+0

Agronomic traits	
Coleoptile length (cm)	-
Crown rot yield loss	-
Black point	MSS
Falling number index	3*p*
Maturity	Short-mid

Variety information	
Pedigree	IGW3110/Mace
Breeder/seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, exc. GST)	$3.50

EMU ROCK$^{\Phi}$

AH

Comments

Short maturity AH wheat best suited mid to late sowings in low rainfall environments. Useful tolerance to crown rot. Large grain size. Among 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$^{\Phi}$ and many other varieties with similar characteristics. Now likely to be superseded by the recently released short maturing AH(N) Vixen$^{\Phi}$.

Yield (% of Mace$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	95	88	95	91	96
Agzone 2	94	91	96	93	92
Agzone 3	92	96	96	91	93
Agzone 4	104	95	96	92	95
Agzone 5	95	94	96	93	93
Agzone 6	87	91	96	94	93

Disease resistance	Adult rating
Nodorum blotch	SVS
S. tritici blotch	S
Yellow spot	MRMS
Stem rust	MS
Stripe rust	MRMS
Leaf rust	SVS
Powdery mildew	S
Flag smut	R
Common bunt	S
RLN (*P. quasitereoides*)	MS
RLN (*P. neglectus*)	MSS
CCN	S
Crown rot	MSS

Flowering 2017 & 2018 DPIRD trials	Days after/before Mace$^{\Phi}$				
	11 Apr	25 Apr	8 May	24 May	20 Jun
Mullewa	-23	-17	-11	-11	-7
Merredin	-19	-17	-10	-3	-2
Katanning	na	-13	-8	-3	-1
Gibson	na	-16	-9	-8	-3

Agronomic traits	
Coleoptile length (cm)	6.5
Crown rot yield loss	Low (<10%)
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, exc. GST)	$3.50

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

DPIRD GRDC

LRPB COBRA(Φ)

AH

Comments

LRPB Cobra(Φ) is an AH variety with a Westonia background that has yielded well in most NVT grown on acid soils. It has performed well in high yielding environments. Cobra(Φ) is susceptible to low falling number after pre-harvest rain. Cobra(Φ) is now below the yield benchmark set by Scepter(Φ), but this variety is moderately resistant to both strains of leaf rust and stem rust.

Yield (% of Mace(Φ))	2014	2015	2016	2017	2018
Agzone 1	94	105	100	101	94
Agzone 2	98	100	101	92	93
Agzone 3	97	95	101	97	94
Agzone 4	97	106	97	91	93
Agzone 5	97	94	101	97	93
Agzone 6	92	99	100	99	102

Disease resistance	Adult rating
Nodorum blotch	MRMS
S. tritici blotch	MSS
Yellow spot	MRMS
Stem rust	MR
Stripe rust	MSS
Leaf rust	MR
Powdery mildew	MSS
Flag smut	MS
Common bunt	SVS
RLN (*P. quasitereoides*)	MS
RLN (*P. neglectus*)	MSS
CCN	MS
Crown rot	S

Flowering selected NVT trials	Days after/before Mace(Φ)
2016 (av sowing date 8 May)	-1
2017 (av sowing date 24 May)	+0
2018 (av sowing date 28 May)	+0
Average	+0

Agronomic traits	
Coleoptile length (cm)	6.6
Crown rot yield loss	Moderate (10-20%)
Black point	MSS
Falling number index	2
Maturity	Short-mid

Variety information	
Pedigree	Westonia/W29
Breeder/seed licensee	LongReach Plant Breeders
Access to seed	Free to trade
EPR ($/t, exc. GST)	$3.50

LRPB HAVOC(Φ)

AH(N)

Comments

LPRB Havoc(Φ) is the latest Australian Hard variety to be released by LongReach. Over the past three years the variety has yielded well incomparison to Mace(Φ). Havoc is slightly shorter in maturity than Mace(Φ). Havoc(Φ) has a low falling number index rating. It is important for growers of Havoc(Φ) to take note of this variety's stem and leaf rust ratings. It is susceptible to both rust types but moderately resistant to stripe rust. Havoc(Φ) is moderately resistant to moderately susceptible to powdery mildew; however, its response may differ on rare occasions where a more virulent isolate occurs.

Yield (% of Mace(Φ))	2014	2015	2016	2017	2018
Agzone 1	-	-	105	100	107
Agzone 2	-	-	100	102	102
Agzone 3	-	-	98	102	108
Agzone 4	-	-	105	97	103
Agzone 5	-	-	96	102	102
Agzone 6	-	-	95	100	106

Disease resistance	Adult rating
Nodorum blotch	MS
S. tritici blotch	MRMS
Yellow spot	MRMS
Stem rust	S
Stripe rust	MR
Leaf rust	S
Powdery mildew	MRMS
Flag smut	MS
Common bunt	R
RLN (*P. quasitereoides*)	-
RLN (*P. neglectus*)	S
CCN	-
Crown rot	S

Flowering 2017 & 2018 DPIRD trials	Days after/before Mace(Φ)				
	11 Apr	25 Apr	8 May	24 May	20 Jun
Mullewa	+0	-3	-2	+1	-2
Merredin	-1	-5	-4	-0	-0
Katanning	-2	-1	-2	-1	-1
Gibson	+0	-3	-0	-3	-3

Agronomic traits	
Coleoptile length (cm)	-
Crown rot yield loss	-
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 grower to grower (WA)
EPR ($/t, exc. GST)	$4.00

(N) denotes the supplementary classification of APWN

MACE$^{\Phi}$

AH(N)

Comments

Mace$^{\Phi}$ is a short-mid maturity AH(N) variety with a Wyalkatchem$^{\Phi}$ background. Previously the benchmark variety for yield in WA, it has been very popular and was widely planted. Scepter$^{\Phi}$ has now superceded Mace$^{\Phi}$ as the dominant variety sown in WA. Mace$^{\Phi}$ has performed well in pre-harvest rainfall condtions due to its falling number index of 5.

Yield (% of Scepter$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	-	90	93	93	96
Agzone 2	-	92	90	95	94
Agzone 3	-	97	91	90	95
Agzone 4	-	92	93	94	95
Agzone 5	-	95	90	90	92
Agzone 6	-	89	93	91	93

Disease resistance	Adult rating
Nodorum blotch	MS
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*)	MS
CCN	MRMS
Crown rot	S

Flowering 2017 & 2018 DPIRD trials	Days after/before Scepter$^{\Phi}$				
	11 Apr	25 Apr	8 May	24 May	20 Jun
Mullewa	-3	-4	-4	-2	-1
Merredin	-5	+2	+1	-1	-1
Katanning	-2	+0	-2	-1	-3
Gibson	-1	-4	-4	-4	-2

Agronomic traits	
Coleoptile length (cm)	6.9
Crown rot yield loss	High (>20%)
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, exc. GST)	$3.00

(N) denotes the supplementary classification of APWN

* = Some races in eastern Australia can attack these varieties.

ROCKSTAR$^{\Phi}$

AH

Comments

RockStar$^{\Phi}$ is a mid-long new AH release from InterGrain. It was included in the NVT for the first time in 2018, yielding similar to Scepter$^{\Phi}$ and higher than the mid-long alternatives such as Catapult$^{\Phi}$, Cutlass$^{\Phi}$, LRPB Trojan$^{\Phi}$ and Magenta$^{\Phi}$. RockStar$^{\Phi}$ is moderately resistant to moderately susceptible to yellow spot and powdery mildew, and susceptible to leaf rust. No early sown trial data available.

Yield (% of Mace$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	-	-	-	-	103
Agzone 2	-	-	-	-	109
Agzone 3	-	-	-	-	107
Agzone 4	-	-	-	-	106
Agzone 5	-	-	-	-	108
Agzone 6	-	-	-	-	109

Disease resistance	Adult rating
Nodorum blotch	-
S. tritici blotch	-
Yellow spot	MRMS*p*
Stem rust	MR*p*
Stripe rust	RMR*p*
Leaf rust	S*p*
Powdery mildew	MRMS*p*
Flag smut	-
Common bunt	-
RLN (*P. quasitereoides*)	-
RLN (*P. neglectus*)	-
CCN	-
Crown rot	-

Flowering selected NVT trials	Days after/before Mace$^{\Phi}$
2016 (av sowing date 8 May)	-
2017 (av sowing date 24 May)	-
2018 (av sowing date 28 May)	+5

Agronomic traits	
Coleoptile length (cm)	-
Crown rot yield loss	-
Black point	-
Falling number index	-
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, exc. GST)	$3.50

p = provisional assessment.

DPIRD GRDC

SCEPTER(Φ)

AH

Comments

Scepter(Φ), released in 2015, is still one of the highest yielding AH varieties (and any other classification) in the NVT over the past four years. This variety is moderately susceptible to susceptible to the latest strain of leaf rust, which is an advantage over Devil(Φ), Vixen(Φ), LRPB Havoc(Φ) and Corack(Φ) as they are more susceptible to the new leaf rust strain. Scepter(Φ) appears to have a similar pre-harvest sprouting tolerance to Mace(Φ), but its powdery mildew and black point ratings are poorer than Mace(Φ) (which is one of its parents). Due to a consistent increase in yield, grain protein is on average lower for this variety. Additional nitrogen will benefit the yield and protein performance of this variety.

Yield (% of Mace(Φ))	2014	2015	2016	2017	2018
Agzone 1	-	110	107	107	104
Agzone 2	-	109	111	105	107
Agzone 3	-	103	110	111	105
Agzone 4	-	109	108	107	105
Agzone 5	-	106	111	111	108
Agzone 6	-	112	107	110	108
Disease resistance	**Adult rating**				
Nodorum blotch	MRMS				
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	S				
Flowering 2017 & 2018 DPIRD trials	**Days after/before Mace(Φ)**				
	11 Apr	**25 Apr**	**8 May**	**24 May**	**20 Jun**
Mullewa	+3	+4	+4	+2	+1
Merredin	+5	-2	-1	+1	+1
Katanning	+2	+0	+2	+1	+3
Gibson	+1	+4	+4	+4	+2
Agronomic traits					
Coleoptile length (cm)	6.6				
Crown rot yield loss	Moderate (10-20%)				
Black point	MS				
Falling number index	5				
Maturity	Short-mid				
Variety information					
Pedigree	RAC1480/2*Mace				
Breeder/seed licensee	AGT				
Access to seed	AGT Affiliates, retailers, or seed sharing				
EPR ($/t, exc. GST)	$3.25				

p = provisional assessment.

* = Some races in eastern Australia can attack these varieties.

VIXEN(Φ)

AH

Comments

Vixen(Φ) is a short maturity, AH released in 2018 by InterGrain. It has only been in the NVT for two years where the data suggests Vixen(Φ) is similar to Scepter(Φ). However, its yields have been more variable. It is moderately resistant to moderately susceptible to stem and stripe rust but susceptible to very susceptible to the latest strain of leaf rust. A provisional falling number rating of 3 means it is not recommended for areas prone to pre-harvest sprouting.

Yield (% of Mace(Φ))	2014	2015	2016	2017	2018
Agzone 1	-	-	-	96	109
Agzone 2	-	-	-	105	105
Agzone 3	-	-	-	-	106
Agzone 4	-	-	-	103	107
Agzone 5	-	-	-	111	109
Agzone 6	-	-	-	-	106
Disease resistance	**Adult rating**				
Nodorum blotch	S				
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*)	-				
RLN (*P. neglectus*)	MRMS				
CCN	-				
Crown rot	S				
Flowering 2018 DPIRD trials	**Days after/before Mace(Φ)**				
	10 Apr	**24 Apr**	**8 May**	**22 May**	**21 Jun**
Mullewa	-26	-12	-9	-8	+0
Merredin	-26	-16	-13	-5	-1
Katanning	na	-7	-10	-3	-3
Gibson	na	-11	-7	-7	-4
Agronomic traits					
Coleoptile length (cm)	-				
Crown rot yield loss	-				
Black point	MS				
Falling number index	3*p*				
Maturity	Short				
Variety information					
Pedigree	Mace/IGW3119				
Breeder/seed licensee	InterGrain				
Access to seed	InterGrain Seed Club members or seed retailers				
EPR ($/t, exc. GST)	$3.50				

p = Provisional assessment.

YITPI(Þ)

AH

Comments

Yitpi(Þ) 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(Þ) has a long coleoptile but is very susceptible to yellow spot and susceptible to stem and leaf rust. This variety has been lower yielding than several new releases in NVT in recent years.

Yield (% of Mace(Þ))	2014	2015	2016	2017	2018
Agzone 1	86	100	94	105	85
Agzone 2	92	92	100	89	91
Agzone 3	95	84	103	94	87
Agzone 4	88	96	89	93	90
Agzone 5	95	81	103	91	87
Agzone 6	88	88	106	98	95

Disease resistance	Adult rating
Nodorum blotch	MS
S. tritici blotch	MRMS
Yellow spot	SVS
Stem rust	S
Stripe rust	MRMS
Leaf rust	S
Powdery mildew	MRMS
Flag smut	MR
Common bunt	S
RLN (*P. quasitereoides*)	MS
RLN (*P. neglectus*)	MSS
CCN	MR
Crown rot	S

Flowering 2017 & 2018 DPIRD trials	Days after/before Mace				
	11 Apr	25 Apr	8 May	24 May	20 Jun
Mullewa	+15	+15	+13	+11	+5
Merredin	+17	+10	+5	+5	+5
Katanning	+18	+11	+6	+6	+8
Gibson	+24	+20	+18	+9	+9

Agronomic traits	
Coleoptile length (cm)	7.8
Crown rot yield loss	Moderate (10-20%)
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, exc. GST)	$1.00

CALINGIRI

ANW

Comments

Calingiri has remained a popular mid-long maturing ANW. Its yields are superseded by the more recently released ANW varieties, Zen(Þ), Ninja(Þ) and Kinsei(Þ). Calingiri is susceptible to very susceptible to stripe rust and powdery mildew and susceptible to leaf rust.

Yield (% of Mace(Þ))	2014	2015	2016	2017	2018
Agzone 1	86	104	94	107	87
Agzone 2	91	94	95	90	93
Agzone 3	95	86	100	94	91
Agzone 4	80	97	88	92	90
Agzone 5	92	81	97	88	85
Agzone 6	93	90	102	95	96

Disease resistance	Adult rating
Nodorum blotch	MSS
S. tritici blotch	MSS
Yellow spot	MSS
Stem rust	MSS
Stripe rust	SVS
Leaf rust	S
Powdery mildew	SVS
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 Mace
2016 (av sowing date 8 May)	+7
2017 (av sowing date 24 May)	+6
2018 (av sowing date 28 May)	+5
Average	+6

Agronomic traits	
Coleoptile length (cm)	6.4
Crown rot yield loss	Moderate (10-20%)
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, exc. GST)	nil

KINSEI$^{\Phi}$

ANW

Comments

Kinsei$^{\Phi}$ is a mid-long noodle wheat released by InterGrain in 2018. It is well suited to early sowing opportunities and has also performed well in the NVT main season plantings. It is a notable improvement over Calingiri and Zen for early sowing. Kinsei$^{\Phi}$ has been in the NVTs for two years where it yields slightly less than Ninja$^{\Phi}$, but out yields both Zen$^{\Phi}$ and Calingiri. Kinsei$^{\Phi}$'s disease ratings are marginally better than Ninja$^{\Phi}$ and Zen$^{\Phi}$.

Yield (% of Mace$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	-	-	-	111	96
Agzone 2	-	-	-	98	104
Agzone 3	-	-	-	106	103
Agzone 4	-	-	-	99	100
Agzone 5	-	-	-	99	95
Agzone 6	-	-	-	104	105
Disease resistance	**Adult rating**				
Nodorum blotch	MRMS*p*				
S. tritici blotch	SVS*p*				
Yellow spot	MS				
Stem rust	MS				
Stripe rust	MRMS				
Leaf rust	S				
Powdery mildew	MSS				
Flag smut	RMR				
Common bunt	RMR*p*				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	S				
CCN	-				
Crown rot	MS*p*				
Flowering 2017 & 2018 DPIRD trials	**Days after/before Mace$^{\Phi}$**				
	11 Apr	**25 Apr**	**8 May**	**24 May**	**20 Jun**
Mullewa	+17	+12	+13	+8	+5
Merredin	+16	+12	+5	+3	+5
Katanning	+12	+6	+5	+7	+7
Gibson	+11	+13	+13	+8	+7
Agronomic traits					
Coleoptile length (cm)	-				
Crown rot yield loss	-				
Black point	MSS				
Falling number index	4				
Maturity	Mid-long				
Variety information					
Pedigree	Complex cross				
Breeder/seed licensee	InterGrain				
Access to seed	Free to trade				
EPR ($/t, exc. GST)	$4.00				

NINJA$^{\Phi}$

ANW

Comments

Ninja$^{\Phi}$ a noodle wheat variety released by InterGrain in 2016 with a Calingiri and Wyalkatchem$^{\Phi}$ background. Ninja$^{\Phi}$ is the highest yielding ANW variety and out yielded Mace$^{\Phi}$ in the past four years, just slightly behind Scepter$^{\Phi}$. This variety is susceptible to very susceptible to stem rust, powdery mildew and the new incursion of leaf rust. However, it has a very useful black point rating.

Yield (% of Mace$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	-	111	104	108	99
Agzone 2	-	106	109	100	101
Agzone 3	-	98	108	107	100
Agzone 4	-	108	103	103	99
Agzone 5	-	100	109	107	103
Agzone 6	-	-	106	107	107
Disease resistance	**Adult rating**				
Nodorum blotch	MRMS				
S. tritici blotch	MSS				
Yellow spot	MRMS				
Stem rust	SVS				
Stripe rust	MS				
Leaf rust	SVS				
Powdery mildew	S				
Flag smut	MR				
Common bunt	RMR				
RLN (*P. quasitereoides*)	-				
RLN (*P. neglectus*)	S				
CCN	MS				
Crown rot	S				
Flowering 2017 & 2018 DPIRD trials	**Days after/before Mace$^{\Phi}$**				
	11 Apr	**25 Apr**	**8 May**	**24 May**	**20 Jun**
Mullewa	+14	+8	+9	+6	+3
Merredin	+12	+4	+1	+1	+3
Katanning	+4	+1	+2	+3	+2
Gibson	na	na	na	na	na
Agronomic traits					
Coleoptile length (cm)	-				
Crown rot yield loss	-				
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, exc. GST)	$4.00				

p = provisional assessment.

SUPREME(Ф)

ANW

Comments

Supreme(Ф) is an Arrino derivative with improved yield and disease resistance. Supreme is premium quality wheat noodle and is well regarded by international customers because of this. Supreme(Ф) is a lower yielding noodle variety compared with Zen(Ф), Ninja(Ф) and Kinsei(Ф). A strength of this variety is its triple rust resistance package, the best rating of the noodle wheats. It has a very short plant height.

Yield (% of Mace(Ф))	2014	2015	2016	2017	2018
Agzone 1	93	96	96	96	92
Agzone 2	95	94	98	91	91
Agzone 3	94	93	98	93	91
Agzone 4	99	99	95	91	92
Agzone 5	95	92	98	93	91
Agzone 6	-	-	98	96	96

Disease resistance	Adult rating
Nodorum blotch	S
S. tritici blotch	MSS
Yellow spot	MS
Stem rust	MRMS
Stripe rust	MR*
Leaf rust	RMR*
Powdery mildew	MSS
Flag smut	MSS
Common bunt	SVS
RLN (*P. quasitereoides*)	-
RLN (*P. neglectus*)	MSS
CCN	S
Crown rot	MSS

Flowering selected NVT trials	Days after/before Mace(Ф)
2016 (av sowing date 8 May)	-1
2017 (av sowing date 24 May)	+0
2018 (av sowing date 28 May)	-3
Average	-1

Agronomic traits	
Coleoptile length (cm)	5.7
Crown rot yield loss	-
Black point	MSS
Falling number index	4
Maturity	Short-mid

Variety information	
Pedigree	LoPh-Nyabing.3*Calingiri/4*VPM Arrino
Breeder/seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, exc. GST)	$3.85

* = Some races in eastern Australia can attack these varieties.

ZEN(Ф)

ANW

Comments

Zen(Ф) is a noodle variety with a Calingiri and Wyalkatchem(Ф) background. Although Zen(Ф)'s yields are generally lower than Kinsei(Ф), they are not significantly different. Zen(Ф) is susceptible to powdery mildew, stem and leaf rust. It has a useful black point and RLN (*P. neglectus*) rating but has a poor falling number rating.

Yield (% of Mace(Ф))	2014	2015	2016	2017	2018
Agzone 1	95	108	101	107	97
Agzone 2	96	102	98	98	102
Agzone 3	100	96	101	101	103
Agzone 4	86	102	97	97	100
Agzone 5	96	94	98	94	94
Agzone 6	-	102	102	99	101

Disease resistance	Adult rating
Nodorum blotch	MRMS
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*)	-
RLN (*P. neglectus*)	MRMS
CCN	S
Crown rot	S

Flowering 2017 & 2018 DPIRD trials	Days after/before Mace(Ф)				
	11 Apr	25 Apr	8 May	24 May	20 Jun
Mullewa	+14	+7	+10	+7	+5
Merredin	+9	+4	+2	+2	+3
Katanning	+5	+3	+2	+2	+3
Gibson	na	na	na	na	na

Agronomic traits	
Coleoptile length (cm)	6.6
Crown rot yield loss	-
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, exc. GST)	$3.85

DPIRD GRDC

BARLEY

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

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 all malt barley varieties segregated in Western Australia (WA), those in stage 2 of malt accreditation with Barley Australia and selected feed varieties (Tables 1 to 13; Figures 1 to 11).

The decision of whether to grow barley with a malt or feed classification 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.

Identifying which option leads to the highest returns for a grower is complex. In some instances, the price premium paid for malt offsets the yield difference between malt and feed varieties. In other situations, the higher yield of feed varieties, the low likelihood of a malt variety being segregated as malt or the higher costs of growing a malt barley may justify the choice to grow a feed variety.

Barley varieties differ in their agronomic fit for different port zones and different environments. Additionally, market demand for malt barley varieties varies with the port zone due to the different domestic and international markets each port zone services. That demand influences the choice of malt variety sown regionally. No one malt or feed variety matches all farming systems or the brewing, distilling and shochu markets we service.

In 2018, four varieties, Spartacus CL$^{\Phi}$, La Trobe$^{\Phi}$, Scope CL$^{\Phi}$ and Bass$^{\Phi}$ (in order of decreasing popularity) occupied three in every four hectares sown to barley (Figure 1). In 2019, the area planted to RGT Planet$^{\Phi}$ and Spartacus CL$^{\Phi}$ has increased significantly. Between them, these two varieties could occupy nearly two-thirds of the WA barley acreage and result in a decreasing area sown to the market-accepted malt varieties Bass$^{\Phi}$, Flinders$^{\Phi}$, La Trobe$^{\Phi}$ and Scope CL$^{\Phi}$.

Changes in disease 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 aggressive Oxford virulent net-type net blotch (NTNB) pathotype, the newly identified leaf disease Ramularia leaf spot (RLS) and potential changes in the virulence of powdery mildew (PM).

Tips for managing grain protein

While it is common and logistically easier to apply the bulk of the fertiliser nitrogen (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. Two management options can assist if the current strategy of applying N up-front typically does not consistently deliver grain with more than 9.5 per cent protein.

Small plot research has shown that variety choice and N timing can increase grain protein concentration without requiring the addition of more N. The first option is to sow a higher-protein variety such as Bass$^{\Phi}$ or even Flinders$^{\Phi}$ or Spartacus CL$^{\Phi}$ (where suitable). The second option is to target around two-thirds of the recommended N for application around the stem elongation stage of crop growth. In some seasons, saving some N for use around flag leaf emergence can also boost grain protein. Should tweaking the timing of the N strategy not provide a consistent enough

protein boost, higher levels of N fertiliser should be considered as well as incorporating legumes pastures and crops in the rotation to boost soil N supply.

Target plant density

When considering how much seed to put in the ground, it is essential to think in terms of plant density (plants per square metre) rather than 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 season), seed viability and establishment conditions. Variety should influence the target plant density. For most malt varieties, a target density of 150–180 plants/m^2 is appropriate unless growing Scope CL$^{\Phi}$ where the target density is 110–130 plants/m^2. For feed barley, a higher target density of 180–220 plants/m^2 is suggested to improve the competitiveness of the crop against weeds. If growing feed barley in paddocks without weeds, then the target density can be adjusted down to 150–180 plants/m^2. The target density in plants/m^2 determines the seed 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 growing La Trobe$^{\Phi}$ barley with a germination of 94 per cent, a kernel weight of 42g per 1000 kernels at a target density of 150 plants/m^2 with an expected establishment of 80 per cent, then the seed rate in kg/ha required to establish 150 plants/m^2 is:

$$\text{seed rate in kg/ha} = 84\text{kg/ha} = \frac{\text{42g x 150 plants/m}^2}{\text{0.94 x 0.80 x 100}}$$

When deciding on which barley variety to sow, grain yield potential needs to balance trade-offs with agronomy, disease resistance, grain quality, segregation opportunities and market demand. Commonly grown varieties differ in their agronomic traits, demonstrating the many ways in which grain yield is achievable. These phenotypic differences may favour one variety over another variety in some seasons but not in other seasons. It is therefore vital to look over seasons and across sites when assessing which variety best suits the farming business.

WHAT IS NEW?

New barley lines that may be of interest to WA barley growers include Banks$^{\Phi}$ (tested as IGB1305), Buff$^{\Phi}$ (tested as IGB1506), Leabrook$^{\Phi}$ (tested as WI4896) and LG Alestar$^{\Phi}$ (tested as SMBA11-2341). Elders will no longer continue commercialising LG Maltstar$^{\Phi}$ (tested as SMBA11-1771) in WA, instead focusing on LG Alestar$^{\Phi}$.

Note that for any new variety under evaluation by Barley Australia, there is no guarantee of malt accreditation and market acceptance (and possible associated malt premiums). Be cautious in sowing large areas with the expectation of future segregations unless there is a clear agronomic or grain yield advantage as a feed barley.

Why consider purchasing seed of these new varieties?

Banks$^{\Phi}$

Key points:

- **Was in stage 2 assessment but on 11 November 2019 Barley Australia announced that Banks$^{\Phi}$ had not been accredited as a malt variety.**
- Suited to medium to high rainfall environments (similar grain yield to La Trobe$^{\Phi}$, higher-yielding than Flinders$^{\Phi}$ and Bass$^{\Phi}$).
- Barley leaf rust (BLR) requires management, as will spot-type net blotch (STNB) and scald as an adult plant.
- Its grain quality and germ end staining risk is similar to Flinders$^{\Phi}$, except screenings (higher risk).

Banks$^{\Phi}$ (WABAR2312/WABAR2332) is a short, semi-dwarf, medium-spring, two-row barley bred by InterGrain and registered in February 2018. It was under evaluation for its suitability as a malt variety. As its performance in stage 2 trials in 2018 was variable in contrast to its performance in stage 1 trials in 2017, it has been held over for further evaluation in stage 2 trials in 2019. **Barley Australia announced Banks$^{\Phi}$ had failed malt accreditation just as this sowing guide was going to print.**

Banks$^{\Phi}$ has been in WA barley National Variety Trials (NVT) since 2015 and is a potential competitor to Bass$^{\Phi}$, Flinders$^{\Phi}$, La Trobe$^{\Phi}$, RGT Planet$^{\Phi}$ and Spartacus CL$^{\Phi}$ in medium to higher rainfall areas of WA.

Banks$^{\Phi}$ has a similar plant type and phenology to Flinders$^{\Phi}$, being 1-2cm taller than Bass$^{\Phi}$ at maturity. There have been observations of brackling (buckling in the lower part of the stem) and lodging

in Banks[Φ] in some commercial crops. Straw strength appears to be comparable to RGT Planet[Φ], but not as robust as either Bass[Φ] or Flinders[Φ]. As a seedling, it has good tolerance to all leaf diseases except BLR. As an adult plant, scald, STNB and BLR may need management. Banks[Φ] has some tolerance to the new Oxford virulent NTNB.

WA barley NVT (2015–2018) suggests that Banks[Φ] has a similar grain yield to La Trobe[Φ], is higher yielding than Bass[Φ] and Flinders[Φ], but does not have the top end yield performance of RGT Planet[Φ]. Across 62 WA barley NVT (2015–2018) where they have been sown side-by-side, Banks[Φ] has yielded lower than La Trobe[Φ] in 11 per cent, the same in 79 per cent and higher in 10 per cent. Relative to RGT Planet[Φ], Banks[Φ] has yielded lower in 33 per cent, the same in 62 per cent and higher in 5 per cent of 42 WA barley NVT (2016–2018).

The hectolitre weight and grain brightness of Banks[Φ] appear to be comparable to Flinders[Φ], but its overall screenings risk is higher than both Bass[Φ] and Flinders[Φ] and slightly lower than La Trobe[Φ]. Germ end staining risk appears to be low, or similar to Flinders[Φ] and lower than Bass[Φ]. There is not enough conclusive data to be definitive on the head loss risk with Banks[Φ], but the data suggests it is more likely to be rated as a medium risk than low risk.

Seed will be available for planting in 2020 from InterGrain SeedClub members and resellers. Seed is also free to trade grower to grower.

Buff[Φ]

Key points:

- Like Litmus[Φ], has aluminium (Al) tolerance that improves grain yield in soil with low pH and high soluble Al, but kernels have a white aleurone.
- Supersedes Litmus[Φ] due to more consistent yield across a range of soils.
- Yields similarly to La Trobe[Φ] on non-acidic soils but higher than La Trobe[Φ] on soils with an acidic profile.
- STNB, PM and BLR need management.
- Under assessment by Barley Australia (stage 1 malt accreditation trials in 2019). The earliest possible accreditation date is March 2021.

Buff[Φ] ((Yambla/3*VB0330)/(VB0229/3*VB0330)/(Haruna Nijo/4*VB0330)/(VB0128/98-041D*014/3*VB0330)/(Buloke/3*VB0330)) is a medium-height, early spring, two-row barley bred by Agriculture Victoria Service, licensed to InterGrain and registered in September 2018. Buff[Φ] physically looks similar to Mundah (with Mundah representing 50 per cent of its pedigree through VB0330) but has different phenology, grain yield, grain characteristics and malt quality.

Buff[Φ] has been in WA barley NVT since 2016 and is a direct competitor to Litmus[Φ] on acidic soils and Compass[Φ], Fathom[Φ], Mundah, La Trobe[Φ], Rosalind[Φ] and Spartacus CL[Φ] (where there are no imidazolinone residues) on non-acidic soils.

Buff[Φ] has similar Al tolerance genetics to Litmus[Φ]. Unlike Litmus[Φ], it has a white aleurone, and its receival will therefore not be restricted as it is for Litmus[Φ]. 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. Al is toxic to barley's roots; hence, barley has reduced productivity on acid soils.

Buff[Φ] has displayed a consistent yield advantage over Litmus, largely on non-acidic soils, in WA barley NVT (2016-2017). Unfortunately, Litmus[Φ] was not sown in the 2018 WA barley NVT, so further comparative yield assessment over a more extended period is not possible. Litmus[Φ] was re-entered to the 2019 WA barley NVT, allowing up to ten additional direct comparisons in trials.

The NVT multi-environment trials (MET) analysis (2016–2018) indicates that Buff[Φ] has a yield potential at least equivalent to La Trobe[Φ] on non-acidic soils and higher than La Trobe[Φ] on soils with an acidic profile. Across 35 WA barley NVT (2016–2018), Buff was the same yield as La Trobe[Φ] in 69 per cent and higher in 31 per cent. To date, Buff[Φ] has not yielded lower than La Trobe[Φ] in an NVT.

Buff[Φ] has improved tolerance to scald (as an adult) and NTNB (as both a seedling and an adult) relative to Litmus[Φ], but its disease resistance profile is poorer against PM. Fungicides may be required to manage STNB, PM and BLR. Its weak PM and BLR resistance limits its practical use in higher rainfall areas.

Seed will be available for planting in 2020 from InterGrain seed club members and resellers. Seed is also free to trade grower to grower.

Leabrook[Φ]

Key points:

- In stage 2 assessment for malt accreditation, with the earliest accreditation date being March 2020.
- Similar agronomic attributes (including lodging risk) to Compass[Φ] but with improved grain yield.
- BLR will require management.

Leabrook[Φ] (County/Commander//Commander) is a tall, medium-spring, two-row barley bred

by the University of Adelaide barley breeding program, registered in September 2017. It is being commercialised by Seednet. Leabrook[Φ] possesses many similar attributes to Compass[Φ] including phenology, plant architecture and grain quality (i.e. lower-than-average hectolitre weight combined with its good grain plumpness) because of similar pedigree, but with improvements in grain yield and malt quality (mostly malt extract).

Leabrook[Φ] has been in WA barley NVT since 2015 and is a competitor to Buff[Φ] (on non-acidic soils), Compass[Φ], Fathom[Φ], La Trobe[Φ] and Spartacus CL[Φ] (where there are no imidazolinone residues) in low to medium rainfall zones. Leabrook[Φ] has had an average 4 per cent yield advantage over Compass[Φ] and La Trobe[Φ] in a state-wide MET analysis of WA barley NVT. Across 62 WA barley NVT (2016–2018), Leabrook[Φ] has yielded lower than Compass[Φ] in 5 per cent, the same in 76 per cent and higher in 19 per cent; and relative to La Trobe[Φ], lower in 6 per cent, the same in 74 per cent and higher in 19 per cent.

Leabrook[Φ] 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[Φ] is comparable to that of Compass[Φ]. Fair straw strength may pose problems in higher-yielding years, high yielding environments (i.e. above 4t/ha) and with excessive N supply, but is not expected to be a significant impediment in low-to-medium rainfall areas. Germ end staining risk is similar to Compass[Φ] and La Trobe[Φ], with more data needed. There is not enough data to be definitive on the head loss risk with Leabrook[Φ].

Seed will be available for planting in 2020 from Seednet.

LG Alestar[Φ]

Key points:

- In stage 2 assessment for malt accreditation, with the earliest accreditation date being March 2020.
- Similar agronomic attributes to Granger[Φ].
- Grain has a white aleurone.

LG Alestar[Φ] (Henley/NSL02-4136A) 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[Φ] has a white aleurone, even though one of its parents Henley has a blue aleurone.

LG Alestar[Φ] was in WA barley NVT from 2011 until 2016 before being re-entered in 2019. It is a potential competitor to Bass[Φ], Flinders[Φ], Granger[Φ], La Trobe[Φ], Lockyer[Φ], Oxford and RGT Planet[Φ] in higher-rainfall areas of WA. WA barley NVT (2012–2016) suggest that the grain yield of LG Alestar[Φ] is comparable to Granger[Φ]. Across 80 WA barley NVT (2011–2016), where they have occurred in the same trial, LG Alestar[Φ] has yielded lower than Granger[Φ] in 22 per cent, the same in 78 per cent and higher in 0 per cent. Across 82 WA barley NVT (2011–2016), LG Alestar[Φ] has yielded lower than La Trobe[Φ] in 46 per cent, the same in 49 per cent and higher in 5 per cent.

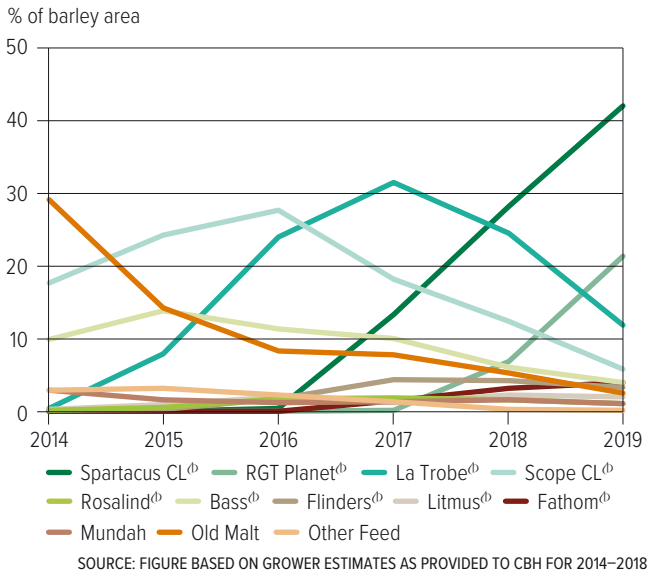
It has durable resistance to PM (based on the *mlo* gene) and resistance to BLR (seedling and adult). Lodging data collected in WA suggests that the straw strength of LG Alestar[Φ] is comparable to that of Granger[Φ]. Grain quality of LG Alestar[Φ] may be a subtle improvement over Granger[Φ] with slightly better grain plumpness and grain brightness, but more analysis of the data needed.

Seed will be available for planting in 2020 from Elders.

WHAT VARIETY SHOULD I GROW?

The following varieties should be high on the list of what to grow – Bass[Φ], Flinders[Φ], La Trobe[Φ], RGT Planet[Φ], Rosalind[Φ], Scope CL[Φ] and Spartacus CL[Φ]. There are also other options for specific agronomic situations such as the sowing of Buff[Φ] and Litmus[Φ] on soils with a subsoil pHCa below 4.8; Compass[Φ] and Fathom[Φ] where improved weed competition might be useful; or Fathom[Φ] where

FIGURE 1 Popularity (per cent of barley area) of top 10 barley varieties (ranking based on forecast area sown in 2019 season) grown in WA over the past five seasons plus forecast for the 2019 season. 'Old' malt includes Baudin[Φ], Buloke[Φ], Commander[Φ], Gairdner, Hamelin, Stirling[Φ] and Vlamingh[Φ].



SOURCE: FIGURE BASED ON GROWER ESTIMATES AS PROVIDED TO CBH FOR 2014–2018 AND FORECAST AREA FOR 2019 ESTIMATED BY BLAKELY PAYNTER, DPIRD

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TABLE 1 Western Australian malt barley industry variety recommendations by port zone for the 2020-21 harvest.

Port zone	Geraldton	Kwinana			Albany		Esperance	Comment
		North (Midlands)	South	North (East)	North	South		
Bass$^{\Phi}$	NO	YES	YES	NO	Limited	Limited	NO	Stable market demand with an excellent malt quality profile.
Flinders$^{\Phi}$	NO	NO	Niche	NO	NO	YES	Niche	Works well as a variety for post-malt blending and sugar-adjunct brewing.
La Trobe$^{\Phi}$	NO	YES	YES	YES	YES	YES	YES	Stable market demand with a recognised quality profile.
RGT Planet$^{\Phi}$	NO	Limited	YES	NO	Limited	YES	YES	Market development for brewing end-use continuing.
Scope CL$^{\Phi}$	NO	Niche	Niche	Niche	Niche	NO	NO	Declining production and declining market demand.
Spartacus CL$^{\Phi}$	YES	YES	YES	YES	YES	YES	YES	Market development for brewing and shochu end-use continuing.

SOURCE: GIWA BARLEY COUNCIL MALT BARLEY VARIETY RECOMMENDATIONS

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.

stubble-borne STNB is a high risk. Oxford is no longer recommended as a variety to grow in WA due to the increased prevalence of NTNB and PM in this variety, along with its susceptibility to STNB. Comments about each barley variety suggested for sowing in WA can be found in the variety snapshot section. For varieties received as malt, the market feedback section provides more specific market information published by the Grain Industry Association of Western Australia (GIWA).

MARKET FEEDBACK

In line with previous advice, the GIWA malt barley variety recommendations for 2020-21 indicate that 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 stronger demand from the trade, which is unwilling to risk buying small, unsaleable parcels.

For the 2020-21 harvest, the following observations from GIWA are relevant:

- Bass$^{\Phi}$ and La Trobe$^{\Phi}$ and to a much lesser extent Flinders$^{\Phi}$ will be the main malt barley varieties sought by the trade for malting and brewing end-use in China, South-East Asia and Japan.
- La Trobe$^{\Phi}$ is the primary malt barley variety used in the manufacture of shochu in Japan and production of La Trobe$^{\Phi}$ is critical to maintaining supply to this premium market.
- The rapid grower adoption of Spartacus CL$^{\Phi}$ is exceeding market demand. International customers are not yet thoroughly familiar with its malting and brewing profile or its relevance for shochu production, but interest is growing. Spartacus CL$^{\Phi}$ is, however, not yet the first choice for buyers of Australian malt barley. Additionally, there are potential market access challenges due to the likelihood of imidazolinone residues in Spartacus CL$^{\Phi}$ grain.
- Scope CL$^{\Phi}$ is being phased out with segregations halted after the 2020-21 harvest. The decline in the planting of Scope CL$^{\Phi}$ coincides with reduced international demand and the emergence of Spartacus CL$^{\Phi}$.
- While RGT Planet$^{\Phi}$ is recognised internationally, it is new to Australian barley and malt customers. As such, they are not entirely familiar with its malting and brewing performance when grown under Australian conditions. As with Spartacus CL$^{\Phi}$, there is potential for supply to exceed market demand at the 2020-21 harvest.
- Baudin$^{\Phi}$ has been phased out as an export malt entity, with no segregations at the 2020-21 harvest. Growers who have previously supplied Baudin$^{\Phi}$ under a domestic malt barley contract should confirm any continuing demand before planting it in autumn 2020.
- Segregation opportunities for Bass$^{\Phi}$, Flinders$^{\Phi}$, La Trobe$^{\Phi}$, RGT Planet$^{\Phi}$, Scope CL$^{\Phi}$ and Spartacus CL$^{\Phi}$ vary by port zone and for the Kwinana and Albany ports, within a port zone (Table 1).

The malt barley variety receival recommendations developed by GIWA (through the GIWA Barley Council) in consultation with the WA barley supply chain are intended to be a guide for growers and consultants to help with the planning of the 2020 barley cropping program. This plan will be reviewed in autumn 2020 and any changes in demand presented to growers.

Three varieties – Banks$^{\Phi}$, Leabrook$^{\Phi}$ and LG Alestar$^{\Phi}$ – are in stage 2 of Barley Australia's accreditation process and are not included in the current 2020–21 variety receival recommendation plan. A decision on the malt accreditation of Banks$^{\Phi}$ is expected by the end of 2019 and for Leabrook$^{\Phi}$ and LG Alestar$^{\Phi}$ in March 2020. It is worth noting that malt accreditation does not guarantee segregation opportunities. For example, Compass$^{\Phi}$ is a recently accredited malt variety with no malt segregations in WA even though there are malt segregations in eastern Australia. Growers will be notified if market development segregations are to be offered at the 2020–21 harvest, should their accreditation be successful. Malt accreditation does not guarantee international markets will be willing to pay a premium for the variety or that there will be demand from customers in their brewing recipe.

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 segregation, whereas other sites may be able to offer two or more malt barley segregations. Growers can support segregation planning through submission of their area planted information and attending pre-harvest meetings.

The Australian barley industry works hard to uphold Australian malt variety quality to the end customer and 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.

International market signals continue to highlight the generally low protein status of Australian malt barley. Growers are encouraged to deliver malt barley grain between 10.5-11.0 per cent protein with a maximum of 20 per cent screenings through a 2.5mm sieve, a hectolitre weight above 64 kg/hL with ryegrass ergot less than 3cm, no whole snails and no glyphosate use near harvest.

MALT BARLEY VARIETIES

New malt varieties are released faster than older malt varieties can be phased out, with rapid turnover of varieties a common sticking point for end-users who desire long-term supply and familiarity to optimise the efficiency of their malt house or brewery. New varieties also increase inefficiency for bulk handlers, with each new malt variety segregated adding to the cost of storage and handling. Therefore, the GIWA barley variety rationalisation plan is trying to balance the benefits to growers from access to new malt varieties with the demand from customers for access to large parcels of the same malt variety over at least five years.

Each malt barley variety grown in WA has unique and different malting attributes. Consequently, brewers purchase varieties subject to their availability, 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 to assist them when deciding which malt variety or varieties to sow in 2020. Market demand, pricing signals and the location of segregations should be considered in partnership with the agronomic management required and the risk associated with delivering malt-grade barley when determining how much area to plant to each malt variety. Varieties listed as PREFERRED are more likely to attract higher premiums than ACCEPTABLE varieties. The malt barley recommendations for the 2020 season are as follows.

Bass$^{\Phi}$

- Bass$^{\Phi}$ is preferred for export as grain and malt.
- Not suitable for the manufacture of shochu in Japan.
- Bass$^{\Phi}$ is well recognised in the international malt barley market with stable demand.
- It can be malted without the use of the growth hormone gibberellic acid, a market-preferred trait.
- Bass$^{\Phi}$ malt has excellent extract and filterability and is suited to markets where high levels of starch-adjuncts are used in the brewing process.
- Grain generally has a higher grain protein concentration than other malt varieties received, enhancing its preference from starch-adjunct brewers.
- Target production zone in 2020 is Kwinana-North (Midlands) and Kwinana-South with limited segregation opportunities in the Albany Port Zone (subject to production volumes).

Flinders(Φ)

- Flinders(Φ) is suitable for export as grain and malt.
- Not suitable for the manufacture of shochu in Japan.
- It can be malted without the use of the growth hormone gibberellic acid, a market preferred trait.
- Flinders(Φ) malt has excellent malt extract and filterability but at a lower enzyme potential than Bass(Φ) malt.
- Flinders(Φ) performs well in markets where sugar-adjunct brewing is undertaken and when blended post-malting with varieties such as Bass(Φ) and La Trobe(Φ) for starch-adjunct brewing.
- The target production zone in 2020 is Albany-South with potential niche segregation opportunities in Kwinana-South and the Esperance Port Zone (subject to production and demand).

La Trobe(Φ)

- La Trobe(Φ) is preferred for export as grain and malt.
- La Trobe(Φ) is a preferred variety for the manufacture of shochu in Japan and the only malt variety accepted and segregated for that premium end use.
- It is widely accepted by all major malting and brewing customers of WA barley and malt.
- La Trobe(Φ) 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(Φ) malt stacks by mixing them with either Hindmarsh(Φ) or Spartacus CL(Φ) or any other variety.
- Target production zones in 2020 are Kwinana, Albany and Esperance port zones.

RGT Planet(Φ)

- RGT Planet(Φ) is suitable for export as grain and malt, but more work is required to gain full international acceptance.
- It is not under assessment for its suitability for the manufacture of shochu in Japan.
- Despite extensive use of RGT Planet(Φ) in brewing markets in Europe and South America, Asian customers of Australian barley and malt are still evaluating it as they would with any new malt variety they receive. The Asian market has yet to see a critical mass of RGT Planet(Φ). The time taken to approve it, however, may be quicker than an unknown malt variety.
- Limited feedback from the international market indicates that RGT Planet(Φ) malt has excellent extract with a moderate enzyme potential and is likely to be suitable for starch-adjunct brewing.
- Target production zones in 2020 are Kwinana-South, Albany-South and Esperance port zones with limited segregation opportunities in Kwinana-North (Midlands) and Albany-North (subject to production volumes).

Scope CL(Φ)

- Scope CL(Φ) is suitable for export as grain and malt.
- It is not suitable for the manufacture of shochu in Japan.
- Scope CL(Φ) malt has good extract with moderate enzyme activity but can suffer from variable filterability.
- While Scope CL(Φ) has a better production fit than Spartacus CL(Φ) with April sowing opportunities, Scope CL(Φ) is in phase-out mode by growers and the trade alike.
- Use only recommended imidazolinone herbicides and be aware of market advice concerning the delivery of grain from paddocks sprayed with an imidazolinone herbicide.
- The 2020-21 harvest is the last harvest that segregations will be offered for Scope CL(Φ) in WA, with potential niche segregation opportunities in Kwinana and Albany-North (subject to production and demand).

Spartacus CL(Φ)

- Spartacus CL(Φ) is suitable for export as grain and malt, but more work is required to gain full international acceptance.
- Assessment of Spartacus CL(Φ) 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 or imidazolinone-free Spartacus CL(Φ) barley can be sourced.
- Large quantities of Spartacus CL(Φ) accumulated in market development stacks at the 2018–19 harvest and countries such as China are still learning how to use Spartacus CL(Φ) in their malt houses and breweries.
- Market feedback suggests that like La Trobe(Φ), Spartacus CL(Φ) 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$^{\Phi}$ malt stacks by mixing them with either Hindmarsh$^{\Phi}$ or La Trobe$^{\Phi}$ 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 2020 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 are available as individual site reports or as multi-environment trial (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, site or group of sites of their choice to assist in selecting the best variety for their environment. Both the single-site and multi-year MET analyses are available at www.nvtonline.com.au.

Tables 2 to 8 present data extracted from the Long Term MET Yield Reporter available at www.nvtonline.com.au. MET data is presented for each year (2014 to 2018) for each of the six Agzones in WA and then averaged across Agzones to provide a statewide MET. 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.

Tables 9 and 10 use single-site data to highlight the probability of one variety yielding less, the same or more than another variety when grown under the same agronomy. Grain yields are compared using the least significant difference (p=0.05) using only barley NVT where both varieties have been sown and harvested.

It is important to note that the single-site analyses only represent varietal performance under one specific set of seasonal and site conditions. Growers should not use the single-site analysis as their sole data source when comparing the performance of a new variety. MET analyses based on Agzones average varietal performance and 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 2014 to 2018 assists with understanding the variability in relative varietal performance across seasons. While Agzones are a simple way to group trials across environments, they may not accurately reflect your location in every season.

Differences in grain yield between varieties sometimes depend on the potential yield of the site. NVT Online, through the Long Term MET Yield Reporter, graphs data at half tonne yield intervals based on trials that match the yield range. Figures 2 to 5 use linear regression to compare varieties at different yield potentials and present varietal trends as the site mean yield increases (the average yield of the varieties sown at that site).

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 fitted to the data. If the linear trend (but not the quadratic trend) was significant ($p<0.05$) a linear polynomial 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.

The data used for this analysis include DPIRD–GRDC (DAW00190 and DAW00224) barley agronomy grain yield data in addition to GRDC NVT barley grain yield data. In some trials, if data for Scope CL$^{\Phi}$ was absent, it was replaced with Buloke$^{\Phi}$ data (due to the closeness of their relationships with each other). 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.

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TABLE 2 Grain yield of barley varieties in Agzone 1 expressed as a per cent of the site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		1.19	1.78	4.17	2.07	4.29
	No. trials	(1)	(1)	(2)	(2)	(2)
DELIVERABLE AS A MALT VARIETY						
Bass(b)	(8)	93	91	94	93	94
Flinders(b)	(6)	98	95	-	93	94
La Trobe(b)	(8)	105	106	100	102	105
RGT Planet(b)	(6)	-	-	107	103	102
Scope CL(b)	(8)	94	97	99	103	103
Spartacus CL(b)	(8)	105	109	99	100	103
STAGE 2 MALT ACCREDITATION						
Banks(b)	(7)	-	109	102	103	102
Leabrook(b)	(7)	-	107	107	111	114
LG Alestar(b)	(1)	-	-	98	-	-
DELIVERABLE AS A FEED VARIETY						
Buff(b)	(5)	-	-	111	119	117
Compass(b)	(8)	106	109	103	109	111
Fathom(b)	(8)	103	103	104	110	112
Granger(b)	(4)	100	101	-	93	-
Litmus(b)	(6)	93	121	102	112	-
Lockyer(b)	(6)	104	95	-	102	104
Mundah	(6)	92	112	-	106	103
Oxford	(5)	98	85	96	89	-
Rosalind(b)	(8)	114	120	107	112	113

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

TABLE 3 Grain yield of barley varieties in Agzone 2 expressed as a per cent of the site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		2.57	2.40	3.91	4.15	4.29
	No. trials	(5)	(6)	(3)	(5)	(7)
DELIVERABLE AS A MALT VARIETY						
Bass(b)	(25)	97	91	92	96	96
Flinders(b)	(26)	103	98	94	98	96
La Trobe(b)	(26)	104	108	98	101	105
RGT Planet(b)	(14)	-	-	106	106	103
Scope CL(b)	(25)	90	93	101	98	100
Spartacus CL(b)	(26)	105	112	94	100	104
STAGE 2 MALT ACCREDITATION						
Banks(b)	(21)	-	109	101	101	102
Leabrook(b)	(21)	-	109	107	106	111
LG Alestar(b)	(14)	100	96	98	-	-
DELIVERABLE AS A FEED VARIETY						
Buff(b)	(14)	-	-	119	107	110
Compass(b)	(26)	100	109	103	103	108
Fathom(b)	(26)	97	100	107	103	107
Granger(b)	(19)	105	103	96	99	-
Litmus(b)	(19)	79	109	107	97	-
Lockyer(b)	(21)	104	97	-	103	103
Mundah	(21)	82	104	-	96	100
Oxford	(16)	107	90	-	99	-
Rosalind(b)	(26)	108	121	105	106	111

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

TABLE 4 Grain yield of barley varieties in Agzone 3 expressed as a per cent of the site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		4.95	3.76	3.59	4.41	3.61
	No. trials	(3)	(5)	(1)	(2)	(3)
DELIVERABLE AS A MALT VARIETY						
Bass[Φ]	(14)	98	88	91	90	93
Flinders[Φ]	(14)	102	99	97	97	98
La Trobe[Φ]	(14)	106	104	100	100	100
RGT Planet[Φ]	(6)	-	-	112	115	110
Scope CL[Φ]	(14)	92	89	96	94	96
Spartacus CL[Φ]	(14)	107	105	100	99	100
STAGE 2 MALT ACCREDITATION						
Banks[Φ]	(11)	-	108	105	104	103
Leabrook[Φ]	(11)	-	109	105	105	104
LG Alestar[Φ]	(9)	99	100	100	-	-
DELIVERABLE AS A FEED VARIETY						
Buff[Φ]	(3)	-	-	-	-	107
Compass[Φ]	(14)	103	102	101	100	101
Fathom[Φ]	(14)	97	98	101	100	100
Granger[Φ]	(14)	103	107	103	103	102
Litmus[Φ]	(11)	88	94	105	100	-
Lockyer[Φ]	(12)	102	102	-	102	101
Mundah	(11)	90	91	-	96	97
Oxford	(14)	103	99	96	98	99
Rosalind[Φ]	(14)	109	117	110	109	107

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

TABLE 5 Grain yield of barley varieties in Agzone 4 expressed as a per cent of the site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		0.36	2.82	-	1.45	3.34
	No. trials	(2)	(2)	(0)	(1)	(2)
DELIVERABLE AS A MALT VARIETY						
Bass[Φ]	(7)	85	96	-	100	93
Flinders[Φ]	(7)	89	98	-	98	94
La Trobe[Φ]	(7)	145	110	-	123	97
RGT Planet[Φ]	(3)	-	-	-	101	103
Scope CL[Φ]	(7)	93	96	-	97	103
Spartacus CL[Φ]	(7)	162	114	-	131	94
STAGE 2 MALT ACCREDITATION						
Banks[Φ]	(5)	-	107	-	110	101
Leabrook[Φ]	(5)	-	111	-	123	105
LG Alestar[Φ]	(4)	67	93	-	-	-
DELIVERABLE AS A FEED VARIETY						
Buff[Φ]	(3)	-	-	-	97	120
Compass[Φ]	(7)	156	112	-	127	102
Fathom[Φ]	(6)	118	103	-	109	107
Granger[Φ]	(5)	90	99	-	92	-
Litmus[Φ]	(5)	159	108	-	110	-
Lockyer[Φ]	(7)	86	98	-	97	102
Mundah	(7)	143	105	-	110	105
Oxford	(5)	42	90	-	80	-
Rosalind[Φ]	(7)	185	120	-	135	104

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

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TABLE 6 Grain yield of barley varieties in Agzone 5 expressed as a per cent of the site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		3.40	3.41	2.61	3.58	2.87
	No. trials	(4)	(4)	(1)	(4)	(3)
DELIVERABLE AS A MALT VARIETY						
Bass(b)	(16)	98	97	90	95	93
Flinders(b)	(15)	101	101	-	100	98
La Trobe(b)	(16)	108	112	96	104	104
RGT Planet(b)	(8)	-	-	121	111	112
Scope CL(b)	(13)	93	91	89	93	-
Spartacus CL(b)	(16)	107	116	97	103	105
STAGE 2 MALT ACCREDITATION						
Banks(b)	(12)	-	107	106	103	105
Leabrook(b)	(12)	-	113	97	109	108
LG Alestar(b)	(9)	95	94	107	-	-
DELIVERABLE AS A FEED VARIETY						
Buff(b)	(8)	-	-	102	101	106
Compass(b)	(16)	107	110	92	102	104
Fathom(b)	(16)	103	100	90	101	101
Granger(b)	(16)	98	101	113	102	102
Litmus(b)	(13)	79	91	97	87	-
Lockyer(b)	(16)	107	101	99	104	101
Mundah	(15)	84	93	-	88	97
Oxford	(15)	103	97	-	103	96
Rosalind(b)	(16)	111	120	105	109	113

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

TABLE 7 Grain yield of barley varieties in Agzone 6 expressed as a per cent of the site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		2.51	3.86	4.13	2.96	4.88
	No. trials	(2)	(2)	(2)	(1)	(2)
DELIVERABLE AS A MALT VARIETY						
Bass(b)	(9)	89	95	86	92	92
Flinders(b)	(9)	101	105	100	109	99
La Trobe(b)	(9)	99	103	96	89	98
RGT Planet(b)	(5)	-	-	127	128	114
Scope CL(b)	(7)	86	87	87	81	-
Spartacus CL(b)	(9)	95	106	95	92	97
STAGE 2 MALT ACCREDITATION						
Banks(b)	(7)	-	105	106	105	103
Leabrook(b)	(7)	-	102	102	81	102
LG Alestar(b)	(6)	104	104	106	-	-
DELIVERABLE AS A FEED VARIETY						
Buff(b)	(2)	-	-	-	-	106
Compass(b)	(9)	94	96	92	75	97
Fathom(b)	(9)	97	91	93	74	98
Granger(b)	(9)	107	111	112	127	105
Litmus(b)	(7)	68	83	90	82	-
Lockyer(b)	(9)	110	101	102	96	102
Mundah	(7)	71	85	-	81	92
Oxford	(9)	114	108	107	122	103
Rosalind(b)	(9)	105	108	108	91	105

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

TABLE 8 Grain yield of barley varieties averaged across Agzones 1–6 expressed as a per cent of the site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		2.85	3.11	3.84	3.50	3.92
	No. trials	(17)	(20)	(9)	(15)	(19)
DELIVERABLE AS A MALT VARIETY						
Bass(b)	(79)	96	93	91	94	94
Flinders(b)	(77)	102	100	97	99	97
La Trobe(b)	(80)	106	107	98	102	102
RGT Planet(b)	(42)	-	-	113	110	106
Scope CL(b)	(74)	91	91	96	95	98
Spartacus CL(b)	(80)	106	110	96	101	101
STAGE 2 MALT ACCREDITATION						
Banks(b)	(63)	-	107	103	103	102
Leabrook(b)	(63)	-	109	105	106	108
LG Alestar(b)	(43)	98	97	101	-	-
DELIVERABLE AS A FEED VARIETY						
Buff(b)	(35)	-	-	112	105	110
Compass(b)	(80)	103	106	99	102	105
Fathom(b)	(79)	99	99	101	101	105
Granger(b)	(67)	103	104	102	101	98
Litmus(b)	(61)	82	98	101	95	-
Lockyer(b)	(71)	104	100	102	102	102
Mundah	(67)	85	95	-	94	99
Oxford	(64)	104	96	99	100	95
Rosalind(b)	(80)	110	118	107	108	109

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

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TABLE 9 Comparisons between two varieties (yield difference compared using least significant difference, p=0.05) – how many times (as a per cent) was variety A (comparator variety) lower-yielding, the same yield or higher-yielding than variety B (base variety, La Trobe(Þ) or RGT Planet(Þ)) when sown together in WA barley NVT?

Variety A	Variety B	Per cent of trials			Comparison years	Number of trials	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 LA TROBE(Þ)							
Banks(Þ)	La Trobe(Þ)	11%	79%	10%	2015–2018	62	Banks(Þ) = La Trobe(Þ)
Bass(Þ)	La Trobe(Þ)	56%	44%	0%	2011–2018	130	Bass(Þ) ≤ La Trobe(Þ)
Buff(Þ)	La Trobe(Þ)	0%	69%	31%	2016–2018	35	Buff(Þ) ≥ La Trobe(Þ)
Compass(Þ)	La Trobe(Þ)	16%	70%	14%	2012–2018	114	Compass(Þ) = La Trobe(Þ)
Fathom(Þ)	La Trobe(Þ)	28%	62%	11%	2011–2018	130	Fathom(Þ) = La Trobe(Þ)
Flinders(Þ)	La Trobe(Þ)	35%	55%	10%	2011–2018	127	Flinders(Þ) ≤ La Trobe(Þ)
Granger(Þ)	La Trobe(Þ)	33%	57%	10%	2011–2018	116	Granger(Þ) ≤ La Trobe(Þ)
Leabrook(Þ)	La Trobe(Þ)	6%	74%	19%	2015–2018	62	Leabrook(Þ) = La Trobe(Þ)
LG Alestar(Þ)	La Trobe(Þ)	46%	49%	5%	2011–2016	82	LG Alestar(Þ) ≤ La Trobe(Þ)
Litmus(Þ)	La Trobe(Þ)	43%	42%	14%	2011–2017	92	Litmus(Þ) ≤ La Trobe(Þ)
Lockyer(Þ)	La Trobe(Þ)	26%	59%	14%	2011–2018	111	Lockyer(Þ) = La Trobe(Þ)
Mundah	La Trobe(Þ)	62%	36%	3%	2011–2018	118	Mundah < La Trobe(Þ)
Oxford	La Trobe(Þ)	48%	41%	11%	2011–2018	104	Oxford ≤ La Trobe(Þ)
RGT Planet(Þ)	La Trobe(Þ)	14%	48%	38%	2016–2018	42	RGT Planet(Þ) ≥ La Trobe(Þ)
Rosalind(Þ)	La Trobe(Þ)	4%	54%	43%	2014–2018	80	Rosalind(Þ) ≥ La Trobe(Þ)
Scope CL(Þ)	La Trobe(Þ)	52%	44%	4%	2011–2018	125	Scope CL(Þ) ≤ La Trobe(Þ)
Spartacus CL(Þ)	La Trobe(Þ)	11%	76%	13%	2014–2018	80	Spartacus CL(Þ) = La Trobe(Þ)
COMPARISONS WITH RGT PLANET(Þ)							
Banks(Þ)	RGT Planet(Þ)	33%	62%	5%	2016–2018	42	Banks(Þ) ≤ RGT Planet(Þ)
Bass(Þ)	RGT Planet(Þ)	61%	39%	0%	2016–2018	42	Bass(Þ) ≤ RGT Planet(Þ)
Buff(Þ)	RGT Planet(Þ)	20%	43%	37%	2016–2018	35	Buff(Þ) ≥ RGT Planet(Þ)
Compass(Þ)	RGT Planet(Þ)	36%	50%	14%	2016–2018	42	Compass(Þ) ≤ RGT Planet(Þ)
Fathom(Þ)	RGT Planet(Þ)	34%	54%	12%	2016–2018	41	Fathom(Þ) ≤ RGT Planet(Þ)
Flinders(Þ)	RGT Planet(Þ)	59%	38%	3%	2016–2018	39	Flinders(Þ) ≤ RGT Planet(Þ)
Granger(Þ)	RGT Planet(Þ)	30%	67%	3%	2016–2018	30	Granger(Þ) ≤ RGT Planet(Þ)
La Trobe(Þ)	RGT Planet(Þ)	38%	48%	14%	2016–2018	42	La Trobe(Þ) ≤ RGT Planet(Þ)
Leabrook(Þ)	RGT Planet(Þ)	24%	60%	17%	2016–2018	42	Leabrook(Þ) = RGT Planet(Þ)
LG Alestar(Þ)	RGT Planet(Þ)	63%	38%	0%	2016	8	LG Alestar(Þ) ≤ RGT Planet(Þ)
Litmus(Þ)	RGT Planet(Þ)	57%	22%	22%	2016–2017	23	Litmus(Þ) ≤ RGT Planet(Þ)
Lockyer(Þ)	RGT Planet(Þ)	35%	62%	3%	2016–2018	34	Lockyer(Þ) ≤ RGT Planet(Þ)
Mundah	RGT Planet(Þ)	43%	57%	0%	2017–2018	30	Mundah ≤ RGT Planet(Þ)
Oxford	RGT Planet(Þ)	59%	41%	0%	2016–2018	27	Oxford ≤ RGT Planet(Þ)
Rosalind(Þ)	RGT Planet(Þ)	24%	50%	26%	2016–2018	42	Rosalind(Þ) = RGT Planet(Þ)
Scope CL(Þ)	RGT Planet(Þ)	47%	50%	3%	2016–2018	36	Scope CL(Þ) ≤ RGT Planet(Þ)
Spartacus CL(Þ)	RGT Planet(Þ)	40%	50%	10%	2016–2018	42	Spartacus CL(Þ) ≤ RGT Planet(Þ)

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 10 Comparisons between two varieties (yield difference compared using least significant difference, p=0.05) – how many times (as a per cent) was variety A (comparator variety) lower-yielding, the same yield or higher-yielding than variety B (base variety, Rosalind(Φ), Bass(Φ), Flinders(Φ) or Spartacus CL(Φ)) when sown together in WA barley NVT?

Variety A	Variety B	Per cent of trials			Comparison years	Number of trials	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(Φ)							
Banks(Φ)	Rosalind(Φ)	37%	58%	5%	2015–2018	62	Banks(Φ) ≤ Rosalind(Φ)
Bass(Φ)	Rosalind(Φ)	72%	27%	1%	2014–2018	79	Bass(Φ) < Rosalind(Φ)
Buff(Φ)	Rosalind(Φ)	23%	51%	26%	2016–2018	35	Buff(Φ) = Rosalind(Φ)
Compass(Φ)	Rosalind(Φ)	39%	59%	3%	2014–2018	80	Compass(Φ) ≤ Rosalind(Φ)
Fathom(Φ)	Rosalind(Φ)	51%	44%	5%	2014–2018	79	Fathom(Φ) ≤ Rosalind(Φ)
Flinders(Φ)	Rosalind(Φ)	66%	31%	3%	2014–2018	77	Flinders(Φ) < Rosalind(Φ)
Granger(Φ)	Rosalind(Φ)	46%	51%	3%	2014–2018	67	Granger(Φ) ≤ Rosalind(Φ)
La Trobe(Φ)	Rosalind(Φ)	43%	54%	4%	2014–2018	80	La Trobe(Φ) ≤ Rosalind(Φ)
Leabrook(Φ)	Rosalind(Φ)	24%	71%	5%	2014–2018	62	Leabrook(Φ) = Rosalind(Φ)
LG Alestar(Φ)	Rosalind(Φ)	65%	35%	0%	2014–2016	43	LG Alestar(Φ) ≤ Rosalind(Φ)
Litmus(Φ)	Rosalind(Φ)	68%	25%	7%	2014–2017	60	Litmus(Φ) < Rosalind(Φ)
Lockyer(Φ)	Rosalind(Φ)	48%	46%	6%	2014–2018	71	Lockyer(Φ) ≤ Rosalind(Φ)
Mundah	Rosalind(Φ)	82%	16%	1%	2014–2016,2018	67	Mundah < Rosalind(Φ)
Oxford	Rosalind(Φ)	55%	41%	5%	2014–2018	64	Oxford ≤ Rosalind(Φ)
RGT Planet(Φ)	Rosalind(Φ)	26%	50%	24%	2016–2018	42	RGT Planet(Φ) = Rosalind(Φ)
Scope CL(Φ)	Rosalind(Φ)	72%	26%	3%	2014–2018	74	Scope CL(Φ) < Rosalind(Φ)
Spartacus CL(Φ)	Rosalind(Φ)	40%	56%	4%	2014–2018	80	Spartacus CL(Φ) ≤ Rosalind(Φ)
COMPARISONS WITH BASS(Φ)							
Banks(Φ)	Bass(Φ)	0%	39%	61%	2015–2018	61	Banks(Φ) ≥ Bass(Φ)
Flinders(Φ)	Bass(Φ)	4%	59%	37%	2011–2018	126	Flinders(Φ) ≥ Bass(Φ)
Leabrook(Φ)	Bass(Φ)	2%	26%	72%	2015–2018	61	Leabrook(Φ) > Bass(Φ)
LG Alestar(Φ)	Bass(Φ)	7%	65%	27%	2011–2016	81	LG Alestar(Φ) = Bass(Φ)
Spartacus CL(Φ)	Bass(Φ)	1%	48%	51%	2014–2018	79	Spartacus CL(Φ) ≥ Bass(Φ)
COMPARISONS WITH FLINDERS(Φ)							
Banks(Φ)	Flinders(Φ)	5%	53%	42%	2015–2018	59	Banks(Φ) ≥ Flinders(Φ)
Leabrook(Φ)	Flinders(Φ)	5%	46%	49%	2015–2018	59	Leabrook(Φ) ≥ Flinders(Φ)
LG Alestar(Φ)	Flinders(Φ)	31%	61%	8%	2011–2016	80	LG Alestar(Φ) = Flinders(Φ)
Spartacus CL(Φ)	Flinders(Φ)	6%	56%	38%	2014–2018	77	Spartacus CL(Φ) ≥ Flinders(Φ)
COMPARISONS WITH SPARTACUS CL(Φ)							
Banks(Φ)	Spartacus CL(Φ)	15%	69%	16%	2015–2018	62	Banks(Φ) = Spartacus CL(Φ)
Buff(Φ)	Spartacus CL(Φ)	9%	43%	49%	2016–2018	35	Buff(Φ) ≥ Spartacus CL(Φ)
Compass(Φ)	Spartacus CL(Φ)	14%	76%	10%	2014–2018	80	Compass(Φ) = Spartacus CL(Φ)
Fathom(Φ)	Spartacus CL(Φ)	27%	57%	16%	2014–2018	79	Fathom(Φ) = Spartacus CL(Φ)
Leabrook(Φ)	Spartacus CL(Φ)	15%	60%	26%	2015–2018	62	Leabrook(Φ) = Spartacus CL(Φ)
Litmus(Φ)	Spartacus CL(Φ)	50%	42%	8%	2014–2017	60	Litmus(Φ) ≤ Spartacus CL(Φ)
Scope CL(Φ)	Spartacus CL(Φ)	51%	43%	5%	2014–2018	74	Scope CL(Φ) ≤ Spartacus CL(Φ)

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

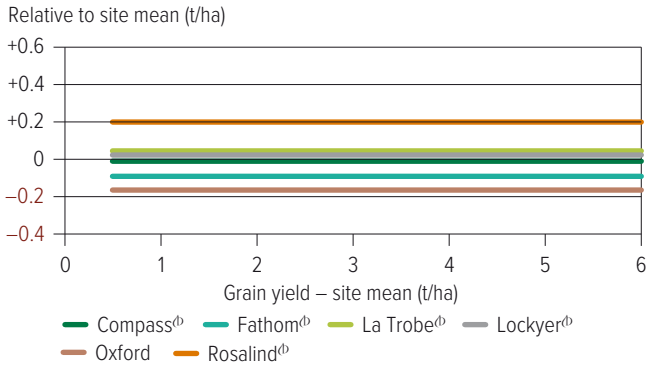
GRAIN YIELD – FEED BARLEY COMPARISONS

The highest yielding varieties in WA are Rosalind$^{\Phi}$ and RGT Planet$^{\Phi}$, with Buff$^{\Phi}$ excelling on soils with an acidic profile (Figures 2 and 3, Tables 2 to 10). RGT Planet$^{\Phi}$ appears to have the highest yield potential at sites above 4t/ha and Rosalind$^{\Phi}$ has the advantage below 2t/ha. The feed varieties Fathom$^{\Phi}$, Compass$^{\Phi}$ and Lockyer$^{\Phi}$ have comparable yields to the malt variety La Trobe$^{\Phi}$, with Compass$^{\Phi}$ appearing to do better in Agzones 1 and 4 and Lockyer$^{\Phi}$ doing better in Agzone 6 than La Trobe$^{\Phi}$. Those four varieties, however, are generally inferior to Rosalind$^{\Phi}$ and RGT Planet$^{\Phi}$. Rosalind$^{\Phi}$ and RGT Planet$^{\Phi}$ were superior to La Trobe$^{\Phi}$ in two of every five barley NVT. The average fitted yield advantage over La Trobe$^{\Phi}$ was 0.17t/ha ($p<0.01$) for Rosalind$^{\Phi}$, and 0.19t/ha ($p<0.05$) for RGT Planet$^{\Phi}$ (Figure 3).

GRAIN YIELD – MALT BARLEY COMPARISONS

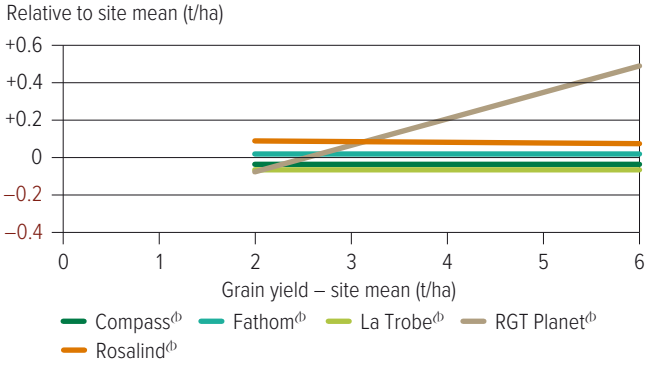
RGT Planet$^{\Phi}$ is the highest-yielding variety segregated for malt, being higher yielding in three of every five comparisons with Bass$^{\Phi}$ and Flinders$^{\Phi}$, half of the direct comparisons with Scope CL$^{\Phi}$, and two of every five comparisons with La Trobe$^{\Phi}$ and Spartacus CL$^{\Phi}$. The advantage of RGT Planet$^{\Phi}$ is apparent above 4t/ha, but for most growers whose harvested yield is most likely to be between 2–4t/ha, there is unlikely to be any significant difference between RGT Planet$^{\Phi}$, Spartacus CL$^{\Phi}$ and La Trobe$^{\Phi}$. While La Trobe$^{\Phi}$ and Spartacus CL$^{\Phi}$ appear to have similar yield, yielding the same in three out of every four barley trials, Figure 4 suggests that Spartacus CL$^{\Phi}$ may be a slightly better option below 2t/ha while La Trobe$^{\Phi}$ may have a slight advantage above 4t/ha. This subtle difference, however, is probably relatively inconsequential to choosing whether to grow La Trobe$^{\Phi}$ or Spartacus CL$^{\Phi}$. The need for an imidazolinone herbicide, the presence of an imidazolinone residue, market signals and differences in their grain quality have a more significant bearing on which variety to grow of those two than subtle differences in their grain yield.

FIGURE 2 Fitted grain yield of Compass$^{\Phi}$, Fathom$^{\Phi}$, Lockyer$^{\Phi}$, Oxford and Rosalind$^{\Phi}$ at different site mean yields (2014–2018).



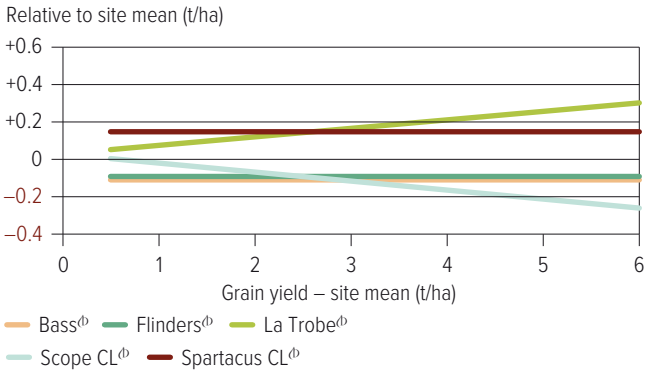
SOURCE: DATA FROM 2014–2018 DPIRD-GRDC BARLEY AGRONOMY AND 2014–2018 GRDC NVT. EACH VARIETY SOWN IN ALL 71 TRIAL-YEARS OF DATA

FIGURE 3 Fitted grain yield of Compass$^{\Phi}$, Fathom$^{\Phi}$, La Trobe$^{\Phi}$, RGT Planet$^{\Phi}$ and Rosalind$^{\Phi}$ at different site mean yields (2016–2018).



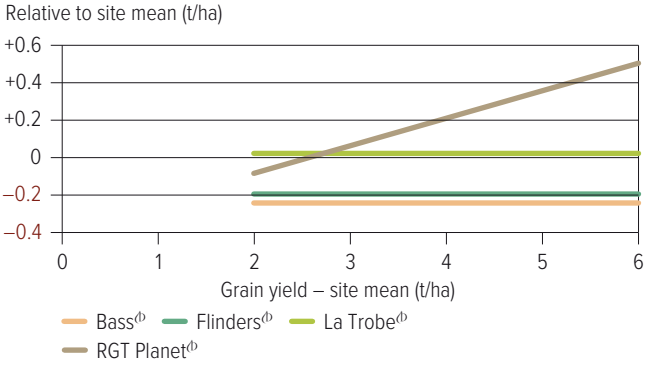
SOURCE: DATA FROM 2016, 2018 DPIRD-GRDC BARLEY AGRONOMY AND 2016–2018 GRDC NVT. EACH VARIETY SOWN IN ALL 51 TRIAL-YEARS OF DATA

FIGURE 4 Fitted grain yield of Bass$^{\Phi}$, Flinders$^{\Phi}$, La Trobe$^{\Phi}$, Scope CL$^{\Phi}$ and Spartacus CL$^{\Phi}$ at different site mean yields (2014–2018).



SOURCE: DATA FROM 2015–2018 DPIRD-GRDC BARLEY AGRONOMY AND 2014–2018 GRDC NVT. EACH VARIETY SOWN IN ALL 112 TRIAL-YEARS OF DATA

FIGURE 5 Fitted grain yield of Bass$^{\Phi}$, Flinders$^{\Phi}$, La Trobe$^{\Phi}$ and RGT Planet$^{\Phi}$ at different site mean yields (2016–2018).



SOURCE: DATA FROM 2016–2018 DPIRD-GRDC BARLEY AGRONOMY AND GRDC NVT. EACH VARIETY SOWN IN ALL 89 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 traits such as straw strength and head loss resistance. However, while grain yield is essential when comparing varieties segregated for malt, their grain quality characteristics are almost equally as important for those chasing the premium on offer for delivery as a Malt1 barley.

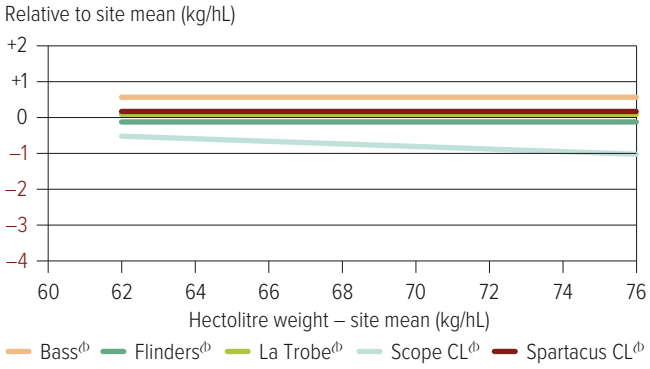
As with the grain yield data presented in Figures 2 to 5, the physical grain quality (hectolitre weight, screenings through a 2.5mm slotted sieve and grain brightness) of a malt variety was plotted relative to the site mean as the site mean increases (Figures 6 to 11). The deviation from the site mean 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 include DPIRD–GRDC (DAW00190 and DAW00224) barley agronomy grain quality data (replicated) in addition to GRDC NVT barley grain quality data (not replicated). In some trials where Scope CL$^{\Phi}$ was absent, Buloke$^{\Phi}$ data substituted (due to the closeness of their relationships with each other).

Figures 6 and 7 compare the hectolitre weight of varieties segregated for malt in WA, Figures 8 and 9 present grain plumpness (per cent through a 2.5mm sieve) comparisons, while Figures 10 and 11 graph grain brightness as the level of weather damage at a site decreased.

Grain quality – hectolitre weight comparisons

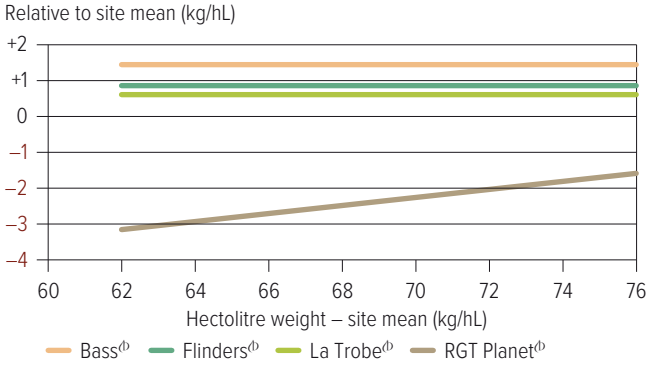
Bass$^{\Phi}$ is the current benchmark variety for hectolitre weight of the six varieties segregated for malt in WA, being slightly higher (+0.5 to 0.7 kg/hL, $p<0.05$) than Flinders$^{\Phi}$, La Trobe$^{\Phi}$ and Spartacus CL$^{\Phi}$, which are similar (Figures 6 and 7). Scope CL$^{\Phi}$ averaged nearly 1kg/hL below Spartacus CL$^{\Phi}$ ($p<0.001$), while the hectolitre weight of RGT Planet$^{\Phi}$ is significantly lower (around 2-3kg/hL lower) than the other five varieties segregated for malt in WA. RGT Planet$^{\Phi}$, therefore, has the highest risk of not meeting Malt1 hectolitre specifications in WA. Conditions that favour a low hectolitre weight in RGT Planet$^{\Phi}$ are often associated with high grain plumpness and, conversely, high hectolitre is often associated with low grain plumpness in RGT Planet$^{\Phi}$. Those observations reflect the elongated grain shape of RGT Planet$^{\Phi}$ kernels.

FIGURE 6 Fitted hectolitre weight of Bass$^{\Phi}$, Flinders$^{\Phi}$, La Trobe$^{\Phi}$, Scope CL$^{\Phi}$ and Spartacus CL$^{\Phi}$ at different site mean hectolitre weights (2014–2018).



SOURCE: DATA FROM 2015–2018 DPIRD-GRDC BARLEY AGRONOMY AND 2014–2018 GRDC NVT. EACH VARIETY SOWN IN ALL 112 TRIAL-YEARS OF DATA

FIGURE 7 Fitted hectolitre weight of Bass$^{\Phi}$, Flinders$^{\Phi}$, La Trobe$^{\Phi}$ and RGT Planet$^{\Phi}$ at different site mean hectolitre weights (2016–2018).



SOURCE: DATA FROM 2016–2018 DPIRD-GRDC BARLEY AGRONOMY AND GRDC NVT. EACH VARIETY SOWN IN ALL 89 TRIAL–YEARS OF DATA

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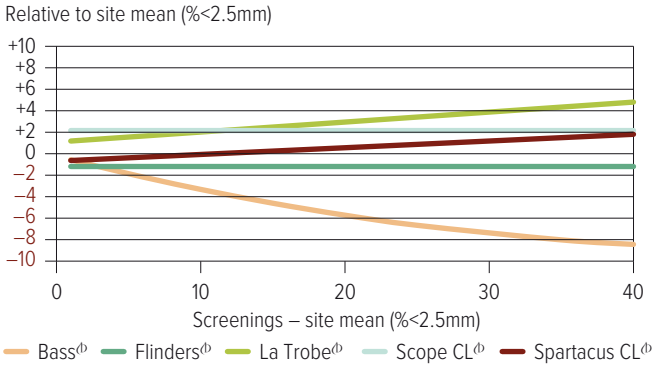
Grain quality – grain plumpness comparisons

The benchmark malt variety for grain plumpness is Bass$^{\phi}$ (Figures 8 and 9), 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$^{\phi}$, although generally less plump than Bass$^{\phi}$, shows improved plumpness compared with other malt varieties. Scope CL$^{\phi}$ shows similar plumpness to La Trobe$^{\phi}$, although both are generally inferior to Spartacus CL$^{\phi}$ for plumpness. Screenings of Spartacus CL$^{\phi}$ are likely to be around two per cent less than La Trobe$^{\phi}$ under the same agronomy. RGT Planet$^{\phi}$ appears to behave more like Baudin$^{\phi}$ (data not shown) than Bass$^{\phi}$ or Flinders$^{\phi}$, with screenings comparable to or slightly higher than La Trobe$^{\phi}$. RGT Planet$^{\phi}$ exhibits a higher risk of exceeding screenings limits compared with other malt varieties, particularly in seasons with a tight finish. At very low screenings, most varieties are similar, but around the Malt1 limit of 20 per cent screenings genetic differences are notable. This may influence Malt1 selection rates across paddocks and seasons, and in response to management treatments.

Grain quality – grain brightness comparisons

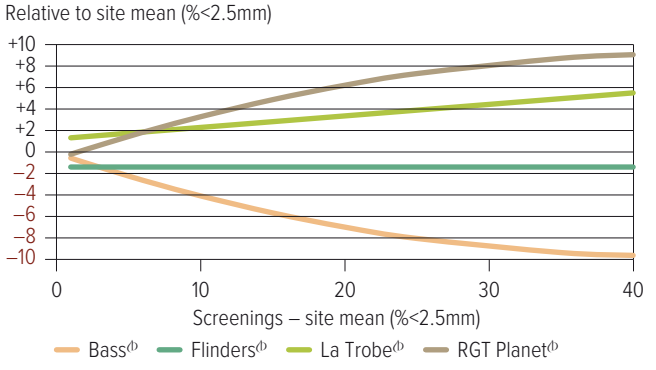
At grain brightness levels below 60 'L*', the benchmark malt varieties are Bass$^{\phi}$ and Flinders$^{\phi}$ (Figures 10 and 11), which are similar to or slightly darker than Baudin$^{\phi}$ (data not shown). La Trobe$^{\phi}$ kernels can be up to 1'L*' darker and Scope CL$^{\phi}$ kernels 0.5'L*' darker than Bass$^{\phi}$ kernels. The grain brightness of Spartacus CL$^{\phi}$ is a slight improvement over La Trobe$^{\phi}$, being higher on average by 0.4'L*' ($p<0.001$) across a range of grain brightness levels. At sites close to the receival limit for Malt1, the brightness of Spartacus CL$^{\phi}$ is comparable to Scope CL$^{\phi}$, with differences exacerbated at sites that produced brighter grain. RGT Planet$^{\phi}$ appears to have a grain brightness between Bass$^{\phi}$ and La Trobe$^{\phi}$.

FIGURE 8 Fitted screenings of Bass$^{\phi}$, Flinders$^{\phi}$, La Trobe$^{\phi}$, Scope CL$^{\phi}$ and Spartacus CL$^{\phi}$ at different site mean screenings (2014–2018).



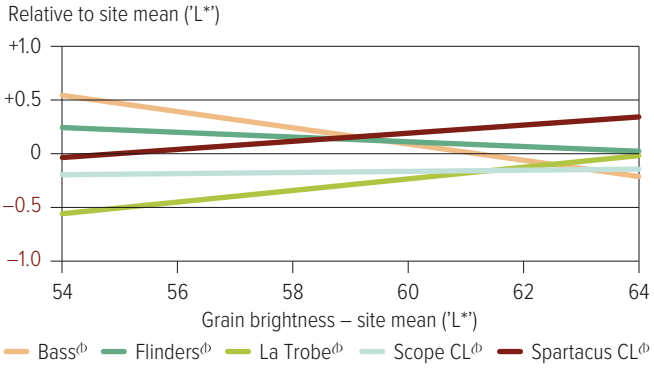
SOURCE: DATA FROM 2015–2018 DPIRD-GRDC BARLEY AGRONOMY AND 2014–2018 GRDC NVT. EACH VARIETY SOWN IN ALL 112 TRIAL-YEARS OF DATA

FIGURE 9 Fitted screenings of Bass$^{\phi}$, Flinders$^{\phi}$, La Trobe$^{\phi}$ and RGT Planet$^{\phi}$ at different site mean screenings (2016–2018).



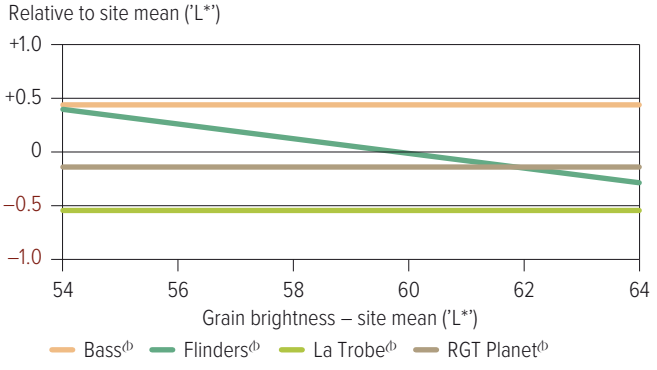
SOURCE: DATA FROM 2016–2018 DPIRD-GRDC BARLEY AGRONOMY AND GRDC NVT. EACH VARIETY SOWN IN ALL 89 TRIAL-YEARS OF DATA

FIGURE 10 Fitted grain brightness of Bass$^{\phi}$, Flinders$^{\phi}$, La Trobe$^{\phi}$, Scope CL$^{\phi}$ and Spartacus CL$^{\phi}$ at different site mean grain brightness (2014–2018).



SOURCE: DATA FROM 2015–2018 DPIRD-GRDC BARLEY AGRONOMY AND 2014–2018 GRDC NVT. EACH VARIETY SOWN IN ALL 112 TRIAL-YEARS OF DATA

FIGURE 11 Fitted grain brightness of Bass$^{\phi}$, Flinders$^{\phi}$, La Trobe$^{\phi}$ and RGT Planet$^{\phi}$ at different site mean grain brightness (2016–2018).



SOURCE: DATA FROM 2016–2018 DPIRD-GRDC BARLEY AGRONOMY AND GRDC NVT. EACH VARIETY SOWN IN ALL 89 TRIAL-YEARS OF DATA

DISEASE 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
- BYDV = barley yellow dwarf virus
- CYDV = cereal yellow dwarf virus

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

Seedling and adult resistance

Disease, virus and nematode resistance data are presented in Tables 11 to 13 and again in the variety snapshots. Leaf disease ratings in the barley section of this guide include seedling and adult-stage resistance ratings for the foliar leaf diseases NTNB, STNB, PM and BLR. There is no seedling data for scald, so only the adult-stage resistance is presented. This year adult resistance ratings (although provisional at this stage) to Oxford virulent NTNB are shown.

Seedling ratings are applicable at early growth stages (two to three-leaf stage) and are important for making decisions on the use of seed or fertiliser-applied fungicide treatments. They 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 early 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), but in some varieties and for some diseases the adult ratings may be applicable as early as late tillering to stem elongation. The variation between the seedling and adult rating of a variety is most likely due to the effectiveness of resistance genes at one or the other stage.

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 for a couple of the varieties listed since the last sowing guide, usually up or down one resistance score, but there have been no significant changes in resistance score as the result of a new pathotype.

New pathotype – NTNB

Be watchful for increased NTNB with a new aggressive pathotype, named Oxford virulent, detected across the south coast. Banks[ϕ] and Granger[ϕ] have the best overall resistance to this new pathotype, being rated as MRMS as seedlings and MS*p* as adult plants. The next best resistance is Buff[ϕ] (MS as seedling and adult), Compass[ϕ] (S as seedling and MS as an adult), Leabrook[ϕ] (MSS as seedling and adult), and LG Alestar[ϕ] (MS as seedling and MSS as an adult). Other varieties are provisionally rated as S to the Oxford virulent NTNB pathotype as adult plants.

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. They are the first recorded detections of this disease in WA. While first detected in Tasmania in 2016 it is present in our neighbouring countries New Zealand (first detected in 1997) and South Africa (first detected in 2015). It is also found in important barley-growing regions such as Scotland, mid-Europe, Argentina and Uruguay. In those environments, it is estimated to cause losses up to 25 per cent and in extreme cases up to 70 per cent of the yield potential through a significant decrease of kernel size and quality.

The fungus is primarily a disease of barley but can infect a wide range of hosts including oats, wheat and a few kinds of grass. 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

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infected barley and grasses, although this generally requires prolonged periods of leaf wetness. Identification of the disease can be difficult as lesions are generally not evident until after flowering and can be easily confused with other similar fungal leaf spotting diseases such as STNB or abiotic symptoms caused by physiological leaf-spotting and boron toxicity (although these abiotic spots are not likely to respond to fungicide application). The potential impact of this disease in WA barley crops is unknown. There are no specific management recommendations for the disease in WA at this stage; however, the fungicides used to manage net blotches in barley, applied at the booting stage, are likely to be active on RLS.

Disease surveillance

Growers and consultants observing barley varieties rated as MRMS, MR or R to scald, NTNB, STNB, PM or BLR carrying significantly higher levels of disease than expected should collect infected material for pathotype identification and fungicide resistance testing. Before spraying the crop with a fungicide, collect leaf samples 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-infected individual leaves to be placed into agar tubing to maintain a live culture for pathotyping. Sample collection kits for PM need to be sourced 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 ACRCP Annual Cereal Rust Survey, Plant Breeding Institute, 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 have been detected in WA. Fungicide management to address resistance issues and to reduce future resistance development will increasingly require the use of fungicide mixtures containing different modes of action, including strobilurins (for example, azoxystrobin and pyraclostrobin) and SDHI (for example, fluxapyroxad and bixafen); and avoiding repetitive applications of single active ingredients or fungicide group.

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 RLS 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 increase the prevalence of scald, especially with early sowing opportunities. A severe early infection can reduce the head number and grain number. Yield losses of up to 45 per cent 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$^{\Phi}$, LG Alestar$^{\Phi}$, Litmus$^{\Phi}$ and Mundah.

Net-type net blotch

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

The CCDM has discovered populations of NTNB resistant to the triazole based DMI fungicide tebuconazole and some other types of triazole fungicides in central and southern regions, including one population in the Esperance region with higher resistance to the DMI fungicides tebuconazole and propiconazole.

Fungicide management of NTNB to address resistance issues and to reduce future resistance development will increasingly require the use of fungicide mixtures containing different modes of action including strobilurins (for example, azoxystrobin and pyraclostrobin) and SDHI (for example, fluxapyroxad 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 was prevalent throughout the state, whereas the Beecher virulent (attacking) isolate was 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, the varietal response will vary accordingly. Litmus$^{\Phi}$ is the most vulnerable variety to NTNB, being susceptible to all three major pathotypes present in WA. In the presence of the Oxford virulent pathotype, Banks$^{\Phi}$, Buff$^{\Phi}$, Compass$^{\Phi}$, Granger$^{\Phi}$, Leabrook$^{\Phi}$ and LG Alestar$^{\Phi}$ have the best 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 due to the lack of seedling resistance in commercially grown varieties.

Spot-type net blotch

STNB develops as small circular or elliptical dark brown spots that become surrounded by a chlorotic zone of varying width. These spots do not elongate to the net-like pattern characteristic of 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 per cent and affect the quality of 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, although this resistant population is also slightly less sensitive to the newer DMIs such as prothioconazole.

Fungicide management of STNB to address resistance issues in the southern regions and reduce future development regionally will increasingly require the use of fungicide mixtures and alternating of products including effective DMI ingredients and modes of action including strobilurins (for example, azoxystrobin and pyraclostrobin) and SDHI (for example, fluxapyroxad and bixafen). As outlined in the disease introduction, where fungicide resistance is suspected samples should be sent to the CCDM for assessment.

Fathom$^{\Phi}$ (MR as a seedling and MRMS as an adult) has the best-combined seedling and adult resistance to STNB of the current varieties. Compass$^{\Phi}$ has some tolerance to STNB, rated as MRMS as a seedling and MSS as an adult. Leabrook$^{\Phi}$ is MS at both stages.

Some varieties susceptible at the adult plant stage have some tolerance at the seedling stage (i.e. Bass$^{\Phi}$ has intermediate resistance at the seedling stage but is susceptible at the adult stage). Partial tolerance at the seedling stage reduces the likelihood of severe early infection, but, like Bass$^{\Phi}$, STNB can still infect 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 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 turn grey and may develop small black fruiting bodies. Early infection can cause yield losses of up to 25 per cent, whereas yield losses at the end of stem elongation reduce yield by around 10 per cent.

The variety with the highest risk of PM is Baudin$^{\Phi}$ (but is no longer suggested to grow), although Oxford may now be susceptible in the lower Great Southern in the presence of the *Ml(St)* virulent pathotype.

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 other modes of action, such as strobilurins (for example, azoxystrobin and pyraclostrobin), SDHI (for example, fluxapyroxad) and amines (spiroxamine), have uncompromised activity against PM.

Varieties grown in WA with intermediate resistance or above (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 such as Granger$^{\Phi}$, LG Alestar$^{\Phi}$, and RGT Planet$^{\Phi}$ 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 believed to be restricted to the south coast at present.

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

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

Virulence to the *MlLa* gene has been detected in barley growing in northern NSW and Queensland, resulting in varieties such as Compass$^{\Phi}$, La Trobe$^{\Phi}$, Rosalind and Spartacus CL$^{\Phi}$ 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, although there are reports of increased virulence on varieties other than Oxford (i.e. Rosalind$^{\Phi}$) in the Stirlings to Coast area. Growers should report a suspected breakdown in varietal resistance for varieties rated as MRMS and above to PM.

Barley leaf rust

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) 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 more than 30 per cent 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$^{\Phi}$) to BLR. Only varieties that carry genes different from *Rph3* or APR genes have some resistance. APR genes usually provide moderate levels of resistance and are not pathotype specific, so are unlikely to be affected by any future pathotype changes. APR resistance 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), so there may still be a need to protect those varieties at early growth stages from early infection.

Temperature and varietal background influence the effectiveness of the *Rph20* gene. Although Flinders$^{\Phi}$, Granger$^{\Phi}$, LG Alestar$^{\Phi}$, Oxford and RGT Planet$^{\Phi}$ all carry the APR *Rph20* gene, their field reaction may vary depending on which allele they have and other minor genes they may carry. 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$^{\Phi}$ 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.

As there are no fungicide options to control crown rot once the crop has established, inoculum levels can be reduced by including non-cereals into the rotation (such as pulses, oilseed, lupin and grass-free pasture), inter-row seeding and maintaining reasonable grass weed control in break crops and between crops.

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$^{(\phi)}$ has the lowest yield loss of the varieties tested in the presence of high crown rot.

Barley and cereal yellow dwarf

Both barley yellow dwarf virus (BYDV) and cereal yellow dwarf virus (CYDV) viruses occur in WA. As the screening for varietal resistance occurs in the field, the resistance score reflects the rating to both being present, although BYDV is more frequent than CYDV at a ratio of approximately 2:1. BYDV can reduce grain yield by up to 80 per cent with seedling infection and up to 20 per cent 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 impact of aphid feeding on plant growth. Varietal resistance to BYDV and CYDV, 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 per cent of tillers with 15 or more aphids).

Russian wheat aphid

Russian wheat aphid (*Diuraphis noxia*) (RWA) has not yet been detected in WA (as of November 2019) but is present in South Australia, Victoria, Tasmania and New South Wales. 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 leaf markings and rolling 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.

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 adjacent areas are necessary control measures.

Chemical control is the primary cultural means of reducing damage from RWA. Chlorpyrifos and pirimicarb are registered for control under two Australian Pesticides and Veterinary Medicines Authority (APVMA) emergency use permits. Prophylactic spraying is discouraged and growers should only spray when economic thresholds are reached.

In WA, report RWA aphid activity (including surveillance resulting in no detection) using the MyPestGuide Reporter, available for Apple and Android smartphones and tablets. The MyPestGuide Reporter is a photographic reporting tool that lets users take up to four photos, map their pest observations and communicate directly with DPIRD.

Root lesion nematodes

Root lesion nematodes (*Pratylenchus* spp) (RLN) are microscopic, worm-like animals that feed on plant roots causing yield loss in susceptible crops including wheat, barley and canola.

At least six million hectares (74 per cent) of WA's broadacre cropping paddocks are infested with RLN, an increase of 11 per cent since an initial statewide survey conducted in 1997-98. Of the 765 paddock samples assessed in the 2014-15 seasons, at least 50 per cent of infested paddocks had RLN at potentially yield-limiting levels. *P. neglectus* was the most frequent RLN, occurring in at least 63 per cent of infested paddocks. *P. quasitereoides* (formerly *P. teres*), unique to WA, was the next most common RLN at around 26 per cent of infected paddocks surveyed.

Cereal yield losses due to RLN are seasonally dependent and are in the order of 5-30 per cent but can be higher. RLN species *Pratylenchus neglectus* and *P. quasitereoides* can cause losses of up to 18 per cent in barley crops. The actual yield loss due to RLN in different barley varieties is not

yet quantified, but the impact of different varieties on nematode populations varies.

The *P. neglectus* and *P. quasitereoides* nematode resistance scores in this sowing guide only reflect WA based observations. The ratings are based on glasshouse trials between 2009–14 for both RLN species plus field trials in 2014-15 for *P. quasitereoides* (three trials) and 2015 for *P. neglectus* (three trials). Provisional ratings are provided for varieties with fewer than three observations, or where there has been no field trial verification of the glasshouse rating.

TABLE 11 Seedling (two to 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(D)	-	MR	S	VS	MRMS	MSS	SVS
Flinders(D)	-	MRMS	MSS	SVS	MSS	R	MS
La Trobe(D)	-	MS	MRMS	S	S	MSS	MS
RGT Planet(D)	-	MRMS	MRMS	S	S	R	MSS
Scope CL(D)	-	MR	MR	S	MSS	R	S
Spartacus CL(D)	-	MS	MRMS	S	SVS	MS	MS
STAGE 2 MALT ACCREDITATION							
Banks(D)	-	MRMS	MS	MRMS	MSS	MRMS	S
Leabrook(D)	-	MRMS	MS	MSS	MS	MR	SVS
LG Alestar(D)	-	MS	MS	MS	S	RMR	MRMS
DELIVERABLE AS A FEED VARIETY							
Buff(D)	-	MRMS	MRMS	MS	MS	S	SVS
Compass(D)	-	MRMS	S	S	MRMS	MRMS	S
Fathom(D)	-	S	MSS	VS	MR	MS	MSS
Granger(D)	-	MRMS	MRMS	MRMS	MSS	R	MS
Litmus(D)	-	MSS	S	S	S	MS	S
Lockyer(D)	-	MR	MR	S	S	MS	S
Mundah	-	S	MS	MSS	MSS	SVS	S
Oxford	-	RMR	MR	S	S	R*	MSS
Rosalind(D)	-	MR	MR	MSS	MS	MS	MRMS

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/s 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 mainly north of Great Eastern Highway, while in the southern regions of WA a new pathotype (Oxford) is present.
[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 stage. *Oxford may show a susceptible reaction where virulence against the *Ml(St)* mildew gene (present in Oxford) exists. There are reports of increased virulence of powdery mildew on Rosalind(D) in the Stirlings to Coast area.

TABLE 12 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]	Adult	Adult	Adult	Adult	Adult	Adult	Adult
DELIVERABLE AS A MALT VARIETY							
Bass(ф)	MRMS	MRMS	MSS	S*p*	S	MSS	SVS
Flinders(ф)	MSS	MRMS	MS	S*p*	S	R	MRMS (late APR)
La Trobe(ф)	MR	MS	MRMS	S*p*	SVS	MS	S
RGT Planet(ф)	MRMS	SVS	MRMS	S*p*	S	R	MRMS (late APR)
Scope CL(ф)	MS	MRMS	MRMS	S*p*	S	R	MSS
Spartacus CL(ф)	MR	MS	MRMS	S*p*	SVS	MRMS	MSS
STAGE 2 MALT ACCREDITATION							
Banks(ф)	S	MS	MS	MS*p*	S	MR	MSS
Leabrook(ф)	MSS	MS	MRMS	MSS	MS	MR	S
LG Alestar(ф)	S	MS	MRMS	MSS	S	MR	MRMS
DELIVERABLE AS A FEED VARIETY							
Buff(ф)	MSS	MRMS	MRMS	MS*p*	S	S	S
Compass(ф)	MS	MRMS	MS	MS*p*	MSS	MRMS	S
Fathom(ф)	MR	S	MSS	S*p*	MRMS	MRMS	MRMS (late APR)
Granger(ф)	MSS	MS	MRMS	MS*p*	SVS	R	MRMS (APR)
Litmus(ф)	SVS	S	S	S*p*	S	MR	S
Lockyer(ф)	MRMS	MS	MRMS	S*p*	S	MS	S
Mundah	S	S	MS	S*p*	S	MSS	S
Oxford	MSS	MRMS	MR	S*p*	S	MR*	MRMS (APR)
Rosalind(ф)	MSS	MS	MR	S*p*	S	MRMS	MR

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/s 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 mainly north of Great Eastern Highway, while in the southern regions of WA a new pathotype (Oxford) is present.
[5] Powdery mildew: *Oxford may show a susceptible reaction where virulence against the *Ml(St)* mildew gene (present in Oxford) exists. There are reports of increased virulence of powdery mildew on Rosalind(ф) in the Stirlings to Coast area.

TABLE 13 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] virus	Root lesion nematode[4]		Cereal cyst nematode[5]
Pathogen	*Fusarium pseudograminearum*		*Pratylenchus neglectus*	*Pratylenchus quasitereoides*	*Heterodera avenae*
Growth stage[2]	Seedling & adult	Seedling & adult	Seedling & adult	Seedling & adult	Seeding & adult
DELIVERABLE AS A MALT VARIETY					
Bass(D)	High	MS	MSS	MSS	S
Flinders(D)	High	MRMS	MS*p*	MSS*p*	S
La Trobe(D)	Moderate	S	MS	MSS	R
RGT Planet(D)	-	MS	-	-	R*p*
Scope CL(D)	High	MRMS	MSS	MS	S
Spartacus CL(D)	Moderate	S	-	-	R
STAGE 2 MALT ACCREDITATION					
Banks(D)	-	MS	-	-	-
Leabrook(D)	-	MSS	-	-	R
LG Alestar(D)	-	MRMS	-	-	R
DELIVERABLE AS A FEED VARIETY					
Buff(D)	-	MRMS	-	-	S
Compass(D)	High	MSS	MSS	S	R
Fathom(D)	Moderate	MRMS	MS*p*	MSS*p*	R
Granger(D)	High	MS	MS	MSS	R
Litmus(D)	Low	S	-	-	MS
Lockyer(D)	-	MS	-	-	-
Mundah	Moderate	MS	-	MRMS*p*	S
Oxford	-	MRMS	-	-	S
Rosalind(D)	Moderate	MSS	-	-	R

SOURCE: CROWN ROT – DANIEL HUBERLI, VIRUS – SANJIV GUPTA, NEMATODES – SARAH COLLINS

[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 virus: 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 impact of aphid feeding on plant growth.
[4] Root lesion nematode: barley varieties vary in the impact of root lesion nematode on their growth. A resistant variety retards nematode development, leading to lower nematode levels in the soil for subsequent crops. *Pratylenchus teres* has been renamed *Pratylenchus quasitereoides*. Ratings based on data collected in WA.
[5] Cereal cyst nematode: all barley varieties are tolerant of cereal cyst nematode, but a resistant variety retards nematode development, leading to lower nematode levels in the soil for subsequent crops.

Cereal cyst nematode

Cereal cyst nematode (*Heterodea avenae*) (CCN) is present in cropping regions around Geraldton and the Avon Valley around Northam, but it can occur in any area. 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.

VARIETY SNAPSHOTS

Variety snapshots are presented for six varieties (Bass$^{\Phi}$, Flinders$^{\Phi}$, La Trobe$^{\Phi}$, RGT Planet$^{\Phi}$, Scope CL$^{\Phi}$ and Spartacus CL$^{\Phi}$) that can be delivered into malt segregations in WA at the 2020-21 harvest (as per GIWA malt barley variety receival recommendations for the 2020/21 harvest); three varieties undergoing stage 2 malt accreditation with Barley Australia (Banks$^{\Phi}$, Leabrook$^{\Phi}$ and LG Alestar$^{\Phi}$); and nine varieties that can only be delivered into feed segregations (Buff$^{\Phi}$, Compass$^{\Phi}$, Fathom$^{\Phi}$, Granger$^{\Phi}$, Litmus$^{\Phi}$, Lockyer$^{\Phi}$, Mundah, Oxford and Rosalind$^{\Phi}$).

The comment section in each snapshot describes essential characteristics of a variety including its 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, www.nvtonline.com.au) is presented relative to a control variety (typically La Trobe$^{\Phi}$) for each year in the period 2014–18. Data is tabulated using the Agzone format.

Disease and nematode resistance ratings are sourced from Tables 11 to 13 and presented for the seedling and adult growth stages of the plant (if known).

Phenology information is an output of a new flowering date predictive program, 'FlowerPower' barley (available at https://biometricsdpird.shinyapps.io/dmmodel6/). 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 is the median predicted date to Z49 (date predicted for 50 per cent of 'normal' seasons) based on FlowerPower barley version 6.1.2. Data is presented relative to a control variety (typically La Trobe$^{\Phi}$) for four model environments (Carnamah, Cunderdin, Katanning and Grass Patch) for four sowing dates (15 April, 5 May, 25 May and 15 June).

Agronomic traits are presented based on published data, data collected by DPIRD and data generated from the DPIRD-GRDC co-funded projects DAW00190 and DAW00224. Data presented includes:

- 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 Stirling, Buloke$^{\Phi}$ and Scope CL$^{\Phi}$ 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 were recorded in high-risk varieties (i.e. Scope CL$^{\Phi}$); and
- grain protein deviation where lower = <-0.3 per cent, slightly lower = -0.3 to -0.1 per cent, average = -0.1 to +0.1 per cent, slightly higher = +0.1 to +0.3 per cent and higher = > +0/3 per cent. Grain protein deviation was calculated and ranked using data from NVT and DPIRD–GRDC funded barley agronomy trials (2005–18) to analyse the relationship between grain yield and grain protein concentration in commercially available barley varieties grown under similar management and environmental conditions in WA. There is a typical relationship whereby 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 end point royalty (EPR) payable are sourced from breeding companies, Variety Central (www.varietycentral.com.au) and IP Australia Plant Breeders Rights database (https://pericles.ipaustralia.gov.au/pbr_db/search.cfm).

BASS(Þ)

DELIVERABLE AS A MALT VARIETY

Comments

Bass(Þ) is a short-height, medium-spring, malt barley acceptable for export as grain and as malt but not for shochu. It has strong market demand from brewing end users, which can often result in a price premium. Best suited to environments with a yield potential above 3t/ha. Across 41 WA barley NVT (2016–2018), Bass(Þ) has yielded lower than RGT Planet(Þ) in 61%, the same in 39% and higher in 0%. It has the best physical grain quality package of all the malt varieties segregated in WA (resulting in a higher strike rate into Malt 1 segregations), with a good hectolitre weight, high grain plumpness and a higher grain protein potential (typically 0.5% higher than La Trobe(Þ) at same yield). It can show a moderate head loss risk in the Esperance Port Zone, but not in other port zones. Fungicides may be required to manage NTNB (Oxford virulent), STNB, PM and BLR. Weed competitiveness is similar to other semi-dwarf varieties. Target production zone in 2020 is Kwinana-North (Midlands) and Kwinana-South with limited segregation opportunities in the Albany Port Zone (subject to production volumes).

Yield (% La Trobe(Þ))	2014	2015	2016	2017	2018
Agzone 1	89	86	94	91	90
Agzone 2	93	84	94	95	91
Agzone 3	92	85	91	90	93
Agzone 4	59	87	-	81	96
Agzone 5	91	87	94	91	89
Agzone 6	90	92	90	103	94
Statewide	91	87	93	92	92

Disease resistance	Seedling	Adult
Scald	-	MRMS
NTNB (Beecher virulent)	MR	MRMS
NTNB (Beecher avirulent)	S	MSS
NTNB (Oxford virulent)	VS	S*p*
STNB	MRMS	S
Powdery mildew	MSS	MSS
Leaf rust (5457P-)	SVS	SVS
BYDV and CYDV	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 La Trobe(Þ)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	+4	+4	+3	+4
Cunderdin	+5	+5	+4	+4
Katanning	+5	+5	+4	+4
Grass Patch	+6	+5	+3	+4

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Medium
Target plant density	150–180 plants/m²
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, exc. GST)	$3.50

p = provisional assessment.

FLINDERS(Þ)

DELIVERABLE AS A MALT VARIETY

Comments

Flinders(Þ) is a short-height, late-spring, malt barley that is acceptable for export as grain and as malt but not for shochu. Flinders(Þ) has gained limited adoption by growers. 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 39 WA barley NVT (2016–18), Flinders(Þ) has yielded lower than RGT Planet(Þ) in 59%, the same in 38% and higher in 3%. It has good physical grain characteristics, being an improvement over La Trobe(Þ) and RGT Planet(Þ). It is resistant to PM (non-*mlo*). Fungicides may be required to manage NTNB (Oxford virulent), STNB and BLR (despite having APR). Weed competitiveness is similar to other semi-dwarf varieties. Target production zone in 2020 is Albany-South with potential niche segregation opportunities in Kwinana-South and the Esperance Port Zone (subject to production and demand).

Yield (% La Trobe(Þ))	2014	2015	2016	2017	2018
Agzone 1	93	90	-	91	90
Agzone 2	99	91	96	97	91
Agzone 3	96	95	97	97	98
Agzone 4	61	89	-	80	97
Agzone 5	94	90	-	96	94
Agzone 6	102	102	104	122	101
Statewide	96	93	99	97	95

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe(Þ)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	+6	+8	+7	+8
Cunderdin	+7	+9	+9	+8
Katanning	+8	+9	+8	+8
Grass Patch	+8	+8	+9	+7

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Short
Target plant density	150–180 plants/m²
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, exc. GST)	$3.80

p = provisional assessment.

LA TROBE(Φ)

DELIVERABLE AS A MALT VARIETY

Comments

La Trobe(Φ) is a medium-height, early spring, malt barley that is suitable for export as grain, as malt and for shochu. Established malt varieties such as La Trobe(Φ) (and Bass(Φ)) are more likely to attract and maintain a premium over feed when the market is oversupplied. La Trobe(Φ) is the only malt variety currently segregated in WA accepted for shochu manufacture in Japan. it is best suited to environments with a yield potential below 4t/ha. Across 42 WA barley NVT (2016–18), La Trobe(Φ) has yielded lower than RGT Planet in 38%, the same in 48% and higher in 14%. Like Spartacus CL(Φ), La Trobe(Φ) 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(Φ) seed crops or malt stacks by contaminating them with Hindmarsh(Φ) or Spartacus CL(Φ) barley. Target production zones in 2020 are Kwinana, Albany and Esperance port zones.

Yield (% Spartacus CL(Φ))	2014	2015	2016	2017	2018
Agzone 1	105	106	100	102	105
Agzone 2	99	96	104	101	101
Agzone 3	99	99	100	101	100
Agzone 4	90	96	-	94	103
Agzone 5	101	97	99	101	99
Agzone 6	104	97	101	97	101
Statewide	100	97	102	101	101

Disease resistance	Seedling	Adult
Scald	-	MR
NTNB (Beecher virulent)	MS	MS
NTNB (Beecher avirulent)	MRMS	MRMS
NTNB (Oxford virulent)	S	S*p*
STNB	S	SVS
Powdery mildew	MSS	MS
Leaf rust (5457P-)	MS	S
BYDV and CYDV	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(Φ)			
	15 Apr	5 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, exc. GST)	$4.00

p = provisional assessment.

RGT PLANET(Φ)

DELIVERABLE AS A MALT VARIETY

Comments

RGT Planet(Φ) is a medium height, medium spring, malt barley accepted for export as grain and as malt but not for shochu. More work is required to gain full international acceptance for RGT Planet(Φ) in our brewing markets. It is well suited to environments with a yield potential above 3t/ha, and more specifically paddocks with a year-in-year-out potential above 5t/ha. Good early vigour suggests it is suited to mixed farms where grain and graze is practised. Across 42 WA barley NVT (2016–18), RGT Planet(Φ) has yielded lower than Rosalind(Φ) in 26%, the same in 50% and higher in 24%. The physical grain quality package of RGT Planet(Φ) is inferior to Bass(Φ) and Flinders(Φ) and is in some respects comparable with La Trobe(Φ). 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). Research from eastern Australia suggests RGT Planet(Φ) has a similar level of weed competitiveness (tested against oats) to Compass(Φ) and Fathom(Φ). Target production zones in 2020 are Kwinana-South, Albany-South and Esperance port zones with limited segregation opportunities in Kwinana-North (Midlands) and Albany-North (subject to production volumes).

Yield (% La Trobe(Φ))	2014	2015	2016	2017	2018
Agzone 1	-	-	107	101	97
Agzone 2	-	-	108	105	98
Agzone 3	-	-	112	115	110
Agzone 4	-	-	-	82	106
Agzone 5	-	-	126	107	108
Agzone 6	-	-	132	144	116
Statewide	-	-	115	108	104

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe(Φ)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	+1	+3	+3	+6
Cunderdin	+2	+4	+4	+6
Katanning	+2	+3	+4	+6
Grass Patch	+2	+3	+3	+6

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	-
Target plant density	-
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, exc. GST)	$4.00

p = provisional assessment.

DPIRD GRDC

SCOPE CL(ϕ)

DELIVERABLE AS A MALT VARIETY

Comments

Scope CL(ϕ) is a tall height, medium spring, malt variety suitable for export as grain and as malt but not for shochu. Scope CL(ϕ) is being phased out with segregations halted after the 2020-21 harvest. It is suited to environments where Intercept®, Intervix® and Sentry® are useful for controlling brome and barley grass or where there are imidazolinone residues. It is better suited than Spartacus CL(ϕ) to April sowing opportunities when sowing into non-Clearfield® wheat stubble (so the in-crop wheat volunteers can be controlled). Across 74 WA barley NVT (2014–18), Scope CL(ϕ) has yielded lower than Spartacus CL(ϕ) in 52%, the same in 43% and higher in 5%. 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. Do not ruin the integrity of Scope CL(ϕ) seed stocks or malt stacks by contaminating them with Buloke or Spartacus CL(ϕ) barley. The 2020-21 harvest is the last harvest that segregations will be offered for Scope CL(ϕ) in WA with potential niche segregation opportunities in Kwinana and Albany-North (subject to production and demand).

Yield (% La Trobe(ϕ))	2014	2015	2016	2017	2018
Agzone 1	90	92	99	101	98
Agzone 2	87	86	103	97	95
Agzone 3	87	86	96	94	96
Agzone 4	64	87	-	79	106
Agzone 5	86	81	93	89	-
Agzone 6	87	84	91	91	-
Statewide	86	85	98	93	96

Disease resistance	Seedling	Adult
Scald	-	MS
NTNB (Beecher virulent)	MR	MRMS
NTNB (Beecher avirulent)	MR	MRMS
NTNB (Oxford virulent)	S	S*p*
STNB	MSS	S
Powdery mildew	R	R
Leaf rust (5457P-)	S	MSS
BYDV and CYDV	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 La Trobe(ϕ)			
	15 Apr	5 May	25 May	15Jun
Carnamah	+9	+8	+5	+6
Cunderdin	+10	+9	+8	+5
Katanning	+11	+9	+7	+5
Grass Patch	+11	+8	+7	+5

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	Short
Target plant density	110–130 plants/m²
Plant height	Tall
Straw strength	Fair
Head loss risk	High
Grain protein deviation	Average

Variety information	
Pedigree	Franklin/VB9104//VB9104
Breeder/seed licensee	AgVic Services/Seednet
Access to seed	Seednet
EPR ($/t, exc. GST)	$3.50

p = provisional assessment.

SPARTACUS CL(ϕ)

DELIVERABLE AS A MALT VARIETY

Comments

Spartacus CL(ϕ) is a medium height, early spring, malt barley suitable for export as grain and as malt, gaining international acceptance. Assessment for the manufacture of shochu in Japan is on hold. It is suited to environments where Intercept®, Intervix® and Sentry® are useful for controlling brome and barley grass or where there are imidazolinone residues. Across 80 WA barley NVT (2014–18), Spartacus CL(ϕ) has yielded lower than La Trobe in 11%, the same in 76% and higher in 13%. Key agronomic differences to La Trobe(ϕ) include 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. The main aesthetic difference is the lack of anthocyanin pigmentation present on its flag leaf auricles, leaf sheaths, awns and head during spring. Fungicides may be required to manage smut, NTNB (Oxford virulent), STNB and BLR. Spartacus CL(ϕ) appears to be a weak competitor with weeds (based on data from eastern Australia). Do not ruin the integrity of Spartacus CL(ϕ) seed stocks or malt stacks by contaminating it with La Trobe(ϕ) or Scope CL(ϕ) barley. Target production zones in 2020 are Geraldton, Kwinana, Albany and Esperance port zones.

Yield (% La Trobe(ϕ))	2014	2015	2016	2017	2018
Agzone 1	100	103	99	98	98
Agzone 2	101	104	96	99	99
Agzone 3	101	101	100	99	100
Agzone 4	112	104	-	107	97
Agzone 5	99	104	101	99	101
Agzone 6	96	103	99	103	99
Statewide	100	103	98	99	99

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe(ϕ)			
	15 Apr	5 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/m²
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	Seed club members and resellers
EPR ($/t, exc. GST)	$4.25

p = provisional assessment.

BANKS(Φ)

FAILED STAGE 2 MALT ACCREDITATION

Comments

Banks(Φ) (tested as IGB1305) is a short height, late spring barley under evaluation by Barley Australia. It is best suited to environments with a yield potential above 3t/ha. Across 42 WA barley NVT (2016–18), Banks(Φ) has yielded lower than RGT Planet(Φ) in 33%, the same in 62% and higher in 5%. Banks(Φ) does not have the top-end yield potential of RGT Planet(Φ); it appears to yield similarly between 3-4t/ha and maybe higher-yielding below 3t/ha. Banks(Φ) has a similar plant type and phenology to Flinders(Φ), being 1-2cm taller than Bass(Φ) at maturity. There have been observations of brackling (buckling in the lower part of the stem) and lodging in Banks(Φ) in some commercial crops. Straw strength appears to be comparable to RGT Planet(Φ), but not as robust as either Bass(Φ) or Flinders(Φ). Physical grain characteristics appear to be comparable to La Trobe(Φ) but with slightly improved grain brightness and grain protein. Fungicides may be required to manage scald, STNB and BLR. Its weed competitiveness has not been evaluated. Banks(Φ) is undergoing stage 2 malt evaluation with Barley Australia. Stage 2 accreditation will happen out of the cycle and is expected to be completed by the end of 2019. On 11 November 2019 Barley Australia announced Banks(Φ) failed stage 2 assessment and has not been accredited as a malt variety.

Yield (% La Trobe(Φ))	2014	2015	2016	2017	2018
Agzone 1	-	103	102	101	97
Agzone 2	-	101	103	100	97
Agzone 3	-	104	105	104	103
Agzone 4	-	97	-	89	104
Agzone 5	-	96	110	99	101
Agzone 6	-	102	110	118	105
Statewide	-	100	105	101	100

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe(Φ)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	+1	+7	+8	+9
Cunderdin	+3	+8	+10	+9
Katanning	+3	+8	+9	+9
Grass Patch	+3	+7	+9	+9

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	Short
Target plant density	-
Plant height	Short
Straw strength	Moderately good
Head loss risk	-
Grain protein deviation	Slightly higher

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

p = provisional assessment.

LEABROOK(Φ)

STAGE 2 MALT ACCREDITATION

Comments

Leabrook(Φ) (tested as WI4896) is a tall height, medium spring barley under evaluation by Barley Australia. It is best suited to environments with a yield potential below 4t/ha where barley leaf rust is not a year-in-year-out problem. Leabrook(Φ) possesses many similar agronomic attributes to Compass(Φ) including pedigree, phenology, plant architecture, straw strength and grain quality, but with improvements in grain yield and malt quality (mostly malt extract). Across 62 WA barley NVT (2016–18), Leabrook(Φ) has yielded lower than Compass(Φ) in 5%, the same in 76% and higher in 19%; and relative to La Trobe(Φ), lower in 6%, the same in 74% and higher in 19%. Fungicides may be required to manage BLR. Its weed competitiveness has not been tested. Leabrook(Φ) has passed stage 1 of the Barley Australia accreditation process and will continue with stage 2 evaluation during 2019, with the earliest accreditation date being March 2020.

Yield (% La Trobe(Φ))	2014	2015	2016	2017	2018
Agzone 1	-	101	107	109	109
Agzone 2	-	101	109	105	106
Agzone 3	-	105	105	105	104
Agzone 4	-	101	-	100	108
Agzone 5	-	101	101	105	104
Agzone 6	-	99	106	91	104
Statewide	-	102	107	104	106

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe(Φ)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	-	-	-	-
Cunderdin	-	-	-	-
Katanning	-	-	-	-
Grass Patch	-	-	-	-

Agronomic traits	
Early growth habit	Semi-erect
Coleoptile length	-
Target plant density	-
Plant height	Tall
Straw strength	Fair
Head loss risk	-
Grain protein deviation	Lower

Variety information	
Pedigree	County/Commander//Commander
Breeder/seed licensee	University of Adelaide/Seednet
Access to seed	Seednet
EPR ($/t, exc. GST)	$3.80

p = provisional assessment.

DPIRD GRDC

LG ALESTAR$^{\Phi}$

STAGE 2 MALT ACCREDITATION

Comments

LG Alestar$^{\Phi}$ (tested as SMBA11-2341) is a medium height, late spring barley being evaluated by Barley Australia. It is best suited to environments above 3t/ha where both powdery mildew and BLR are a problem. The grain of LG Alestar$^{\Phi}$ has a white aleurone, even though one of its parents Henley has a blue aleurone. Across 80 WA barley NVT (2011–16), LG Alestar$^{\Phi}$ has yielded lower than Granger$^{\Phi}$ in 22%, the same in 78% and higher in 0%. Across 82 WA barley NVT (2011–16), LG Alestar$^{\Phi}$ has yielded lower than La Trobe$^{\Phi}$ in 46%, the same in 49% and higher in 5%. 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 we do not have enough data to assess its head loss risk. LG Alestar$^{\Phi}$ has passed stage 1 of the Barley Australia accreditation process and will continue with stage 2 evaluation during 2019, with the earliest accreditation date being March 2020.

Yield (% La Trobe$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	-	-	98	-	-
Agzone 2	96	89	100	-	-
Agzone 3	93	96	100	-	-
Agzone 4	46	85	-	-	-
Agzone 5	88	84	111	-	-
Agzone 6	105	101	110	-	-
Statewide	92	91	103	-	-

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe$^{\Phi}$			
	15 Apr	5 May	25 May	15 Jun
Carnamah	-	-	-	-
Cunderdin	-	-	-	-
Katanning	-	-	-	-
Grass Patch	-	-	-	-

Agronomic traits	
Early growth habit	Prostrate
Coleoptile length	-
Target plant density	-
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, exc. GST)	$3.80

p = provisional assessment.

BUFF$^{\Phi}$

DELIVERABLE AS A FEED VARIETY

Comments

Buff$^{\Phi}$ is a medium height, early spring barley under evaluation by Barley Australia that supersedes Litmus$^{\Phi}$. Buff$^{\Phi}$ has similar Al tolerance genetics to Litmus$^{\Phi}$, but unlike Litmus$^{\Phi}$, it has a white aleurone. Receival of Buff$^{\Phi}$ will therefore not be restricted due to aleurone colour like it is for Litmus$^{\Phi}$. Unlike Litmus$^{\Phi}$, Buff$^{\Phi}$ is a competitor on non-acidic soils to Fathom$^{\Phi}$, La Trobe$^{\Phi}$ (and its derivatives) and Rosalind$^{\Phi}$. Across 35 WA barley NVT (2016–18), Buff$^{\Phi}$ has yielded lower than Rosalind$^{\Phi}$ in 23%, the same in 51% and higher in 26%. In those same trials, Buff$^{\Phi}$ yielded lower than La Trobe$^{\Phi}$ in 0%, same in 69% and higher in 31%. Across 17 WA barley NVT trials (2016-2017), Buff$^{\Phi}$ has yielded lower than Litmus in 0%, the same in 41% and higher in 59%. The overall disease resistance profile of Buff$^{\Phi}$ is similar to Litmus$^{\Phi}$ with improvements in its tolerance to scald and NTNB. Fungicides may be required to manage STNB, PM and BLR. Its weed competitiveness has not been tested. Buff$^{\Phi}$ is undergoing stage 1 malt accreditation trials with Barley Australia during 2019, with the earliest accreditation date being March 2021.

Yield (% La Trobe$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	-	-	111	117	111
Agzone 2	-	-	121	106	105
Agzone 3	-	-	-	-	107
Agzone 4	-	-	-	79	124
Agzone 5	-	-	106	97	102
Agzone 6	-	-	-	-	108
Statewide	-	-	114	103	108

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe$^{\Phi}$			
	15 Apr	5 May	25 May	15 Jun
Carnamah	-	-	-	-
Cunderdin	-	-	-	-
Katanning	-	-	-	-
Grass Patch	-	-	-	-

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

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

p = provisional assessment.

COMPASS(Ф)

DELIVERABLE AS A FEED VARIETY

Comments

Compass(Ф) is a tall height, early spring barley only deliverable into feed stacks in WA. It is best suited to environments with a yield potential below 4t/ha and where weed-competitive barley is required. Compass(Ф) has a similar grain yield potential to La Trobe(Ф) and Spartacus CL(Ф) in WA, and in about one-quarter of situations is higher yielding than Fathom(Ф), but rarely out-yields Rosalind(Ф). Across 80 WA barley NVT (2014–18), Compass(Ф) has yielded lower than Rosalind(Ф) in 39%, the same in 59% and higher in 3%. Across 114 WA barley NVT (2012–18), Compass(Ф) has yielded lower than La Trobe(Ф) in 16%, the same in 70% and higher in 14%. Compass(Ф) is susceptible to lodging, particularly in high-yielding situations. Compass(Ф) 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) and BLR. Compass(Ф), like Fathom(Ф), 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(Ф) is received as a feed variety in WA.

Yield (% La Trobe(Ф))	2014	2015	2016	2017	2018
Agzone 1	101	103	103	107	106
Agzone 2	96	101	105	102	103
Agzone 3	97	98	101	100	101
Agzone 4	108	102	-	103	105
Agzone 5	99	98	96	98	100
Agzone 6	95	93	96	84	99
Statewide	97	99	101	100	103

Disease resistance	Seedling	Adult
Scald	-	MS
NTNB (Beecher virulent)	MRMS	MRMS
NTNB (Beecher avirulent)	S	MS
NTNB (Oxford virulent)	S	MS*p*
STNB	MRMS	MSS
Powdery mildew	MRMS	MRMS
Leaf rust (5457P-)	S	S
BYDV and CYDV	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 La Trobe(Ф)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	-2	+0	+1	+2
Cunderdin	-2	+0	+1	+2
Katanning	-2	+0	+1	+2
Grass Patch	-2	+0	+1	+2

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
EPR ($/t, exc. GST)	$3.80

p = provisional assessment.

FATHOM(Ф)

DELIVERABLE AS A FEED VARIETY

Comments

Fathom(Ф) 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 113 WA barley NVT (2012–18), Fathom(Ф) has yielded lower than Compass in 22%, the same in 67% and higher in 11%. Across 79 WA barley NVT (2014–18), Fathom(Ф) has yielded lower than Rosalind(Ф) in 51%, the same in 44% and higher in 5%. Fungicides may be required to manage early infections of NTNB and BLR. Fathom(Ф) 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(Ф) is one of the more weed-competitive barley varieties being similar to Compass(Ф) and RGT Planet(Ф) in eastern state weed competition trials. Fathom(Ф) was the 10th most popular barley variety in 2018, accounting for 2% of the state's barley acreage, but was primarily grown in the Esperance Port Zone and nowhere else.

Yield (% La Trobe(Ф))	2014	2015	2016	2017	2018
Agzone 1	98	97	104	108	107
Agzone 2	93	93	109	102	102
Agzone 3	92	94	101	100	100
Agzone 4	81	94	-	89	110
Agzone 5	95	89	94	97	97
Agzone 6	98	88	97	83	100
Statewide	93	93	103	99	103

Disease resistance	Seedling	Adult
Scald	-	MR
NTNB (Beecher virulent)	S	S
NTNB (Beecher avirulent)	MSS	MSS
NTNB (Oxford virulent)	VS	S*p*
STNB	MR	MRMS
Powdery mildew	MS	MRMS
Leaf rust (5457P-)	MSS	MRMS (late APR)
BYDV and CYDV	MRMS	MRMS
RLN (*P. neglectus*)	MS*p*	MS*p*
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 La Trobe(Ф)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	+11	+9	+5	+3
Cunderdin	+13	+10	+7	+3
Katanning	+13	+10	+6	+3
Grass Patch	+13	+9	+6	+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	Low

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

p = provisional assessment.

GRANGER(ф)

DELIVERABLE AS A FEED VARIETY

Comments

Granger(ф) is a medium height, medium spring barley no longer segregated as a malt variety in WA and deliverable only into feed stacks. It is best suited to environments with a yield potential above 3t/ha where powdery mildew and BLR are a problem. Across 67 WA barley NVT (2014–18), Granger(ф) has yielded lower than Rosalind(ф) in 46%, the same in 51% and higher in 3%. Across 30 WA barley NVT (2016–18), Granger(ф) has yielded lower than RGT Planet(ф) in 30%, the same in 67% and higher in 3%. It has resistance to PM due to *mlo* gene and to BLR due to *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(ф) is received as a feed variety in WA.

Yield (% La Trobe(ф))	2014	2015	2016	2017	2018
Agzone 1	95	95	-	91	-
Agzone 2	101	95	98	98	-
Agzone 3	97	103	103	103	102
Agzone 4	62	90	-	75	-
Agzone 5	91	90	118	98	98
Agzone 6	108	108	117	143	107
Statewide	97	97	104	99	96

Disease resistance	Seedling	Adult
Scald	-	MSS
NTNB (Beecher virulent)	MRMS	MS
NTNB (Beecher avirulent)	MRMS	MRMS
NTNB (Oxford virulent)	MRMS	MS*p*
STNB	MSS	SVS
Powdery mildew	R	R
Leaf rust (5457P-)	MS	MRMS (APR)
BYDV and CYDV	MS	MS
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 La Trobe(ф)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	+2	+4	+4	+6
Cunderdin	+4	+6	+6	+6
Katanning	+4	+5	+5	+6
Grass Patch	+4	+5	+5	+6

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, exc. GST)	$2.95

p = provisional assessment.

LITMUS(ф)

DELIVERABLE AS A FEED VARIETY

Comments

Litmus(ф) is a tall height, early spring, feed barley with improved tolerance to low soil pH and high soil Al that is superseded by Buff(ф). Best suited to environments where the sub-soil (10-30cm) has a pHCa below 4.8. Across 17 WA barley NVT trials (2016-2017), Litmus(ф) has yielded lower than Buff(ф) in 59%, the same in 41% and higher in 0%, with no head-head comparisons available from the 2018 season. Litmus(ф) has fair straw strength, is susceptible to all leaf diseases but has the lowest yield loss in the presence of crown rot. 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(ф) was the ninth most popular barley variety in 2018, accounting for 2% of the state's barley acreage, being more popular in the Geraldton and Kwinana port zones than in the Albany and Esperance port zones.

Yield (% La Trobe(ф))	2014	2015	2016	2017	2018
Agzone 1	89	114	102	110	-
Agzone 2	76	101	109	96	-
Agzone 3	83	90	105	100	-
Agzone 4	110	98	-	89	-
Agzone 5	73	81	101	84	-
Agzone 6	69	81	94	92	-
Statewide	77	92	103	93	-

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe(ф)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	-9	-5	-4	-1
Cunderdin	-11	-6	-3	-2
Katanning	-10	-6	-4	-2
Grass Patch	-10	-5	-3	-2

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, exc. GST)	$3.80

p = provisional assessment.

LOCKYER(ф)

DELIVERABLE AS A FEED VARIETY

Comments

Lockyer(ф) is a short, late spring, feed barley best suited to environments with a yield potential above 4t/ha (i.e. Agzone 6). Across 71 WA barley NVT (2014–18), Lockyer(ф) has yielded lower than Rosalind(ф) in 48%, the same in 46% and higher in 6%. Across 34 WA barley NVT trials (2016-2018), Lockyer(ф) has yielded lower than RGT Planet(ф) in 35%, the same in 62% and higher in 3%. Lockyer(ф) has one of the most prolonged durations to awn peep of commercial spring barley varieties. Fungicides may be required to manage NTNB (Oxford virulent), STNB and BLR. Its reaction to weed competition is unknown.

Yield (% La Trobe(ф))	2014	2015	2016	2017	2018
Agzone 1	99	90	-	100	99
Agzone 2	100	90	-	102	98
Agzone 3	96	98	-	102	101
Agzone 4	59	89	-	79	105
Agzone 5	99	90	103	100	97
Agzone 6	111	98	106	108	104
Statewide	98	93	104	100	100

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe(ф)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	+15	+14	+9	+7
Cunderdin	+17	+16	+12	+7
Katanning	+17	+16	+11	+7
Grass Patch	+16	+13	+11	+6

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

Variety information	
Pedigree	Tantangara/VB9104
Breeder/seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, exc. GST)	$1.50

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 where early season weed control is necessary. Across 67 WA barley NVT (2014–15, 2017–18), Mundah has yielded lower than Rosalind(ф) in 83%, the same in 16% and higher in 1%. Mundah can suffer from head loss and lodging. Fungicides may be required to manage scald, NTNB (Beecher virulent and Oxford virulent), STNB, PM and BLR. Mundah appears to have similar weed competitiveness to Compass(ф) and Fathom(ф), although it has not been tested side by side in the same trials.

Yield (% La Trobe(ф))	2014	2015	2016	2017	2018
Agzone 1	88	106	-	104	98
Agzone 2	79	96	-	95	95
Agzone 3	85	88	-	96	97
Agzone 4	99	95	-	89	108
Agzone 5	78	83	-	85	93
Agzone 6	72	83	-	91	94
Statewide	80	89	-	92	97

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe(ф)			
	15 Apr	5 May	25 May	15 Jun
Carnamah	-6	-6	-7	-3
Cunderdin	-6	-7	-6	-5
Katanning	-6	-6	-6	-5
Grass Patch	-6	-6	-6	-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	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.

DPIRD GRDC

OXFORD

DELIVERABLE AS A FEED VARIETY

Comments

Oxford is a short height, late spring, feed barley best suited to environments with a yield potential above 4t/ha (i.e. Agzone 6). Oxford performs best with late April or early May planting, but its yield potential falls rapidly as seeding is delayed. Across 64 WA barley NVT (2014–18), Oxford has yielded lower than Rosalind$^{\Phi}$ in 55%, the same in 41% and higher in 4%. Across 27 WA barley NVT (2016–18), Oxford has yielded lower than RGT Planet$^{\Phi}$ in 59%, the same in 41% and higher in 0%. Oxford appears to be sensitive to flowering frost. Fungicides may be required to manage NTNB (Oxford virulent), STNB and early season BLR. There is evidence of increasing virulence of PM on Oxford barley, mainly on the south coast. Weed competitiveness is similar to other semi-dwarf varieties. Oxford is superseded by newer varieties such as Rosalind$^{\Phi}$ and RGT Planet$^{\Phi}$.

Yield (% La Trobe$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	93	80	96	87	-
Agzone 2	103	83	-	98	-
Agzone 3	97	95	96	98	99
Agzone 4	29	82	-	65	-
Agzone 5	95	87	-	99	92
Agzone 6	115	105	111	137	105
Statewide	98	90	101	98	93

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe$^{\Phi}$			
	15 Apr	5 May	25 May	15 Jun
Carnamah	+16	+12	+7	+7
Cunderdin	+18	+13	+9	+6
Katanning	+19	+15	+8	+6
Grass Patch	+18	+12	+9	+6

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

Variety information	
Pedigree	Tavern/Chime
Breeder/seed licensee	Limagrain
Access to seed	Free to trade
EPR ($/t, exc. GST)	$2.50

p = provisional assessment.
* May show a susceptible reaction where virulence against the *Ml(St)* mildew gene (present in Oxford) exists.

ROSALIND$^{\Phi}$

DELIVERABLE AS A FEED VARIETY

Comments

Rosalind$^{\Phi}$ is a medium height, early spring, feed barley that suits all environments where there is a low probability of delivering malt-grade barley. Rosalind$^{\Phi}$ is the yield benchmark for barley in WA, regularly out-yielding La Trobe$^{\Phi}$ and Spartacus CL$^{\Phi}$. Across 80 WA barley NVT (2014–18), Rosalind$^{\Phi}$ has yielded lower than La Trobe$^{\Phi}$ in 4%, the same in 54% and higher in 43%. Rosalind$^{\Phi}$ appears to be inferior to RGT Planet$^{\Phi}$ at yields above 4t/ha and better below 3t/ha. Across 42 WA barley NVT trials (2016-2018), Rosalind$^{\Phi}$ has yielded lower than RGT Planet$^{\Phi}$ in 24%, the same in 50% and higher in 26%. 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$^{\Phi}$ as it may indicate the presence of a new pathotype. Its weed competitiveness is unknown. Rosalind$^{\Phi}$ was the eigth most popular barley variety in 2018, accounting for 3% of the state's barley acreage and being comparable in popularity across port zones.

Yield (% La Trobe$^{\Phi}$)	2014	2015	2016	2017	2018
Agzone 1	109	113	107	110	108
Agzone 2	104	112	107	105	106
Agzone 3	103	113	110	109	107
Agzone 4	128	109	-	110	107
Agzone 5	103	107	109	105	109
Agzone 6	106	105	113	102	107
Statewide	104	110	109	106	107

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

FlowerPower predicted flowering date (days to Z49)	Relative to La Trobe$^{\Phi}$			
	15 Apr	5 May	25 May	15 Jun
Carnamah	-3	-1	+0	+1
Cunderdin	-3	-1	+0	+1
Katanning	-3	-2	+0	+1
Grass Patch	-3	-2	+0	+1

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, exc. GST)	$3.50

p = provisional assessment.

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DPIRD GRDC

CANOLA

By Jackie Bucat, DPIRD

CANOLA VARIETY HIGHLIGHTS FOR 2020

- The new Nuseed hybrid TT variety, HyTTec® Trident, has high yields, predicted to be 10 to 20 per cent ahead of other hybrid varieties.
- Nuseed has released a new OP TT variety, ATR Flathead. Nuseed anticipates yields to be similar to ATR Bonito(ϕ) with a higher blackleg resistance rating, provisionally identified as moderately resistant (MR).
- Pacific Seeds released Hyola® 540XC, first variety with a combination of glyphosate and Clearfield® tolerance (GT+CL). This is intended for use where imidazolinone soil residues may be present, after IMI cereal and pulse crops.
- Growers have started to use TruFlex® (TF) varieties in the 2019 season. New TruFlex® variety releases are Xseed™ Raptor, InVigor® R4022P and Hyola® 540XC (GT+CL). These will complement previously released TruFlex® varieties Hyola® 410XX and the combination TT and glyphosate-tolerant (TT+ GT) variety, Hyola® 530XT.
- This edition of the canola variety guide includes the first National Variety Trials (NVT) data for 2018 TT releases: early maturity varieties InVigor® T3510 and SF Spark TT and mid-maturity varieties Pioneer® 45T03 and Hyola® 550TT.

WA CANOLA TYPES

There are numerous herbicide tolerance systems available in WA canola varieties.

- Triazine tolerant (TT) – tolerant to selected triazine herbicides.
- Glyphosate tolerant (GT) – tolerant to Monsanto glyphosate herbicide. This includes both Roundup Ready® and TruFlex® varieties.

TruFlex® has an extended spray window and greater flexibility of herbicide applications, compared with Roundup Ready® types. TruFlex® varieties can be sprayed from emergence to first flower, compared with emergence to six-leaf stage for Roundup Ready® canola, and can have two applications at a higher label rate of 1.3kg/ha or three applications at 0.9kg/ha.

- Clearfield® (CL) – tolerant of imidazolinone (IMI) herbicides (marketed as Clearfield®).
- Conventional canola (CC) varieties do not have extra herbicide tolerance.
- All types of canola including CC varieties are tolerant of clopyralid and grass selective herbicides.

There are also several 'stacked' varieties with tolerance to more than one herbicide group.

- triazine tolerant and glyphosate tolerant (TT+GT), including TT+RR (BASF 300TR) and TT+TF (Hyola® 530XT)
- triazine tolerant and Clearfield® (TT+CL), Hyola®580CT
- glyphosate tolerant and Clearfield® (GT+CL) the Pacific Seeds TruFlex® variety, Hyola® 540XC.

Always check suitability of herbicides by referring to the herbicide label.

All canola varieties with glyphosate tolerance were developed using single gene genetic modification (GM).

There are also different canola breeding types:

- open pollinated (OP); and
- hybrid (Hy).

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

PodGuard® is a trait from BASF that strengthens canola pods and reduces the risk of pod shatter.

THE NATIONAL VARIETY TRIALS (NVT) PROGRAM

Yield and oil data in this report were generated from the GRDC National Variety Trials (NVT) and accessed from NVT online and from Neale Sutton at NVT.

The objective of the NVT system is to provide growers and their advisers with independent information on the performance of newly released varieties of winter field crops, relative to the current commercial varieties grown in their area. The intention is to have two years of data ready at the time each new variety is released for commercial production.

This report presents the results from the WA trials from 2014 to 2018. There were 190 successful canola trials in WA during this period and 693 nationally. The long-term multi-environment trials (MET) analysis uses data from all Australian NVT trials (WA, NSW, Vic and SA) from 2014 to 2018. All trial results are available online at www.nvtonline.com.au or on the NVT long term yield app. The NVT program is a GRDC investment.

Yield predictions are reported from the long-term MET, where data is analysed across years and environments. Summary yield data is presented for all herbicide tolerance types, and grouped by yield levels (Tables 2 and 3). The long-term MET predicted yield is presented for all trials where the variety was present in the trial. Not all WA trials were included in Tables 2 and 3; for example, there were a couple of trials outside the 0.5–3.5t/ha yield range shown. All data is available at www.nvtonline.com.au.

Yield predictions are also presented for each Agzone for the TT and glyphosate-tolerant trials, using the long term MET data (Tables 4 to 11). Clearfield® varieties were not included in these tables due to the small proportion of area covered, only 1.3 per cent of the total area of canola in 2018 (CBH data). Full information about Clearfield® varieties is available from www.nvtonline.com.au.

Early and Mid trials

Canola trials are divided into Early and Mid trials (refer to canola Agzone map on the back cover). The Early trials are sown in shorter-season environments that may suit early maturity varieties, largely in Agzones 1, 4 and 5. Mid trials are sown in longer-season environments that may suit mid maturity varieties, largely in Agzones 3 and 6. Agzone 2 has a mix of both Early and Mid trials.

Early and Mid trials have similar sowing times and a similar complement of varieties. Results from the Early and Mid series are analysed separately, requiring the results to be presented separately (Tables 2 to 11).

Oil concentration data

The NVT canola oil data analysis was completed by Andrew van Burgel, DPIRD. A single oil sample was analysed from each variety in each trial.

Oil concentrations are presented as the varietal difference, compared with the average oil concentration of all varieties of the same herbicide tolerance system.

Relative value of yield and oil

Generally, yield affects crop financial value more than oil concentration. A relatively small yield increase of 100kg/ha will increase crop value by $50/ha but a one per cent increase in oil concentration will only contribute an extra $7.50/t/ha to crop value (at $500/t canola price).

The yield that is the same value as a one per cent change in oil concentration (more than 42 per cent) is: 15kg/ha for a 1t/ha crop; 30kg/ha for a 2t/ha crop; and 45kg/ha for a 3t/ha crop.

NVT agronomy

All trials are treated with Impact-in-Furrow® at 400mL/ha. Seeding rates are adjusted to target 40 plants/m^2 in the Early series trials and 50 plants/m^2 in the Mid series trials (see back cover for locations).

BLACKLEG RESISTANCE DATA

Blackleg data was reproduced from a GRDC Factsheet, *2019 Spring Blackleg Management Guide*. Please refer to this for further information about the importance of blackleg ratings, resistance groups and management of blackleg.

BUYING TT CANOLA FOR SEED AND SELLING CANOLA GRAIN

Some varieties have an end point royalty (EPR). This is a risk-sharing arrangement between growers and the company. It is imperative that growers continue to pay EPRs to support further OP releases. HyTTec® Trophy and now HyTTec® Trident are the first hybrid varieties to have an EPR.

Purchase commercially available seed from registered sellers (Table 1). Harvested crop can be retained on-farm for use as seed. However, retained seed from hybrid crops is not the same as the parent and can have reduced performance.

TABLE 1 Canola variety maturity, oil content, blackleg resistance rating, EPR, release and seed access.

Variety	Herbicide tolerance	Heterosis	Harvest maturity	Oil content (diff. to mean)	Blackleg resistance rating	Blackleg group	EPR $/t	Release	Seed access
ATR Bonito(ф)	TT	OP	4	1.1	MS	A	5	2013	Nuseed
ATR Flathead#	TT	OP	4	-	-	-	5	2019	Nuseed
ATR-Gem(ф)	TT	OP	4	0.8	-	A	-	2011	Not for sale
ATR Mako(ф)	TT	OP	4	-0.7	MRMS	A	5	2015	Nuseed
ATR-Stingray(ф)	TT	OP	3	0.4	MRMS	C	-	2011	Nuseed
ATR Wahoo(ф)	TT	OP	6	0.3	MS	A	5	2013	Nuseed
DG 670TT	TT	Hy	6	-0.9	MR	BF	-	2017	Seednet
Hyola® 350TT	TT	Hy	3	-1.0	R	ABDF	-	2017	Advanta Seeds
Hyola® 550TT	TT	Hy	5	0.1	RMR	ABDF	-	2018	Advanta Seeds
Hyola® 559TT	TT	Hy	5	0.9	MR	ABD	-	2012	Advanta Seeds
Hyola® 650TT	TT	Hy	6	0.1	R	ABD	-	2013	Advanta Seeds
HyTTec® Trident#	TT	Hy	3	0.6	R	ABDF	10	2019	Nuseed
HyTTec® Trophy	TT	Hy	4	0.1	RMR	ABD	10	2017	Nuseed
InVigor® T 3510	TT	Hy	3	-0.7	MS	BF	-	2018	BASF
InVigor® T 4510	TT	Hy	4	-0.5	MRMS	BF	-	2016	BASF
Pioneer® 44T02 TT	TT	Hy	4	-0.1	RMR	ABD	-	2016	Pioneer
Pioneer® 45T03 TT	TT	Hy	5	0.0	RMR	ABD	-	2018	Pioneer
SF Ignite TT	TT	Hy	5	-0.2	MR	BF	-	2017	Seed Force
SF Spark TT	TT	Hy	3	0.4	RMR	ABDF	-	2018	Seed Force
SF Turbine TT	TT	Hy	4	-1.0	MRMS	BF	-	2015	Seed Force
Yetna(ф)	TT	OP	4	-2.9	-	-	5	2015	Agronomy for Profit
Hyola® 580CT	TT+CL	Hy	5	-0.7	R	BC	-	2018	Advanta Seeds
BASF 3000TR	TT+RR	Hy	3	0.2	MSS	B	-	2016	BASF
Hyola® 530XT	TT+TF	Hy	5	0.7	-	-	-	2018	Advanta Seeds
DG 408RR	RR	Hy	4	1.6	MS	AC	-	2017	Seednet
Hyola® 404RR	RR	Hy	4	0.9	MR	ABD	-	2010	Advanta Seeds
Hyola® 410XX	TF	Hy	4	0.7	-	-	-	2018	Advanta Seeds
Hyola® 506RR	RR	Hy	5	0.0	R	ABD	-	2017	Advanta Seeds
InVigor® R 3520	RR	Hy	3	0.0	MR	?	-	2017	BASF
InVigor® R 4022P#	TF	Hy	4	-	-	-	-	2019	BASF
InVigor® R 5520P	RR	Hy	5	-0.5	MRMS	AC	-	2016	BASF
Nuseed GT-42	RR	Hy	4	-0.9	R	ABDF	-	2016	Nuseed
Nuseed GT-53	RR	Hy	5	-0.7	R	ABDF	-	2016	Nuseed
Pioneer® 43Y23 RR	RR	Hy	3	-1.8	MR	B	-	2012	Pioneer
Pioneer® 43Y29 RR	RR	Hy	3	0.0	MR	BC	-	2018	Pioneer
Pioneer® 44Y27 RR	RR	Hy	4	-0.2	RMR	B	-	2017	Pioneer
Pioneer® 45Y25 RR	RR	Hy	5	0.3	MR	BC	-	2015	Pioneer
Pioneer® 45Y28 RR	RR	Hy	5	0.5	MR	BC	-	2018	Pioneer
Xseed Raptor#	TF	Hy	4	1.6	-	-	-	2019	Nuseed
Hyola 540XC#	TF+CL	HY	5	-	-	-	-	2019	Advanta Seeds
Banker CL	CL	Hy	6	0.2	MR	A	-	2016	Heritage Seeds
Hyola® 575CL	CL	Hy	5	0.0	R	BF	-	2010	Advanta Seeds
Pioneer® 43Y92 CL	CL	Hy	3	0.2	RMR	B	-	2017	Pioneer
Pioneer® 44Y90 CL	CL	Hy	4	0.4	RMR	B	-	2015	Pioneer
Pioneer® 45Y91 CL	CL	Hy	5	1.0	MR	B	-	2016	Pioneer
Pioneer® 45Y93 CL	CL	Hy	5	1.3	RMR	BC	-	2018	Pioneer
Saintly CL	CL	Hy	5	0.9	MR	B	-	2018	Heritage Seeds

Varieties ordered alphabetically, within herbicide types. Key for Herbicide tolerance and Heterosis on page 84. # = New releases.
Maturity: Information provided by licensees. Maturity key: 3 = early, 4 = early–mid, 5 = mid, 6 = mid–late, 7 = late.
Oil content: TT variety average 44.6%, RR variety average 45.6% and CL variety average 45.4%
Blackleg resistance rating key; R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible.

TABLE 2 Mid WA NVT 2014–18 summary.
Long-term MET predicted yields grouped by yield levels and presented as a percentage of the mean yield.

Site mean yield (t/ha)				1.0–1.5	1.5–2.0	2.0–2.5	2.5–3.0	3.0–3.5
	Type	Maturity	No. trials	[12]	[14]	[10]	[8]	[6]
TRIAZINE TOLERANT								
ATR-Stingray(ϕ)	TT OP	3	[34]	89	100	97	95	91
ATR Bonito(ϕ)	TT OP	4	[49]	96	98	98	98	98
ATR Mako(ϕ)	TT OP	4	[45]	99	97	98	98	99
ATR-Gem(ϕ)	TT OP	4	[20]	93	95	96	96	96
Yetna(ϕ)	TT OP	4	[2]	90	-	-	91	
ATR Wahoo(ϕ)	TT OP	6	[21]	92	96	99	99	99
HyTTec® Trident	TT Hy	3	[9]	130	125	128	127	-
Hyola® 350TT	TT Hy	3	[16]	112	111	110	109	-
InVigor® T 3510	TT Hy	3	[5]	110	112	109	109	-
SF Spark TT	TT Hy	3	[4]	-	107	103	103	-
HyTTec® Trophy	TT Hy	4	[16]	119	116	119	118	-
InVigor® T 4510	TT Hy	4	[30]	114	114	116	115	118
SF Turbine TT	TT Hy	4	[31]	108	110	109	108	109
Pioneer® 44T02 TT	TT Hy	4	[30]	112	108	107	106	108
Hyola® 550TT	TT Hy	5	[7]	-	109	111	111	-
SF Ignite TT	TT Hy	5	[28]	104	111	114	112	114
Hyola® 559TT	TT Hy	5	[50]	113	106	107	108	110
Pioneer® 45T03 TT	TT Hy	5	[5]	-	107	106	104	-
DG 670TT	TT Hy	6	[25]	106	109	113	112	114
Hyola® 650TT	TT Hy	6	[39]	108	104	107	108	111
TRIAZINE TOLERANT + ROUNDUP READY®								
BASF 3000 TR	TT+RR Hy	3	[6]	104	99	97	97	-
Hyola® 530XT	TT+TF Hy	5	[1]	-	-	110	-	-
TRIAZINE TOLERANT + CLEARFIELD®								
Hyola® 580CT	TT+CL Hy	5	[17]	103	101	102	103	-
	Type	Maturity	No. trials	[8]	[10]	[6]	[6]	[6]
GLYPHOSATE TOLERANT								
Pioneer® 43Y29 RR	RR Hy	3	[3]	-	109	108	-	107
Pioneer® 43Y23 (RR)	RR Hy	3	[19]	108	105	103	103	102
InVigor® R 3520	RR Hy	3	[9]	-	101	96	98	96
Pioneer® 44Y27 (RR)	RR Hy	4	[19]	114	112	109	110	108
Xseed® Raptor	TF+CL Hy	4	[1]	-	-	113	-	-
Hyola® 410XX	TF Hy	4	[1]	-	-	108	-	-
DG 408RR	RR Hy	4	[10]	108	104	105	105	105
Nuseed GT-42	RR Hy	4	[30]	103	98	101	100	102
Hyola® 404RR	RR Hy	4	[29]	104	98	96	97	97
Pioneer® 45Y28 RR	RR Hy	5	[10]	-	110	112	111	111
Nuseed GT-53	RR Hy	5	[31]	112	105	111	110	112
Pioneer® 45Y25 (RR)	RR Hy	5	[32]	102	105	109	108	109
InVigor® R 5520P	RR Hy	5	[19]	103	105	104	104	103
Hyola® 506RR	RR Hy	5	[18]	104	103	104	104	104
	Type	Maturity	No. trials	[5]	[7]	[8]	[5]	[6]
CLEARFIELD®								
Pioneer® 43Y92 (CL)	CL Hy	3	[11]	-	111	111	109	109
Pioneer® 44Y90 (CL)	CL Hy	4	[25]	112	112	114	111	112
Pioneer® 45Y93 CL	CL Hy	5	[7]	110	113	116	-	-
Saintly CL	CL Hy	5	[15]	113	111	111	108	-
Pioneer® 45Y91 (CL)	CL Hy	5	[16]	104	107	108	105	105
Hyola® 575CL	CL Hy	5	[31]	91	93	92	92	90
Banker CL	CL Hy	6	[19]	106	109	111	108	-

TABLE 3 Early WA NVT 2014–18 summary.
Long-term MET predicted yields grouped by yield levels and presented as a percentage of the mean yield.

Site mean yield (t/ha)				0.5–1.0	1.0–1.5	1.5–2.0	2.0–2.5	2.5–3.0
	Type	Maturity	No. trials	[7]	[6]	[13]	[6]	[3]
TRIAZINE TOLERANT								
ATR-Stingray(ϕ)	TT OP	3	[22]	94	93	94	95	96
ATR Bonito(ϕ)	TT OP	4	[37]	98	98	98	98	98
ATR Mako(ϕ)	TT OP	4	[10]	97	100	101	-	101
ATR-Gem(ϕ)	TT OP	4	[4]	88	94	96	-	-
Yetna(ϕ)	TT OP	4	[3]	81	85	-	-	-
HyTTec® Trident	TT Hy	3	[10]	147	131	128	126	-
SF Spark TT	TT Hy	3	[1]	-	-	115	-	-
Hyola® 350TT	TT Hy	3	[13]	108	110	110	109	108
InVigor® T 3510	TT Hy	3	[7]	121	112	109	109	-
InVigor® T 4510	TT Hy	4	[24]	121	115	113	112	111
HyTTec® Trophy	TT Hy	4	[15]	126	115	113	113	111
Pioneer® 44T02 TT	TT Hy	4	[27]	117	112	111	110	109
SF Turbine TT	TT Hy	4	[22]	115	110	108	108	106
Hyola® 559TT	TT Hy	5	[33]	121	113	111	110	109
Hyola® 550TT	TT Hy	5	[1]	111	-	-	-	-
DG 670TT	TT Hy	6	[1]	102	-	-	-	-
Hyola® 650TT	TT Hy	6	[6]	94	100	101	-	-
TRIAZINE TOLERANT + ROUNDUP READY®								
BASF 3000 TR	TT+RR Hy	3	[21]	124	109	105	106	104
TRIAZINE TOLERANT + CLEARFIELD®								
Hyola® 580CT	TT+CL Hy	5	[2]	99	-	99	-	-
	Type	Maturity	No. trials	[3]	[4]	[10]	[6]	[2]
GLYPHOSATE TOLERANT								
Pioneer® 43Y29 RR	RR Hy	3	[6]	110	-	108	105	109
InVigor® R 3520	RR Hy	3	[19]	104	108	107	109	104
Pioneer® 43Y23 (RR)	RR Hy	3	[26]	107	109	106	107	102
Pioneer® 44Y27 (RR)	RR Hy	4	[17]	113	-	114	112	112
DG 408RR	RR Hy	4	[19]	116	113	111	110	105
Hyola® 404RR	RR Hy	4	[27]	106	106	103	104	99
Nuseed GT-42	RR Hy	4	[13]	100	98	98	98	99
Pioneer® 45Y28 RR	RR Hy	5	[6]	111	-	111	109	110
Nuseed GT-53	RR Hy	5	[17]	111	108	107	106	105
Pioneer® 45Y25 (RR)	RR Hy	5	[8]	105	102	106	103	-
Hyola® 506RR	RR Hy	5	[8]	109	106	106	105	-
	Type	Maturity	No. trials	[1]	[2]	[3]	[0]	[2]
CLEARFIELD®								
Pioneer® 43Y92 (CL)	CL Hy	3	[6]	119	-	112	-	109
Pioneer® 44Y90 (CL)	CL Hy	4	[6]	118	-	113	-	110
Saintly CL	CL Hy	5	[1]	116	-	-	-	-
Hyola® 575CL	CL Hy	5	[7]	90	99	96	-	95
Banker CL	CL Hy	6	[2]	107	-	-	-	107

TT NVT RESULTS

The new variety HyTTec® Trident has the highest predicted yield in the Mid NVT series, even though it is a short (3) maturity variety. HyTTec® Trophy and InVigor® T4510 were second and third highest yielding, respectively. The next highest yielding varieties were the longer-season varieties Hyola® 550TT, SF Ignite TT and DG 670TT, all with similar high yields, particularly in the higher-yielding trials.

HyTTec® Trident also has the highest predicted yield for the Early NVT series, followed by InVigor® T4510 and HyTTec® Trophy. SF Spark had a high yield in a single WA Early series trial. The next highest yielding varieties were Hyola® 559TT and Pioneer® 44T02TT.

Most recent data shows that ATR Bonito(ϕ) is still the most widely grown variety in WA, at 53 per cent of total canola area in 2018, or 73 per cent of the area of all TT canola. However, ATR Bonito(ϕ) yields are well below hybrid TT varieties in NVT. The lower yields are offset by lower seed prices and a lower risk production system. Current DPIRD recommendations to manage risk and profit are to consider changing to hybrid TT varieties when expected yields are around 1.3t/ha, and for all growers to test hybrid TT profitability with test strips on-farm.

GT NVT YIELD RESULTS

Glyphosate tolerant (GT) varieties include both RR and TruFlex. Pioneer® 45Y28RR was the highest-yielding GT variety in the Mid trial series. Yields were especially high for the trials over 2.5t/ha. Pioneer® 44Y27RR was the second highest yielding variety overall and was highest yielding for Mid trials below 2t/ha and Agzone2. Xseed™ Raptor was the highest-yielding variety in the 2017 Kojonup trial, although further results are needed to confirm performance. The next highest yielding varieties were InVigor® R 4020P, Nuseed GT-53, and then Hyola® 410XX.

Pioneer® 44Y27RR was the highest yielding variety in the Early trial series, followed by Pioneer® 45Y28RR. The yield advantage of Pioneer® 44Y27RR was amplified at higher-yielding sites. The next highest yielding varieties were DG 408RR and Pioneer® 43Y29RR. DG 408RR had most competitive yields in 0.5-1.5t/ha yield range and Agzone 2 due to a very high yield in the Nyabing 2018 trial.

CL NVT RESULTS

The early-mid maturity Pioneer® 44Y90 CL had the highest demonstrated yields across all yield groups overall, showing its adaptability. The new mid season variety Pioneer® 45Y93CL had the highest mean MET, suggesting its overall yields would be higher if it was present in each trial. The next highest yielding varieties were Pioneer® 43Y92CL and Saintly CL.

RECENT VARIETY RELEASES

Hybrid TT

HyTTec® Trident is a new hybrid release from Nuseed. It has the highest yields across Early and Mid trial series for all yield levels and years. It has been tested in 19 trials in 2017 and 2018. HyTTec® Trident has a resistant (R) blackleg rating and oil content of 0.6 per cent above average. HyTTec® Trident has an end point royalty (EPR) of $10/t.

InVigor® T3510 is a recent early maturity variety from BASF, showing similar yields to Hyola® 350TT.

SF Spark TT is an early maturity variety released by Seed Force in 2018. The predicted yield for the Early trial series was based on a single trial at Yealering in 2018. More testing is required to be confident of variety performance. SF Spark TT is in 16 WA trials this season.

Hyola® 550TT has slightly higher yields than Hyola 559TT in the Mid NVT series. It also has a higher blackleg rating of RMR.

OP TT varieties

ATR Flathead is the new OP variety from Nuseed. It is in NVT for the first time in 2019 in 17 WA trials. Company information suggests yields similar to ATR Bonito(ϕ) but a higher blackleg resistance rating of MR (provisional).

Glyphosate tolerant varieties (both RR and TruFlex® (TF) varieties)

Hyola® 410XX is a recent TruFlex® release from Pacific Seeds. There is only a single WA NVT result from Kojonup in 2017, however it is in 19 NVT Early and Mid-series trials in 2019. This variety needs further testing to build confidence in its performance.

InVigor® R4022P is the new release from BASF, with TruFlex® and Podguard®. It is in its first year of NVT (2019).

Pioneer® 45Y28RR was the highest-yielding variety in the Mid GT NVT series (along with the single WA trial for Xseed™ Raptor). Although it was released in 2018, 2020 will be the first growing season for commercial seed availability. Pioneer® 45Y28RR has been in 16 trials, all in 2017. It has a moderately resistant blackleg rating (MR).

Xseed™ Raptor is the 2019 TruFlex® release from Nuseed. Xseed Raptor showed promising yield from its single WA NVT entry at Kojonup. The single WA oil result from Xseed™ Raptor is also promising, at 1.6 per cent above the RR average. More testing is required to be confident of variety performance. It is in 19 WA trials in 2019.

Clearfield varieties

Pioneer® 45Y93CL was released last year. This was the highest yielding CL hybrid overall.

Saintly CL was a 2018 release from Heritage Seeds. It was particularly competitive for the yield range 1-1.5t/ha.

TABLE 4 Agzone 2 Mid-season canola NVT 2014–18. Long-term MET predicted yield expressed as a percentage of mean yield.

Year				2014	2015	2016	2017	2018
Site mean yield (t/ha)				1.27	1.44	2.66	2.04	2.09
	Type	Maturity	No. trials	[6]	[3]	[5]	[4]	[4]
TT, TT+CL, TT+RR VARIETIES								
ATR Bonito(ϕ)	TT OP	4	[22]	96	96	98	99	97
ATR-Gem(ϕ)	TT OP	4	[9]	92	91	-	-	-
ATR Mako(ϕ)	TT OP	4	[20]	98	98	98	98	99
ATR-Stingray(ϕ)	TT OP	3	[20]	90	94	96	99	91
DG 670TT	TT Hy	6	[9]	-	-	110	-	106
Hyola® 350TT	TT Hy	3	[5]	-	-	-	108	110
Hyola® 550TT	TT Hy	5	[3]	-	-	-	-	111
Hyola® 559TT	TT Hy	5	[22]	114	112	108	105	111
Hyola® 650TT	TT Hy	6	[13]	108	102	107	104	107
HyTTec® Trident	TT Hy	3	[5]	-	-	-	121	126
HyTTec® Trophy	TT Hy	4	[8]	-	-	-	114	116
InVigor® T 3510	TT Hy	3	[4]	-	-	-	-	107
InVigor® T 4510	TT Hy	4	[13]	-	-	115	112	112
Pioneer® 44T02 TT	TT Hy	4	[16]	-	115	108	106	109
Pioneer® 45T03 TT	TT Hy	5	[1]	-	-	-	-	100
SF Ignite TT	TT Hy	5	[12]	-	-	111	110	105
SF Spark TT	TT Hy	3	[3]	-	-	-	-	103
SF Turbine TT	TT Hy	4	[16]	-	110	110	108	107
Yetna(ϕ)	TT OP	4	[1]	-	91	-	-	-
Hyola 580CT	TT+CL Hy	5	[6]	-	-	-	101	102
BASF 3000TR	TT+RR Hy	3	[6]	-	-	-	98	102
Site mean yield (t/ha)				1.24	1.44	2.72	1.86	2.13
	Type	Maturity	No. trials	[4]	[3]	[4]	[3]	[3]
RR AND TF VARIETIES								
DG 408RR	RR Hy	4	[10]	-	-	105	104	106
Hyola® 404RR	RR Hy	4	[17]	101	107	98	97	103
Hyola® 506RR	RR Hy	5	[7]	-	-	104	103	103
InVigor® R 3520	RR Hy	3	[7]	-	-	100	-	104
InVigor® R 5520P	RR Hy	5	[6]	-	-	105	106	100
Nuseed GT-42	RR Hy	4	[14]	104	102	100	98	105
Nuseed GT-53	RR Hy	5	[15]	116	108	109	104	114
Pioneer® 43Y23 RR	RR Hy	3	[17]	105	110	105	106	103
Pioneer® 43Y29 RR	RR Hy	3	[1]	-	-	-	110	-
Pioneer® 44Y27 RR	RR Hy	4	[10]	-	-	112	112	107
Pioneer® 45Y25 RR	RR Hy	5	[14]	107	97	107	105	104
Pioneer® 45Y28 RR	RR Hy	5	[4]	-	-	-	109	108

Combined herbicide tolerance varieties

Hyola® 580CT has a combination of TT and CL tolerance. It is intended for use where soil residues may be a problem, rather than for spraying with imidazolinone herbicides. Although Hyola® 580CT is a medium length maturity, it has fast development speed when sown in mid April, so may not suit very early sowing.

Hyola® 530XT is a TruFlex® variety with a combination of glyphosate and TT tolerance. NVT is limited to a single high yield result in Kojonup in 2017. More results are needed to be confident of variety performance and it is in 10 WA trials this season.

Hyola® 540XC is a TruFlex® variety, tolerant to both glyphosate and Clearfield® imidazolinone herbicide. It is released by Pacific Seeds and is entered into NVT for the first time in 2019.

TABLE 5 Agzone 3 Mid-season canola NVT 2014–18. Long-term MET predicted yield expressed as a percentage of mean yield.

Year				2014	2015	2016	2017	2018
Site mean yield (t/ha)				2.84	2.12	3.28	2.23	2.59
	Type	Maturity	No. trials	[3]	[3]	[2]	[3]	[3]
TT, TT+CL, TT+RR VARIETIES								
ATR Bonito(ф)	TT OP	4	[13]	98	97	98	100	98
ATR-Gem(ф)	TT OP	4	[6]	97	93	-	-	-
ATR Mako(ф)	TT OP	4	[14]	100	96	98	96	99
ATR Stingray(ф)	TT OP	3	[8]	91	99	93	-	-
ATR Wahoo(ф)	TT OP	6	[12]	99	92	101	104	99
DG 670TT	TT Hy	6	[8]	-	-	118	120	113
Hyola® 350TT	TT Hy	3	[5]	-	-	-	110	110
Hyola® 550TT	TT Hy	5	[2]	-	-	-	-	113
Hyola® 559TT	TT Hy	5	[14]	109	109	110	103	110
Hyola® 650TT	TT Hy	6	[14]	110	103	112	107	110
HyTTec® Trident	TT Hy	3	[3]	-	-	-	-	130
HyTTec® Trophy	TT Hy	4	[4]	-	-	-	122	121
InVigor® T 4510	TT Hy	4	[8]	-	-	121	120	116
Pioneer® 44T02 TT	TT Hy	4	[8]	-	112	108	104	-
Pioneer® 45T03 TT	TT Hy	5	[2]	-	-	-	-	103
SF Ignite TT	TT Hy	5	[8]	-	-	118	123	112
SF Turbine TT	TT Hy	4	[11]	-	112	111	112	108
Hyola® 580CT	TT+CL Hy	5	[6]	-	-	-	102	104
Hyola® 530XT	TT+TF Hy	5	[1]	-	-	-	110	-
Site mean yield (t/ha)				3.24	2.03	3.19	2.26	2.46
	Type	Maturity	No. trials	[2]	[2]	[1]	[2]	[2]
RR AND TF VARIETIES								
Hyola® 404RR	RR Hy	4	[5]	98	101	-	92	-
Hyola® 410XX	TF Hy	4	[1]	-	-	-	108	-
Hyola® 506RR	RR Hy	5	[5]	-	-	105	104	104
InVigor® R 3520	RR Hy	3	[1]	-	-	95	-	-
InVigor® R 5520P	RR Hy	5	[6]	-	107	106	106	103
Nuseed GT-42	RR Hy	4	[7]	-	98	100	98	103
Nuseed GT-53	RR Hy	5	[7]	-	105	113	109	114
Pioneer® 43Y23 RR	RR Hy	3	[2]	-	110	-	102	-
Pioneer® 43Y29 RR	RR Hy	3	[1]	-	-	-	111	-
Pioneer® 44Y27 RR	RR Hy	4	[4]	-	-	114	111	110
Pioneer® 45Y25 RR	RR Hy	5	[8]	108	102	113	113	108
Pioneer® 45Y28 RR	RR Hy	5	[3]	-	-	-	114	112
Xseed™ Raptor	TF Hy	4	[1]	-	-	-	114	-

TABLE 6 Agzone 5 Mid-season canola NVT 2014–18. Long-term MET predicted yield expressed as a percentage of mean yield.

Year				2014	2015	2016	2017	2018
Site mean yield (t/ha)					1.93	1.42	1.37	1.36
	Type	Maturity	No. trials	[0]	[1]	[1]	[1]	[1]
TT VARIETIES								
ATR Bonito(ϕ)	TT OP	4	[4]	-	99	98	98	96
ATR-Gem(ϕ)	TT OP	4	[1]	-	96	-	-	-
ATR Mako(ϕ)	TT OP	4	[2]	-	95	106	-	-
ATR-Stingray(ϕ)	TT OP	3	[2]	-	107	-	-	91
ATR Wahoo(ϕ)	TT OP	6	[2]	-	98	108	-	-
DG 670TT	TT Hy	6	[2]	-	-	118	-	103
Hyola® 350TT	TT Hy	3	[2]	-	-	-	109	111
Hyola® 559TT	TT Hy	5	[4]	-	102	117	108	112
Hyola® 650TT	TT Hy	6	[2]	-	101	-	-	105
HyTTec® Trident	TT Hy	3	[1]	-	-	-	124	-
HyTTec® Trophy	TT Hy	4	[2]	-	-	-	116	116
InVigor® T 3510	TT Hy	3	[1]	-	-	-	-	109
InVigor® T 4510	TT Hy	4	[3]	-	-	116	113	111
Pioneer® 44T02 TT	TT Hy	4	[3]	-	106	-	107	112
SF Ignite TT	TT Hy	5	[2]	-	-	109	109	-
SF Turbine TT	TT Hy	4	[2]	-	-	97	107	-

TABLE 7 Agzone 6 Mid-season canola NVT 2014–18. Long-term MET predicted yield expressed as a percentage of mean yield.

Year				2014	2015	2016	2017	2018
Site mean yield (t/ha)				1.29	2.49	1.84	1.74	2.03
	Type	Maturity	No. trials	[1]	[3]	[1]	[3]	[2]
TT, TT+CL VARIETIES								
ATR Bonito(ϕ)	TT OP	4	[10]	96	99	99	101	96
ATR-Gem(ϕ)	TT OP	4	[4]	91	99	-	-	-
ATR Mako(ϕ)	TT OP	4	[9]	98	100	98	97	96
ATR-Stingray(ϕ)	TT OP	3	[4]	95	91	-	-	-
ATR Wahoo(ϕ)	TT OP	6	[7]	-	105	100	106	91
DG 670TT	TT Hy	6	[6]	-	-	114	115	109
Hyola® 350TT	TT Hy	3	[4]	-	-	-	105	117
Hyola® 550TT	TT Hy	5	[2]	-	-	-	-	114
Hyola® 559TT	TT Hy	5	[10]	111	108	108	99	112
Hyola® 650TT	TT Hy	6	[10]	102	113	109	104	105
HyTTec® Trophy	TT Hy	4	[2]	-	-	-	113	124
InVigor® T 4510	TT Hy	4	[6]	-	-	116	113	119
Pioneer® 44T02 TT	TT Hy	4	[3]	-	103	-	-	-
Pioneer® 45T03 TT	TT Hy	5	[2]	-	-	-	-	108
SF Ignite TT	TT Hy	5	[6]	-	-	114	119	111
SF Spark TT	TT Hy	3	[1]	-	-	-	-	110
SF Turbine TT	TT Hy	4	[2]	-	106	-	108	-
Yetna(ϕ)	TT OP	4	[1]	-	90	-	-	-
Hyola® 580CT	TT+CL Hy	5	[5]	-	-	-	101	101
Site mean yield (t/ha)				1.29	2.5	1.84	2.22	2.01
	Type	Maturity	No. trials	[1]	[3]	[1]	[3]	[2]
RR AND TF VARIETIES								
Hyola® 404RR	RR Hy	4	[7]	106	93	-	91	-
Hyola® 506RR	RR Hy	5	[6]	-	-	104	102	105
InVigor® R 3520	RR Hy	3	[1]	-	-	95	-	-
InVigor® R 5520P	RR Hy	5	[7]	-	102	104	105	107
Nuseed GT-42	RR Hy	4	[9]	-	102	100	96	99
Nuseed GT-53	RR Hy	5	[9]	-	114	110	100	109
Pioneer® 43Y29 RR	RR Hy	3	[1]	-	-	-	108	-
Pioneer® 44Y27 RR	RR Hy	4	[5]	-	-	109	105	119
Pioneer® 45Y25 RR	RR Hy	5	[10]	98	114	109	109	104
Pioneer® 45Y28 RR	RR Hy	5	[3]	-	-	-	108	113

TABLE 8 Agzone 1 Early-season canola NVT 2014–18. Long-term MET predicted yield expressed as a percentage of mean yield.

Year				2014	2015	2016	2017	2018
Site mean yield (t/ha)				0.71	-	3.07	1.3	1.52
	Type	Maturity	No. trials	[1]	[0]	[2]	[2]	[1]
TT, TT+CL, TT+RR VARIETIES								
ATR Bonito(◊)	TT OP	4	[5]	101	-	96	97	99
ATR-Stingray(◊)	TT OP	3	[1]	111	-	-	-	-
Hyola® 350TT	TT Hy	3	[3]	-	-	-	117	105
Hyola® 559TT	TT Hy	5	[6]	109	-	109	114	111
Hyola® 650TT	TT Hy	6	[1]	-	-	-	-	97
HyTTec® Trident	TT Hy	3	[2]	-	-	-	132	131
HyTTec® Trophy	TT Hy	4	[3]	-	-	-	113	117
InVigor® T 3510	TT Hy	3	[1]	-	-	-	-	112
InVigor® T 4510	TT Hy	4	[5]	-	-	117	120	110
Pioneer® 44T02 TT	TT Hy	4	[5]	-	-	112	115	110
SF Turbine TT	TT Hy	4	[2]	-	-	-	114	106
Hyola® 580CT	TT+CL Hy	5	[2]	-	-	-	99	99
BASF 3000TR	TT+RR Hy	3	[5]	-	-	90	100	114
Site mean yield (t/ha)				0.71	-	3.07	1.3	1.52
	Type	Maturity	No. trials	[1]	[0]	[2]	[2]	[1]
RR VARIETIES								
DG 408RR	RR Hy	4	[5]	-	-	107	114	110
Hyola® 404RR	RR Hy	4	[6]	111	-	97	103	106
Hyola® 506RR	RR Hy	5	[3]	-	-	-	109	103
InVigor® R 3520	RR Hy	3	[5]	-	-	101	105	114
Nuseed GT-42	RR Hy	4	[5]	-	-	101	100	96
Nuseed GT-53	RR Hy	5	[5]	-	-	108	111	104
Pioneer® 43Y23 RR	RR Hy	3	[6]	116	-	100	106	111
Pioneer® 43Y29 RR	RR Hy	3	[2]	-	-	-	109	-
Pioneer® 44Y27 RR	RR Hy	4	[5]	-	-	117	117	112
Pioneer® 45Y25 RR	RR Hy	5	[1]	-	-	114	-	-
Pioneer® 45Y28 RR	RR Hy	5	[2]	-	-	-	112	-

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TABLE 9 Agzone 2 Early-season canola NVT 2014–18. Long-term MET predicted yield expressed as a percentage of mean yield.

Year				2014	2015	2016	2017	2018
Site mean yield (t/ha)				1.68	1.11	2.04	1.89	1.70
	Type	Maturity	No. trials	[2]	[2]	[3]	[2]	[3]
TT, TT+RR VARIETIES								
ATR Bonito(ϕ)	TT OP	4	[12]	97	97	98	98	98
ATR-Gem(ϕ)	TT OP	4	[2]	95	97	-	-	-
ATR Mako(ϕ)	TT OP	4	[3]	100	102	-	-	-
ATR-Stingray(ϕ)	TT OP	3	[10]	87	90	95	94	93
Hyola® 350TT	TT Hy	3	[4]	-	-	-	111	110
Hyola® 559TT	TT Hy	5	[12]	112	111	109	109	114
Hyola® 650TT	TT Hy	6	[3]	103	105	-	-	-
HyTTec® Trident	TT Hy	3	[5]	-	-	-	123	131
HyTTec® Trophy	TT Hy	4	[5]	-	-	-	110	115
InVigor® T 3510	TT Hy	3	[3]	-	-	-	-	112
InVigor® T 4510	TT Hy	4	[8]	-	-	111	112	116
Pioneer® 44T02 TT	TT Hy	4	[10]	-	112	109	110	112
SF Spark TT	TT Hy	3	[1]	-	-	-	-	115
SF Turbine TT	TT Hy	4	[10]	-	111	107	107	111
Yetna(ϕ)	TT OP	4	[2]	-	83	-	-	-
BASF 3000TR	TT+RR Hy	3	[10]	-	99	104	101	109
Site mean yield (t/ha)				1.66	1.08	2.02	1.89	1.74
	Type	Maturity	No. trials	[2]	[2]	[3]	[2]	[3]
RR VARIETIES								
DG 408RR	RR Hy	4	[8]	-	-	108	107	115
Hyola® 404RR	RR Hy	4	[12]	106	101	103	101	107
Hyola® 506RR	RR Hy	5	[3]	-	-	-	-	107
InVigor® R 3520	RR Hy	3	[8]	-	-	107	106	109
Nuseed GT-42	RR Hy	4	[5]	-	99	98	-	-
Nuseed GT-53	RR Hy	5	[10]	-	108	105	105	109
Pioneer® 43Y23 RR	RR Hy	3	[12]	105	104	106	104	110
Pioneer® 43Y29 RR	RR Hy	3	[2]	-	-	-	108	-
Pioneer® 44Y27 RR	RR Hy	4	[6]	-	-	111	113	113
Pioneer® 45Y25 RR	RR Hy	5	[4]	-	109	104	-	-
Pioneer® 45Y28 RR	RR Hy	5	[2]	-	-	-	110	-

TABLE 10 Agzone 4 Early-season canola NVT 2014–18. Long-term MET predicted yield expressed as a percentage of mean yield.

Year				2014	2015	2016	2017	2018
Site mean yield (t/ha)				0.49	-	2.25	2.22	1.78
	Type	Maturity	No. trials	[1]	[0]	[1]	[1]	[2]
TT, TT+RR VARIETIES								
ATR Bonito(ϕ)	TT OP	4	[5]	99	-	98	98	98
ATR Mako(ϕ)	TT OP	4	[1]	101	-	-	-	-
ATR-Stingray(ϕ)	TT OP	3	[3]	108	-	-	-	91
Hyola® 350TT	TT Hy	3	[2]	-	-	-	112	112
Hyola® 559TT	TT Hy	5	[4]	110	-	118	-	110
HyTTec® Trident	TT Hy	3	[3]	-	-	-	129	124
HyTTec® Trophy	TT Hy	4	[3]	-	-	-	113	110
InVigor® T 3510	TT Hy	3	[2]	-	-	-	-	108
InVigor® T 4510	TT Hy	4	[4]	-	-	118	115	115
Pioneer® 44T02 TT	TT Hy	4	[4]	-	-	116	112	111
SF Turbine TT	TT Hy	4	[2]	-	-	111	109	-
BASF 3000TR	TT+RR Hy	3	[4]	-	-	118	103	101
Site mean yield (t/ha)				0.49	-	2.25	2.22	1.78
	Type	Maturity	No. trials	[1]	[0]	[1]	[1]	[2]
RR VARIETIES								
DG 408RR	RR Hy	4	[4]	-	-	117	110	111
Hyola® 404RR	RR Hy	4	[5]	101	-	109	102	103
Hyola® 506RR	RR Hy	5	[2]	-	-	-	-	106
InVigor® R 3520	RR Hy	3	[4]	-	-	119	108	104
Nuseed GT-42	RR Hy	4	[1]	-	-	95	-	-
Pioneer® 43Y23 RR	RR Hy	3	[5]	111	-	116	106	105
Pioneer® 43Y29 RR	RR Hy	3	[1]	-	-	-	108	-
Pioneer® 44Y27 RR	RR Hy	4	[4]	-	-	119	115	112
Pioneer® 45Y28 RR	RR Hy	5	[1]	-	-	-	112	-

TABLE 11 Agzone 5 Early-season canola NVT 2014–18. Long-term MET predicted yield expressed as a percentage of mean yield.

Year				2014	2015	2016	2017	2018
Site mean yield (t/ha)				1.21	2.01	1.67	1.72	0.65
	Type	Maturity	No. trials	[4]	[2]	[3]	[3]	[1]
TT, TT+RR VARIETIES								
ATR Bonito(ф)	TT OP	4	[13]	99	99	98	99	96
ATR-Gem(ф)	TT OP	4	[1]	95	-	-	-	-
ATR Mako(ф)	TT OP	4	[5]	100	-	-	99	-
ATR-Stingray(ф)	TT OP	3	[7]	102	102	-	-	82
ATR Wahoo(ф)	TT OP	6	[1]	83	-	-	-	-
DG 670TT	TT Hy	6	[1]	-	-	-	-	101
Hyola® 350TT	TT Hy	3	[4]	-	-	-	107	111
Hyola® 550TT	TT Hy	5	[1]	-	-	-	-	111
Hyola® 559TT	TT Hy	5	[10]	110	112	112	-	150
Hyola® 650TT	TT Hy	6	[1]	97	-	-	-	-
HyTTec® Trophy	TT Hy	4	[4]	-	-	-	117	152
InVigor® T 3510	TT Hy	3	[1]	-	-	-	-	151
InVigor® T 4510	TT Hy	4	[7]	-	-	113	113	149
Pioneer® 44T02 TT	TT Hy	4	[8]	-	110	111	111	-
SF Turbine TT	TT Hy	4	[8]	-	105	108	108	-
Yetna(ф)	TT OP	4	[1]	-	80	-	-	-
BASF 3000TR	TT+RR Hy	3	[2]	-	-	108	113	-
Site mean yield (t/ha)				1.47	-	1.67	2.66	-
	Type	Maturity	No. trials	[1]	[0]	[1]	[1]	[0]
RR VARIETIES								
DG 408RR	RR Hy	4	[2]	-	-	112	103	-
Hyola® 404RR	RR Hy	4	[3]	102	-	102	98	-
InVigor® R 3520	RR Hy	3	[2]	-	-	107	105	-
Nuseed GT-42	RR Hy	4	[2]	-	-	99	99	-
Nuseed GT-53	RR Hy	5	[2]	-	-	109	103	-
Pioneer® 43Y23 RR	RR Hy	3	[3]	109	-	106	102	-
Pioneer® 43Y29 RR	RR Hy	3	[1]	-	-	-	109	-
Pioneer® 44Y27 RR	RR Hy	4	[2]	-	-	118	111	-
Pioneer® 45Y25 RR	RR Hy	5	[2]	100	-	110	-	-
Pioneer® 45Y28 RR	RR Hy	5	[1]	-	-	-	110	-

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Abbreviations

CC	conventional canola
CL	Clearfield®
GT	glyphosate tolerant
Hy	hybrid
MET	multi-environment trials
NVT	National Variety Trials
OP	open pollinated
RR	Roundup Ready®
TF	TruFlex®
TT	triazine tolerant

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OAT

By Georgie Troup, DPIRD

INTRODUCTION

The oat section of this sowing guide is designed to help you determine which milling oat or export hay variety to grow in your region. This section provides variety characteristics, disease ratings and agronomic information for oat varieties that offer growers the best opportunity to meet market requirements. This information should be read in conjunction with industry information provided in the Grains Industry 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 on an as-needs basis to ensure that WA grain standards are fit-for-purpose to customer requirements and set to maximise returns to the WA grain value chain. In 2018, a review was conducted and resulted in the changes shown in Table 1 to the Oat2 receival standards for the 2019-20 harvest.

Changes to receival standards for 2019-20 harvest

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(ϕ) oats. Each variety has its own strengths and weaknesses and their characteristics will determine their suitability for your area. No one 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.

Nitrogen management

When growers are making decisions on 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?
- Strategy for nitrogen application differs for grain and hay.
- Seasonal rainfall to date. If the season is dry the positive impact of applied nitrogen on yield is less.
- Hay yield of Bannister(ϕ) and Williams(ϕ) responds similarly to applied nitrogen (increased hay yield, but decreased hay quality).
- Increasing nitrogen results in increased screenings and decreased hectolitre weight. Williams(ϕ) and Carrolup are more sensitive than Bannister(ϕ) to increased nitrogen.

Target plant density

Traditionally, growers have sown oats with a set seeding rate. However, this approach can mean growers may not achieve their target plant density, reducing their ability to achieve optimum yield and/or quality.

Variable plant density at establishment may be due to differences in seed size, germination percentages and sowing conditions. It is recommended that growers determine the 1000

TABLE 1 Changes to oat receival standards for 2019-20 harvest.

Standard	2018-19 harvest	2019-20 harvest
Oat2 screenings (maximum)	N/A	15%
Oat2 groat count	144 per 2 black plastic measure	72 per 2 black plastic measure

Suggested target plant density.

Crop purpose	Lower rainfall zone (e.g. Agzone 4)	Higher rainfall zone (e.g. Agzone 3)
Grain	160 plants/m^2	240 plants/m^2
Export hay	240 plants/m^2	320 plants/m^2

grain weight of their seed, which is then used to determine the target sowing rate (kg/ha).

The seed rate calculation is:

$$\text{seed rate (kg/ha)} = \frac{\text{Target plant density (plants/m2)* Average grain weight (mg)]}}{\text{Expected establishment per cent (\%)}}$$

For example, if the desired plant population is 240 plants/m^2, the average grain weight is 40 milligrams (mg) and expected establishment is 80 per cent the calculation is: (240 * 40) / 80 = 120 kg/ha.

Management of grain staining

Bannister$^{\Phi}$ oats is one of the top three varieties grown in WA for grain and is becoming more popular due to its yield advantage over Carrolup$^{\Phi}$, and its better grain quality than Williams$^{\Phi}$. However, Bannister$^{\Phi}$ is susceptible to septoria and in higher rainfall areas where septoria is more prevalent there is greater risk of growers having grain downgraded at harvest due to grain staining.

Research investigating the best timing for fungicide application for septoria control and its impact on grain staining at harvest in Bannister$^{\Phi}$ oat crops (sown into oat stubble) found that:

- fungicide applied at flag leaf emergence or later significantly reduced severity of septoria on the Flag-1 leaf.
- the most effective treatment to protect the flag leaf is a two-spray regime, with the first application applied at stem elongation-flag leaf emergence and the second application at flag leaf emergence-head emergence.

In high disease pressure scenarios (e.g. growing a susceptible variety, oat-on-oat rotation, or high rainfall regions), the data generated from research suggests that if disease pressure becomes evident at stem elongation then growers should implement a two-spray regime, with applications applied at stem elongation and flag emergence to provide 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 will provide more protection than other spray strategies, protecting the flag leaf and potentially providing a yield benefit.

Pre-harvest rainfall (between grain filling and harvest) has also resulted in grain staining in Bannister$^{\Phi}$ crops. In this scenario, applying late fungicides to reduce grain staining has proved to be unreliable.

What's new?

One new oat grain variety – Bilby$^{\Phi}$ (tested as 06204-16) – and one new oat hay variety – Koorabup$^{\Phi}$ (tested as 05096-32) – were released for commercial production in 2019. Bilby$^{\Phi}$ underwent commercial milling evaluation in early 2019 and was approved for Oat1 milling classification in Western Australia. While there is no commercial hay variety evaluation, Koorabup$^{\Phi}$ has performed similarly to other accepted export hay varieties in yield and quality.

Bilby$^{\Phi}$ is a cross between two breeding lines, 98011-6 and 98240-19. Bilby$^{\Phi}$ is a dwarf, early-mid season variety. Its grain yield and quality are between that of Kojonup$^{\Phi}$ and the higher-yielding varieties Bannister$^{\Phi}$ and Williams$^{\Phi}$ (based on data from NVT 2016–18 and DPIRD oat agronomy 2017-18). Without a yield advantage over Bannister$^{\Phi}$ or Wandering$^{\Phi}$, it is not expected that Bilby$^{\Phi}$ will displace these dominating varieties in the WA oat growing environment. The National Oat Breeding Program has developed this variety, along with Kowari$^{\Phi}$, to have high β-glucan, an important nutritional quality trait that is valued by oat markets worldwide.

Seed is available through Heritage Seeds. PBR and EPR of $2.50/tonne (exc. GST) apply.

Koorabup$^{\Phi}$ is a cross between two WA breeding lines. Koorabup$^{\Phi}$ is a mid-tall, early mid to mid-season variety. Koorabup$^{\Phi}$ has excellent hay colour and similar in quality to Wintaroo$^{\Phi}$. Hay yield is slightly higher than Carrolup, but lower than Brusher$^{\Phi}$ (based on data from the National Oat Breeding Program). Koorabup$^{\Phi}$ has good resistance to septoria, rust and bacterial blight. The National Oat Breeding Program has developed this variety with improved grain quality compared with other hay varieties and improved septoria resistance.

Seed is available through AEXCO. PBR and EPR of $2/tonne (exc. GST) apply.

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What should I grow?

Based on their performance in the NVT and agronomy trials, varieties have been suggested for the high, medium and low-rainfall areas. The decision 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; and
3. location of receival segregations for Oat1 and Oat2 varieties.

Grain

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

If growers are targeting the OWAN or Oat2 market, then Wandering(Φ) is suggested.

Newly released variety Bilby(Φ) performed well in the 2018 NVT series, but performance over multiple seasons is required to determine best fit for this variety.

Hay

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

Variety eligibility for delivery

TABLE 2 Oat varieties and their suitability for grain (Oat1, Oat2, OWAN) and export hay.

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

*Released in 2019

YIELD COMPARISONS

Variety trials are conducted across Australia and are supported and overseen by the Grains Research and Development Corporation (GRDC) through the National Variety Trials (NVT). Grain yield comparisons are presented in Tables 3 to 7. Each year the NVT coordinates approximately 31 oat variety trials, of which 10 are located in Western Australia.

Data presented is based on trials from 2014 to 2018. While many varieties are included in the NVT (current and older varieties, new experimental varieties and some specialty varieties), only current deliverable milling oat varieties are included here. To find the latest NVT data (long-term and seasonal), visit www.nvtonline.com.au or download the NVT yield app.

Grain yield data is presented by grouping the trials into six Agzones. These Agzones have been developed to group together environmental regions that give similar crop performance in WA.

TABLE 3 Grain yield in Agzone 2 expressed as a per cent of site mean yield, 2014–18.

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		3.35	2.97	4.11	3.15	3.67
	No. trials	(5)	(7)	(6)	(7)	(5)
DELIVERABLE AS A MILLING (OAT1 OR OAT2) VARIETY						
Bannister(Φ)	(30)	107	113	122	115	117
Bilby(Φ)	(30)	104	110	109	112	112
Carrolup	(30)	91	93	95	96	99
Durack(Φ)	(30)	96	96	87	94	94
Kojonup(Φ)	(30)	101	98	106	102	100
Kowari(Φ)	(30)	100	103	100	104	104
Mitika(Φ)	(30)	98	98	97	100	99
Wandering(Φ)	(30)	110	114	123	110	113
Williams(Φ)	(30)	108	113	114	113	114
Yallara(Φ)	(30)	96	95	93	92	94

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

TABLE 4 Grain yield in Agzone 3 expressed as a per cent of site mean yield, 2014–18.

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		3.36	3.03	4.11	4.07	3.02
	No. trials	(3)	(3)	(4)	(4)	(4)
DELIVERABLE AS A MILLING (OAT1 OR OAT2) VARIETY						
Bannister(Φ)	(18)	112	111	113	112	115
Bilby(Φ)	(18)	97	107	102	102	105
Carrolup	(18)	96	92	101	98	100
Durack(Φ)	(18)	90	97	93	93	91
Kojonup(Φ)	(18)	117	101	102	109	108
Kowari(Φ)	(18)	90	100	98	96	98
Mitika(Φ)	(18)	89	95	96	93	96
Wandering(Φ)	(18)	106	111	117	109	112
Williams(Φ)	(18)	121	117	111	116	114
Yallara(Φ)	(18)	97	96	101	98	96

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

TABLE 5 Grain yield in Agzone 4 expressed as a per cent of site mean yield, 2015–18.

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)			2.19	3.72	3.43	2.06
	No. trials		(1)	(1)	(1)	(1)
DELIVERABLE AS A MILLING (OAT1 OR OAT2) VARIETY						
Bannister(Φ)	(4)	-	113	115	133	115
Bilby(Φ)	(4)	-	114	106	116	115
Carrolup	(4)	-	96	95	99	99
Durack(Φ)	(4)	-	95	93	77	101
Kojonup(Φ)	(4)	-	97	100	111	90
Kowari(Φ)	(4)	-	109	100	105	107
Mitika(Φ)	(4)	-	106	96	103	99
Wandering(Φ)	(4)	-	109	122	129	119
Williams(Φ)	(4)	-	103	112	109	116
Yallara(Φ)	(4)	-	90	99	86	98

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

TABLE 6 Grain yield in Agzone 5 expressed as a per cent of site mean yield, 2014–18.

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		2.30	3.17	2.79	2.84	3.05
	No. trials	(1)	(2)	(1)	(2)	(1)
DELIVERABLE AS A MILLING (OAT1 OR OAT2) VARIETY						
Bannister(Þ)	(7)	109	113	130	133	114
Bilby(Þ)	(7)	109	108	115	122	109
Carrolup	(7)	95	93	102	99	98
Durack(Þ)	(7)	100	95	85	83	97
Kojonup(Þ)	(7)	93	99	112	111	98
Kowari(Þ)	(7)	105	102	101	107	102
Mitika(Þ)	(7)	101	98	95	101	96
Wandering(Þ)	(7)	114	116	118	117	115
Williams(Þ)	(7)	106	111	129	124	118
Yallara(Þ)	(7)	98	97	89	82	98

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

TABLE 7 Grain yield in Agzone 6 expressed as a per cent of site mean yield, 2014–18.

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		4.13	3.73	1.82	3.56	4.82
	No. trials	(1)	(1)	(1)	(1)	(1)
DELIVERABLE AS A MILLING (OAT1 OR OAT2) VARIETY						
Bannister(Þ)	(5)	110	131	150	118	128
Bilby(Þ)	(5)	110	136	135	112	111
Carrolup	(5)	90	84	100	98	104
Durack(Þ)	(5)	94	83	79	86	85
Kojonup(Þ)	(5)	104	111	128	118	115
Kowari(Þ)	(5)	104	119	105	102	97
Mitika(Þ)	(5)	101	111	88	101	91
Wandering(Þ)	(5)	105	103	109	97	118
Williams(Þ)	(5)	108	116	168	114	132
Yallara(Þ)	(5)	90	64	71	82	92

SOURCE: BASED ON MET ANALYSIS FROM NVT ONLINE, NVTONLINE.COM.AU

DISEASE RESISTANCE RATINGS

Disease and virus resistance data are presented in Table 8.

TABLE 8 Disease characteristics of oat varieties, 2019.

Variety	Septoria	Rust		BYDV[1]	Bacterial blight	CCN[2] Resistance	CCN tolerance
		Leaf	Stem				
Bannister(Þ)	S	R	RMS	MRMS	MRS	R	MI
Bilby(Þ)	S	R	MSVS	MRMS	MS	S	No data
Brusher(Þ)	S-S	RMS	MRS	MRMS	MRS	R	MI
Carrolup	SVS	SVS	MSS	MSS	MRS	S	I
Durack(Þ)	SVS	RS	MS	MSS	MRS	R	MI-MT
Forester(Þ)	MRS	RMS	RMS	MS	MSS	MS	MI
Kojonup(Þ)	SVS	SVS	MSS	MS	MRS	VS	I
Koorabup(Þ)	MRMS	RMR	RMS	MS	MR	S	No data
Kowari(Þ)	SVS	R	MRMS	MS	MR	VS	I
Mitika(Þ)	SVS	MR	MRMS	S	MR	VS	I
Mulgara(Þ)	MRS	MR	MRMS	MSS	MR	R	MT
Wandering(Þ)	SVS	VS	MSVS	MS	MRS	VS	I
Williams(Þ)	MRMS	RMR	MR	MRMS	R	S	I
Winjardie	SVS	SVS	MRS	MSS	S	S	I
Wintaroo(Þ)	MSS	SVS	MR	MS	MR	R	MT
Yallara(Þ)	S	RMS	MRMS	MS	MRS	R	I

SOURCE: NATIONAL OAT BREEDING PROGRAM

Note: Stem rust, leaf rust, [1] Barley yellow dwarf virus (BYDV) and Septoria reactions are from WA trials. Bacterial blight and [2] cereal cyst nematode (CCN) are from SA and Victorian trials. Rust and BYDV reactions may vary in different regions and with different seasonal conditions depending on the prevalent pathotype/serotype. Crop monitoring is essential. CCN tolerance indicates the ability of the variety to grow and yield in the presence of CCN. Resistance refers to the ability of the variety to reduce CCN carryover.

VS = very susceptible S = susceptible MS = moderately susceptible MR = moderately resistant MI = moderately intolerant MT = moderately tolerant R = resistant T = tolerant I = intolerant

GRAIN QUALITY

Grain quality characteristics are important to consider when selecting an oat variety.

In Western Australia, delivery of oat grain into the segregations of Oat1 and Oat2 is limited mainly by two key grain quality specifications: hectolitre weight and screenings.

Hectolitre weight, screenings and 1000 grain weight of the 12 oat varieties suggested for WA when grown in WA are in Table 9.

TABLE 9 Grain quality data of oat varieties from trials in Western Australia, 2014–18.

Variety	Hectolitre weight (kg/hL)	1000 grain weight (g)	Screenings (%)
Bannister(Þ)	48.9	39.9	4.6
Bilby(Þ)	47.1	39	5.8
Carrolup	46.9	36.9	6
Durack(Þ)	48.3	36.2	5.3
Kojonup(Þ)	47.7	36.9	4.3
Koorabup(Þ)	49	36.6	3.5
Kowari(Þ)	49	38	4.2
Mitika(Þ)	50	38.8	3.3
Wandering(Þ)	47.5	39.4	4.8
Williams(Þ)	50.5	38.2	5.9
Yallara(Þ)	49.2	35.9	4.7
No. trials	18	16	18

SOURCE: NVT AND NATIONAL OAT BREEDING PROGRAM

HAY YIELD AND QUALITY COMPARISONS

Hay yield and quality comparisons are provided by the National Oat Breeding Program, led by Pamela Zwer at the South Australian Research and Development Institute. Trials conducted in Western Australia are delivered by the DPIRD staff based at Northam. The focus of the National Oat Breeding Program is to improve productivity and quality in new oat varieties developed for hay and grain end users. Average hay yield comparisons for varieties eligible for export hay are listed in Table 10.

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TABLE 10 Average hay yield (t/ha) of varieties from trials in Western Australia, 2014–18.

Variety	Hay yield (t/ha)
Bannister(Φ)	7
Brusher(Φ)	7.3
Carrolup	6.6
Durack(Φ)	6.2
Forester(Φ)	6.9
Koorabup(Φ)	6.7
Mulgara(Φ)	6.9
Swan	7.4
Wandering(Φ)	7
Williams(Φ)	6.7
Winjardie	7.3
Wintaroo(Φ)	7.5
Yallara(Φ)	7.1
No. sites	11

Analysis by Chris Lisle, BBAGI SOURCE: DATA COURTESY NATIONAL OAT BREEDING PROGRAM

TABLE 11 Quality standards to meet export hay requirements in Western Australia.

Parameter	Grade 1	Grade 2	Grade 3	Grade 4
Crude protein (% CP)	>4	<4	<4	<4
Water soluble carbohydrates (% WSC)	>22	>18	>14	>14
Estimated metabolisable energy (est. ME MJ/kg DM)	>9.5	<9.5	<9.5	<9.5
Acid detergent fibre (% ADF)	<30-32	>32-35	>35-37	>37-40
Neutral detergent fibre (% NDF)	<55	<55-59	<64	>64
In vitro digestibility (% DMD)	>60	>58	>56	>53
Stem thickness (mm)	<6	<8	<9	>9-12

The quality of hay is determined by the variety grown, agronomy applied to the crop, the crop growth stage at which the hay is cut and the conditions during the period between cutting and baling. Table 11 describes the suggested quality specifications growers need to achieve to meet export hay requirements.

Hay varieties differ in their quality. All of the varieties listed in Table 12 are deliverable as export hay varieties when grown in the right environment, with the right agronomy and the right seasonal conditions. Growers are encouraged to discuss with their intended hay buyer which variety they intend to sow to ensure that it meets current market demands.

TABLE 12 Average hay quality of oat varieties in Western Australia, 2014–18.

Variety	Digestibility (% dm)	[1]WSC (% dm)	[2]ADF (% dm)	[3]NDF (% dm)	Crude protein (%dm)	Stem diameter[4]
Bannister(Φ)	69.3	32.5	27.5	48.5	7.2	M
Brusher(Φ)	67.6	32.9	28.2	49.3	6.8	M
Carrolup	66.3	31.9	29.2	49.8	6.8	M
Durack(Φ)	66.2	30.2	29	50	7.1	M
Forester(Φ)	68.9	34.2	28.2	46.7	6.9	MT
Koorabup(Φ)	66.1	29.5	29.3	51.2	6.8	MF
Mulgara(Φ)	67.7	32	28.3	49.4	6.8	M
Swan	66.3	30.8	29.4	50.9	6.7	M
Wandering(Φ)	68.9	33.3	27.5	48.8	7.2	M
Williams(Φ)	66.7	30.7	29	50.1	7.5	MT
Winjardie	67	31.3	28.9	50.4	6.7	M
Wintaroo(Φ)	66.8	30.6	29.3	50.7	6.2	M
Yallara(Φ)	67.5	32	28.5	48.6	6.7	MF
No. sites	7	9	8	9	9	

Analysis by Chris Lisle, BBAGI SOURCE: DATA COURTESY NATIONAL OAT BREEDING PROGRAM

[1]WSC=water soluble carbohydrates [2]ADF=acid detergent fibre [3]NDF=neutral detergent fibre [4]Stem diameter: F = fine MF = moderately fine MT = moderately thick T = thick VT = very thick.

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Company and industry abbreviations:

- BBAGI - Bioinformatics and Biometrics for the Australian Grains Industry
- CBH – Co-operative Bulk Handling
- CBB – Centre for Bioinformatics and Biometrics
- DPIRD – Department of Primary Industries and Regional Development (formerly DAFWA)
- GIWA – Grain Industry Association of Western Australia
- GRDC – Grains Research and Development Corporation
- NVT – National Variety Trials
- SAGI – Statistics for the Australian Grains Industry

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PULSE GUIDE

By Mark Seymour, Andrew Blake, Martin Harries, Harmohinder Dhammu, Stacey Hansch, 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 5 Desi types	
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	6	Herbicide damage an issue on sandier soils
Lupin – narrow-leaf	4 to 7	Sand to sandy loam	3	-	
Lupin – albus	5.5 to 7.5	Loamy sand to loam	4	-	Higher pH than NLL
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[1] x IMI herbicides increased interest. Very high prices in 2018 around $1000/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 put peas under pressure in the rotation.
Lentil	• Seek advice before growing lentils. • Wide range of grower 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 markets, investigate marketing.
Vetch	• Particularly suited to farmers with livestock. • Species available that can be sown very early and grazed multiple times. • Grain vetch growers need to talk to marketers as the demand for grain can be variable.

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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 (120g/L)
Example product		Spin Flo®	Bravo® Weather Stik® Barrack Betterstick® Nufarm Unite® 720	Sipcam Echo® 900 WDG (Fungicide)	Dithane™ Rainshield™ Neo Tec™	Fortress® 500 Sumitomo 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		
	Downy mildew/BGM		1.1–1.8L	0.9–1.5kg	1.0–2.2kg				0.75–1.0L
	Powdery mildew							145mL	
Faba bean	Ascochyta				1.0–2.2kg		400–600 mL		0.75–1.0L
	Cercospora				1.0–2.2kg		400–600 mL	145mL#	300mL
	Chocolate spot	500mL	1.4–2.3L	1.2–1.9kg	1.0–2.2kg	500 mL	600 mL		0.75–1.0L
	Rust		1.4–2.3L	1.2–1.9kg	1.0–2.2kg		600 mL	145mL#	300mL
Lentil	Ascochyta blight		1.0–2.0L	0.8–1.6kg	1.0–2.2kg		400–600 mL		0.75–1.0L
	Botrytis grey mould	500mL	1.0–2.0L	0.8–1.6kg	1.0–2.2kg	500 mL	400–600 mL		0.75–1.0L
	Sclerotinia								
Lupin	Anthracnose				1.0–2.2kg				
	Sclerotinia								
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

LUPIN

INTRODUCTION

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 Western Australia 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[Φ]. It is early maturing (similar to Jurien[Φ]), with metribuzin tolerance similar to Mandelup[Φ]. Coyote[Φ] is moderately susceptible to phomopsis; graze lupin stubbles with care in high-risk environments.

WHAT VARIETY SHOULD I GROW?

Besides looking for stable high yields, growers generally chose 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[Φ] and Mandelup[Φ].

Please refer to Figure 2 on outside back cover 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 a percentage of site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		2.94	3.90	3.12	1.64	2.18
	No. of trials	(2)	(3)	(4)	(3)	(4)
Coromup[Φ]	(16)	92	96	102	97	114
Coyote[Φ]	(16)	104	109	106	121	126
Jenabillup[Φ]	(16)	99	97	93	93	116
Mandelup[Φ]	(12)	89	104	107	110	-
PBA Barlock[Φ]	(12)	107	105	118	102	-
PBA Bateman[Φ]	(3)	105	107	102	-	118
PBA Gunyidi[Φ]	(12)	104	104	105	109	-
PBA Jurien[Φ]	(12)	107	110	128	111	-
PBA Leeman[Φ]	(13)	88	99	96	-	121
Tanjil[Φ]	(12)	94	96	95	95	-

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

NOTE: For all Agzones in 2018, Mandelup[Φ], PBA Barlock[Φ], PBA Gunyidi[Φ] and PBA Jurien[Φ] 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 a percentage of site mean yield for each trial year (2014, 2015 and 2018).

Year		2014	2015	2018
Site mean yield (t/ha)		1.91	2.59	3.21
	No. of trials	(2)	(2)	(1)
Coromup(ф)	(5)	96	97	123
Coyote(ф)	(5)	103	105	137
Jenabillup(ф)	(5)	98	96	126
Mandelup(ф)	(4)	101	99	-
PBA Barlock(ф)	(4)	100	109	-
PBA Bateman(ф)	(5)	101	104	128
PBA Gunyidi(ф)	(4)	101	104	-
PBA Jurien(ф)	(4)	102	113	-
PBA Leeman(ф)	(5)	100	96	130
Tanjil(ф)	(4)	98	96	-

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

NOTE: For all Agzones in 2018, Mandelup(ф), PBA Barlock(ф), PBA Gunyidi(ф) and PBA Jurien(ф) 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 a percentage of site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		1.24	2.34	2.57	1.90	1.95
	No. of trials	(1)	(1)	(1)	(1)	(1)
Coromup(ф)	(5)	90	103	111	104	96
Coyote(ф)	(5)	112	101	94	115	117
Jenabillup(ф)	(5)	99	98	93	101	110
Mandelup(ф)	(4)	110	107	107	101	-
PBA Barlock(ф)	(4)	102	101	118	105	-
PBA Bateman(ф)	(4)	108	99	91	-	113
PBA Gunyidi(ф)	(4)	103	100	100	107	-
PBA Jurien(ф)	(4)	107	104	126	107	-
PBA Leeman(ф)	(4)	99	105	97	-	106
Tanjil(ф)	(4)	92	101	101	95	-

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

NOTE: For all Agzones in 2018, Mandelup(ф), PBA Barlock(ф), PBA Gunyidi(ф) and PBA Jurien(ф) 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 a percentage of site mean yield for each trial year (2014–18).

Year		2014	2015	2017	2018
Site mean yield (t/ha)		1.79	1.20	2.76	2.40
	No. of trials	(2)	(2)	(2)	(1)
Coromup(ф)	(7)	91	99	98	107
Coyote(ф)	(7)	135	126	107	125
Jenabillup(ф)	(7)	114	107	95	108
Mandelup(ф)	(6)	90	113	89	-
PBA Barlock(ф)	(6)	108	105	106	-
PBA Bateman(ф)	(5)	142	125	-	124
PBA Gunyidi(ф)	(6)	114	107	106	-
PBA Jurien(ф)	(6)	104	109	108	-
PBA Leeman(ф)	(5)	85	100	-	108
Tanjil(ф)	(6)	80	88	98	-

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

NOTE: For all Agzones in 2018, Mandelup(ф), PBA Barlock(ф), PBA Gunyidi(ф) and PBA Jurien(ф) 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 a percentage of site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		1.91	2.00	2.52	1.73	1.97
	No. of trials	(2)	(3)	(2)	(3)	(3)
Coromup(ф)	(13)	88	101	95	102	133
Coyote(ф)	(13)	106	111	116	127	139
Jenabillup(ф)	(13)	99	101	97	97	128
Mandelup(ф)	(10)	97	107	100	111	-
PBA Barlock(ф)	(10)	101	107	107	105	-
PBA Bateman(ф)	(10)	105	110	115	-	131
PBA Gunyidi(ф)	(10)	103	104	108	111	-
PBA Jurien(ф)	(10)	102	110	112	113	-
PBA Leeman(ф)	(10)	93	98	98	-	128
Tanjil(ф)	(10)	94	94	93	93	-

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

NOTE: For all Agzones in 2018, Mandelup(ф), PBA Barlock(ф), PBA Gunyidi(ф) and PBA Jurien(ф) 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 a percentage of site mean yield for each trial year (2014–17).

Year		2014	2015	2016	2017
Site mean yield (t/ha)		3.08	2.14	0.89	3.02
	No. of trials	(1)	(1)	(1)	(1)
Coromup(ф)	(4)	90	97	98	91
Coyote(ф)	(4)	105	110	109	100
Jenabillup(ф)	(4)	96	100	88	94
Mandelup(ф)	(4)	101	108	111	96
PBA Barlock(ф)	(4)	104	104	114	97
PBA Bateman(ф)	(3)	103	107	102	-
PBA Gunyidi(ф)	(4)	103	103	105	101
PBA Jurien(ф)	(4)	107	107	126	98
PBA Leeman(ф)	(3)	96	99	102	-
Tanjil(ф)	(4)	95	94	96	101

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

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

TABLE 7 Grain yield of narrow-leaf lupin varieties in Agzone 7 expressed as a percentage of site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		0.89	1.09	1.80	0.33	1.74
	No. of trials	(2)	(2)	(3)	(1)	(2)
Coromup(ф)	(10)	89	94	96	187	116
Coyote(ф)	(10)	104	115	105	94	128
Jenabillup(ф)	(9)	98	99	95	117	112
Mandelup(ф)	(8)	97	115	105	101	-
PBA Barlock(ф)	(8)	104	106	110	118	-
PBA Bateman(ф)	(7)	102	111	102	-	119
PBA Gunyidi(ф)	(8)	102	104	103	101	-
PBA Jurien(ф)	(8)	106	112	116	116	-
PBA Leeman(ф)	(7)	93	100	96	-	122
Tanjil(ф)	(8)	95	92	95	118	-

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

NOTE: For all Agzones in 2018, Mandelup(ф), PBA Barlock(ф), PBA Gunyidi(ф) and PBA Jurien(ф) 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 a percentage of site mean yield for each trial year (2014, 2017 and 2018).

Year		2014	2017	2018
Site mean yield (t/ha)		2.68	1.85	1.13
	No. of trials	(1)	(1)	(1)
Coromup[Ф]	(3)	87	89	70
Coyote[Ф]	(3)	108	124	146
Jenabillup[Ф]	(3)	89	103	89
Mandelup[Ф]	(2)	110	117	-
PBA Barlock[Ф]	(2)	106	96	-
PBA Bateman[Ф]	(2)	101	-	151
PBA Gunyidi[Ф]	(2)	104	105	-
PBA Jurien[Ф]	(2)	115	99	-
PBA Leeman[Ф]	(1)	101	-	-
Tanjil[Ф]	(2)	95	90	-

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

NOTE: For all Agzones in 2018, Mandelup[Ф], PBA Barlock[Ф], PBA Gunyidi[Ф] and PBA Jurien[Ф] 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 spot	Phomposis (stem)	Anthracnose	Grey spot	CMV (seed)	BYMV	Aphid
Coromup[Ф]	MRMS	MS	R	MR	R	MR	MS	R
Coyote[Ф]	-	MS	MS	MR	R	MR	MRMS	-
Jenabillup[Ф]	MRMS	MRMS	MS	MS	R	MS	MR	R
Mandelup[Ф]	MS	MS	R	MR	R	MS	S	R
PBA Barlock[Ф]	MR	MS	MR	R	R	MR	MS	R
PBA Bateman[Ф]	MRMS	MS	MR	MRMS	R	MR	MR	R
PBA Gunyidi[Ф]	MR	MS	R	MR	S	MR	MS	R
PBA Jurien[Ф]	MRMS	MS	R	R	R	MS	MR	R
PBA Leeman[Ф]	MRMS	MS	R	MRMS	R	MS	MS	R
Tanjil[Ф]	MR	MS	R	R	R	R	MS	R

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

SOURCE: PULSE BREEDING AUSTRALIA (PBA) TRIALS PROGRAM 2008–14, NVT AND AGT DATA

TABLE 10 Seed quality of narrow-leaf lupin varieties.

Variety	100 seed weight (g)*	Protein as % of Mandelup[Ф]	Alkaloid as % of Mandelup[Ф]
Coromup[Ф]	14.5	-	-
Coyote[Ф]	14.7	Similar to Mandelup[Ф]	Similar to Mandelup[Ф] and PBA Jurien[Ф]
Jenabillup[Ф]	15.6	103	67
PBA Barlock[Ф]	13.9	97	115
PBA Bateman[Ф]	15	-	-
PBA Gunyidi[Ф]	13.3	102	100
PBA Jurien[Ф]	14.7	102	105
PBA Leeman[Ф]	15	-	-
Tanjil[Ф]	13.3	100	113
Mandelup[Ф]	**14.7**	**32%**	**0.017**

SOURCE: * NVT; PROTEIN AND ALKALOID – % AS RECEIVED, WHOLE SEED, 6 SITES, 2010–14. CHEMCENTRE, BENTLEY, WA STANDARD PROTEIN AND ALKALOID ANALYSIS FOR NARROW-LEAF LUPIN

DPIRD GRDC

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 risk of brown spot disease 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.
- 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 per square metre.

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 per cent 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 narrow 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-emergent herbicides

- Atrazine 900g/kg (e.g. Atradex® WG) at 280–560g/ha
- Dimethenamid-P 720g/L (e.g. Outlook®) at 1L/ha
- Diuron 900g/kg (e.g. Diurex® WG) at 1.1kg/ha
- Pendimethalin 440g/L (e.g. Stomp®) at 1.5–2.25L/ha
- Propyzamide 900g/kg (e.g. Imtrade 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 0.55–1.6kg/ha
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.86–1.2kg/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

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 Western Australia, 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 subgroup within Group C herbicides, addition of 0.55–1.1kg/ha of diuron (900g a.i./kg) will assist in management of 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

Herbicides for broadleaf weed control

- Diflufenican 500g/L (e.g. Brodal® Options, Bonanza® Elite) at 100-200mL/ha
- Metosulam 100g/L (e.g. Eclipse®) at 50–70mL/ha
- Metribuzin 750g/kg (e.g. Stacato®, Mentor® WG) at 100–150g/ha plus 100mL/ha Broadal® (diflufenican 500g/L)
- Picolinafen 750g/kg (e.g. Conquest Glocker 750 WG Herbicide, Sniper®) at 33–50g/ha
- Simazine 900g/kg (e.g. Simagranz®) at 0.4–1.1kg/ha as a top-up application following a pre-emergence application of Simazine

Herbicides for grass weed control

- Butroxydim 250g/kg (e.g. Factor® WG) at 80–180g/ha
- Clethodim 240g/L (e.g. Select®, Status®) at 150–500mL/ha
- Diclofop-methyl 375g/L (e.g. Rhino®) at 1–2L/ha
- Fluazifop-p 128g/L (e.g. Fusilade® Forte) at 410–820mL/ha
- Haloxyfop-R 520g/L (e.g. Verdict®) at 50–100mL/ha
- Propaquizafop 100g/L (e.g. Shogun®) at 200–450mL/ha
- Quizalofop-p-ethyl 200g/L (e.g. Elantra® Xtreme®, Leopard® 200) at 65–190mL/ha
- Sethoxydim 186g/L (e.g. Sertin®) at 0.5–1L/ha

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 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 or atrazine) 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®) and picolinafen (e.g. Sniper®) alone, or in combination with other herbicides, cause bleaching/leaf spotting on most of the lupin varieties. Symptoms typically outgrow with time.
- The use of metribuzin alone, or in combination with other herbicides, may cause leaf burn and slight crop suppression in most varieties. Maximum rate of metribuzin 750 registered for post-emergent use on lupins is 112.5g a.i./ha from four leaves until bud emergence. Newer lupin varieties such as PBA Gunyidi$^{\Phi}$, PBA Barlock$^{\Phi}$, PBA Leeman$^{\Phi}$ and Coyote$^{\Phi}$ have better metribuzin tolerance than older varieties such as Tanjil$^{\Phi}$.
- 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 typical 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.
- Crop-top when 80 per cent 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 per cent) and spray before 80 per cent 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 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 per cent of lupin leaves have dropped off. Early 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
- Pod fill: native budworm

Aphid threshold

- Consider controlling aphids in flowering lupins if more than 30 per cent of the crop is infested.

Native budworm threshold

- 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 loss of yield due to lodging, pod shattering and pod drop. Start harvesting as soon as the moisture content reaches 14 per cent. 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. Take special care when harvesting seed for next year's crop. Harvest it 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 you select a variety with tolerance to Ascochyta, have a disease management plan, use an inoculant 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 not knowing the germination rate of chickpeas, resulting in very poor establishment.

WHAT TYPE AND VARIETY OF CHICKPEA 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$^{\Phi}$ and Neelam$^{\Phi}$ 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		16–27	PBA Striker$^{\Phi}$, Gen836, Neelam$^{\Phi}$
Kabuli type	Small	6–8	20–35	Gen090, Gen079
	Medium	7–9	35–45	Almaz, PBA Monarch$^{\Phi}$
	Large	8–10	40–50	Kalkee
	Very large	9–11	50–65	Kimberley Large

SOURCE: AUSTRALIAN PULSE VARIETY GUIDE 2016 (PULSE AUSTRALIA)

Grain yield

TABLE 2 Grain yield of chickpea varieties (and year of release) in Agzone 1 expressed as a percentage of site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		0.8	1.6	1.54	0.64	1.37
	No. of trials	(1)	(3)	(2)	(3)	(3)
DESI TYPE						
Ambar(Φ) (2013)	(12)	111	95	106	97	102
Genesis 836 (2006)	(12)	98	91	96	96	99
Neelam(Φ) (2013)	(12)	114	110	112	103	105
PBA Maiden(Φ) (2013)	(12)	97	93	102	101	103
PBA Slasher(Φ) (2009)	(12)	106	105	107	103	104
PBA Striker(Φ) (2012)	(12)	100	103	112	111	111
KABULI TYPE						
Genesis 090 (2005)	(12)	110	116	113	108	106

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 3 Grain yield of chickpea varieties in Agzone 2 expressed as a percentage of site mean yield for each trial year (2014–17).

Year		2014	2015	2016	2017
Site mean yield (t/ha)		0.95	1.27	0.97	1.00
	No. of trials	(3)	(2)	(1)	(1)
DESI TYPE					
Ambar(Φ)	(7)	102	96	110	104
Genesis 836	(7)	95	94	101	100
Neelam(Φ)	(7)	113	105	111	103
PBA Maiden(Φ)	(7)	105	100	109	103
PBA Slasher(Φ)	(7)	110	104	109	103
PBA Striker(Φ)	(7)	110	112	112	107
KABULI TYPE					
Genesis 090	(7)	113	112	107	103

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 4 Grain yield of chickpea varieties in Agzone 3.

Year		2017
Site mean yield (t/ha)		1.86
	No. of trials	(1)
DESI TYPE		
Ambar(Φ)	(1)	94
Genesis 836	(1)	98
Neelam(Φ)	(1)	100
PBA Maiden(Φ)	(1)	104
PBA Slasher(Φ)	(1)	103
PBA Striker(Φ)	(1)	106
KABULI TYPE		
Genesis 090	(1)	102

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 5 Grain yield of chickpea varieties in Agzone 4 expressed as a percentage of site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		0.62	1.45	1.82	0.59	0.93
	No. of trials	(1)	(2)	(1)	(2)	(1)
DESI TYPE						
Ambar(Φ)	(7)	118	100	113	96	105
Genesis 836	(7)	107	95	98	93	101
Neelam(Φ)	(7)	102	106	118	105	104
PBA Maiden(Φ)	(7)	100	94	111	88	101
PBA Slasher(Φ)	(7)	96	101	113	99	102
PBA Striker(Φ)	(7)	120	101	125	106	99
KABULI TYPE						
Genesis 090	(6)	104	109	-	114	101

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

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Disease ratings for selected chickpea varieties

TABLE 6 Disease resistance ratings for chickpea varieties.

	Ascochyta blight			Phytophthora root rot	Root lesion nematodes	
	Northern region	Southern region	Seed		*Pratylenchus thornei*	*Pratylenchus neglectus*
DESI TYPE						
Ambar(Φ)	MRMS	S	S	VS	MS	MRMS
Genesis 836	S	S	S	VS	-	-
Neelam(Φ)	MRMS	MS	S	VS	MS	MRMS
PBA Maiden(Φ)	MS	S	S	VS	MRMS	MRMS
PBA Slasher(Φ)	MRMS	S	S	VS	MRMS	MRMS
PBA Striker(Φ)	MS	S	S	VS	-	MRMS
KABULI TYPE						
Genesis 090	MR	MS	S	VS	MS	MRMS

R=resistant, MR=moderately resistant, MS=moderately susceptible, S=susceptible
The aggressive southern strain of Ascochyta has not been found in WA.

Variety traits

TABLE 7 Chickpea 100 seed weight (g) 2016–18.

Region	Agzone 1	Agzone 2	Agzone 4
No. of trials	(5)	(5)	(5)
DESI TYPE			
Ambar(Φ)	17	15	18
Neelam(Φ)	16	15	18
PBA Maiden(Φ)	20	18	21
PBA Slasher(Φ)	16	16	18
PBA Striker(Φ)	20	19	20
KABULI TYPE			
Genesis 090	22	23	22

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 8 Desi chickpea variety traits.

Variety	Plant height (cm)		Maturity	Lodging resistance
	Mingenew NVT 2019	Merredin NVT 2019		
Ambar(Φ)	-	-	Early	VG
Neelam(Φ)	48	33	Mid	VG
PBA Maiden(Φ)	43	30	Mid	M
PBA Slasher(Φ)	45	31	Mid	M
PBA Striker(Φ)	46	31	Early	M

SOURCE: NSW DPI WINTER CROP VARIETY SOWING GUIDE (2019), MERREDIN AND MINGENEW NVT TRIALS SEPT 2019

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 command a premium above desi types.

Sowing depth

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

Seed dressing and rhizobia

- P-Pickel T, let dry then apply Group N inoculum or use granular products such as ALOSCA at 10kg/ha.

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. May 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 – always know 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

The following herbicides are registered on chickpea 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

- 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
- Flumioxazin 500g/kg (Terrain®) at 180g/ha
- Pendimethalin 440g/L (e.g. Stomp®) at 1.5–2.25L/ha
- Propyzamide 900g/kg (e.g. Imtrade 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 750g/kg + isoxaflutole 75g/kg (e.g. Palmero® TX) at 1kg/ha

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- Tri-allate 500g/L (e.g. Avadex® Xtra) at 1.6L/ha
- Trifluralin 480g/L (e.g. TriflurX®) at 1.25–1.7L/ha plus 1.1kg/ha Simazine 900 DF
- Trifluralin 350g/L + Tri-allate 550g/L (e.g. Jetti Duo®) at 1.45-1.8L/ha

Post-sowing pre-emergent

- Diuron 900g/kg (e.g. Diurex® WG, not all brands) at 550–830g/ha
- Isoxaflutole 750g/kg (e.g. Balance®, Palmero®) at 100g/ha
- Metribuzin 750g/kg (e.g. Stacato®) at 180–380g/ha
- Simazine 900g/kg WG at 0.55–1.1kg/ha
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.6–0.86kg/ha
- Terbuthylazine 750g/kg + isoxaflutole 75g/kg (e.g. Palmero® TX) at 0.7–1kg/ha

Post-emergent – for broadleaf weeds

- Flumetsulam 800g/kg (e.g. Broadstrike®) at 25g/ha

Post-emergent – for grass weeds

- Butroxydim 250g/kg (e.g. Factor® WG) at 80–180g/ha
- Clethodim 240g/L (e.g. Select®, Status®) at 150–500mL/ha
- Fluazifop-p 128g/L (e.g. Fusilade® Forte) at 500mL/ha
- Haloxyfop-R 520g/L (e.g. Verdict®) at 50–100mL/ha
- Propaquizafop 100g/L (e.g. Shogun®) at 200–450mL/ha
- Quizalofop-p-ethyl 200g/L (e.g. Elantra® Xtreme®, Leopard® 200) at 65–190mL/ha
- Sethoxydim 186g/L (e.g. Sertin®) at 0.5–1L/ha

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.

Pre-seeding

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

Post emergence fungicide options

- 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 – http://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 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 physiologically mature and less than 15 per cent green pod. DO NOT harvest 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 per cent of chickpea pods within crop have turned yellow-brown. Early applications 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 per cent (start at 100 per cent).
- 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 nowadays.

WHAT IS NEW?

PBA Bendoc$^{\Phi}$ 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$^{\Phi}$ (Permit 8684) until 30 April 2022.

PBA Bendoc$^{\Phi}$ 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$^{\Phi}$. There are seed bulkups occurring in WA in 2019 and seed is available from Seednet with an EPR of $3.90/t.

PBA Marne$^{\Phi}$ was also 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$^{\Phi}$ is a mid-season flowering faba bean that has high yield potential in higher rainfall and long growing season districts. It has a greater 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$^{\Phi}$ 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$^{\Phi}$ yields have been comparable to PBA Samira$^{\Phi}$. An end point royalty (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$^{\Phi}$ 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$^{\Phi}$ – but they must also be prepared to have a robust fungicide program as PBA Bendoc$^{\Phi}$ has slightly lower disease ratings than PBA Samira$^{\Phi}$. Although PBA Warda$^{\Phi}$ and PBA Nasma$^{\Phi}$ 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 a per cent of site mean yield for each trial year (2016–18).

Agzone	Agzone 3		Agzone 5			
Year		2017		2016	2017	2018
Site mean yield (t/ha)		0.70		3.82	1.40	3.09
	No. of trials	(2)	No. of trials	(2)	(2)	(2)
Farah(Φ)	(2)	95	(6)	94	105	97
Fiesta VF	-	-	(2)	-	-	96
Nura(Φ)	(2)	109	(6)	92	89	95
PBA Bendoc(Φ)	(2)	103	(6)	98	109	97
PBA Marne(Φ)	(2)	115	(6)	107	88	104
PBA Nasma(Φ)	-	-	(2)	-	-	107
PBA Rana(Φ)	(2)	82	(6)	88	98	95
PBA Samira(Φ)	(2)	92	(6)	99	106	99
PBA Warda(Φ)	-	-	(2)	-	-	107
PBA Zahra(Φ)	(2)	99	(6)	99	104	99

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
Farah(Φ)	Medium	690 (590–760)	Light brown-brown	Medium	Early-mid	Early-mid	MS
Fiesta VF	Medium	690 (570–780)	Light brown-brown	Medium	Early-mid	Early-mid	MS
Nura(Φ)	Small-med	680 (550–790)	Light buff	Short	Mid	Early-mid	MR
PBA Bendoc(Φ)	Medium	640 (500–720)	Light brown	Medium	Mid	Early-mid	MS
PBA Marne(Φ)	Medium	740 (610–870)	Light brown	Medium	Early-mid	Early-mid	MR
PBA Rana(Φ)	Med-large	750 (650–900)	Light brown	Med/tall	Mid	Mid	MR
PBA Samira(Φ)	Medium	740 (580–870)	Light brown	Medium	Mid	Mid	MR
PBA Zahra(Φ)	Med-large	740 (620–860)	Light brown	Med/tall	Mid	Mid-late	MR

TABLE 3 Faba bean variety disease ratings.

Variety	Chocolate spot	Ascochyta blight		Rust	Cercospora leaf spot	PSbMV seed stain	Nematode resistance	
		Pathotype 1	Pathotype 2				*Pratylenchus thornei*	*Pratylenchus neglectus*
Cairo	VS	S	S	MS	S	-	S	-
Doza(Φ)	MS	S	S	RMR	S	-	S	MR
Farah(Φ)	S	RMR	S	S	S	S	MS	MR
Fiesta VF	S	MS	S	S	S	S	MS	MR
Nura(Φ)	MS	RMR	RMR	MS	S	VS	MS	MR
PBA Bendoc(Φ)	S	RMR	RMR	S	S	S	MS	MR
PBA Marne(Φ)	S	RMR	MRMS	MR	S	MR	MS	MR
PBA Nanu(Φ)	-	-	S	RMR	S	-	MR	-
PBA Nasma(Φ)	MS	S	S	RMR	S	-	S	MR
PBA Rana(Φ)	MS	R	MRMS	MS	S	MR	MS	MR
PBA Samira(Φ)	MS	RMR	RMR	MS	S	S	MRMS	MR
PBA Warda(Φ)	MS	S	S	RMR	S	-	MS	MR
PBA Zahra(Φ)	MS	R	MRMS	MS	S	S	MS	MR

R=resistant, MR=moderately resistant, MS=moderately susceptible, S=susceptible
PSbMV = pea seedborne mosaic virus

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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 (>450mm)

- 15 May to 7 June.
- In higher rainfall areas, early sowing can predispose the crop to disease.

Medium-rainfall areas (350–450mm)

- 15 April to 30 May.

Low rainfall areas (<350mm)

- 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 25–30plants/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 per cent.

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.
- Excessive N application at sowing is unnecessary as it will restrict nodulation and reduce N-fixation.

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, etc.

Pre-emergent herbicides

- Cyanazine 900g/kg (e.g. Bladex®) at 1.1kg/ha
- Diuron 900g/kg (e.g. Diurex® WG) at 0.55–1.1kg/ha
- Flumioxazin 500g/kg (e.g. Terrain®) at 180g/ha
- Imazethapyr 700g/kg (e.g. Spinnaker® WDG) at 70g/ha
- Metribuzin 750g/kg (e.g. Stacato®, Mentor® WG) at 180–380g/ha (PSPE* only, 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. Imtrade 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 WG at 1.1–1.4kg/ha (use lower rate on lighter soil types)
- Terbuthylazine 875g/kg (e.g. Terbyne® Xtreme®) at 0.6–1.2kg/ha
- Tri-allate 500g/L (e.g. Avadex® Xtra) at 1.6L/ha
- Trifluralin 480g/L (e.g. TriflurX®) at 800mL/ha plus 1.1 kg/ha Nufarm Simazine 900 DF

* PSPE = Post-sowing pre-emergent

Post-emergent herbicides for broadleaf weed control

- Pyraflufen-ethyl 20g/L (e.g. Ecopar®) at 800mL/ha
- PBA Bendoc$^{\phi}$ 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 Bendoc$^{\phi}$. The permit is valid till 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
- Clethodim 240g/L (e.g. Select®, Status®) at 150–500mL/ha
- Fluazifop-p 128g/L (e.g. Fusilade® Forte) at 410mL/ha
- Haloxyfop-R 520g/L (e.g. Verdict®) at 50–100mL/ha
- Propaquizafop 100g/L (e.g. Shogun®) at 200–450mL/ha
- Quizalofop-p-ethyl 200g/L (e.g. Elantra® Xtreme®, Leopard® 200) at 65–190mL/ha
- Sethoxydim 186g/L (e.g. Sertin®) at 0.5–1L/ha

Insect control

- 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 human consumption quality beans 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.

DPIRD GRDC

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 is 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 fungicides are carbendazim, procymidone, Veritas® (tebuconazole + azoxystrobin), or Aviator® Xpro® (prothioconazole + bixafen) and chlorothalonil.

Cercospora

- Often seen 6–8 weeks after sowing.
- Suggested fungicides are Veritas® (tebuconazole + azoxystrobin) or Aviator® Xpro® (prothioconazole + bixafen) and tebuconazole (refer PER13752).

Rust

- only if greater than five per cent leaf coverage after flowering.
- 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 per cent) 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 ripening and weed problems at harvest. Do not harvest for seven days after application.
- Glyphosate 690g/kg (e.g. Roundup Ready® Herbicide with PLANTFIELD®) at 250 to 1400g/ha. Apply when faba bean pods turn black and average seed moisture content is below 30 per cent. Application before this time may significantly reduce yields (in practice losses in excess of 25 per cent 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 plus plus 1% Hasten or high-quality methylated seed oil (MSO) of the spray volume. Apply when 30–80 per cent 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	Fan speed: High
Drum speed: 300–600rpm	Concave clearance: 15–35mm
Top sieve: 32–38mm	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$^{\Phi}$ types or Australian dun – e.g. Parafield. Kaspa$^{\Phi}$ types are favoured in the Indian subcontinent, while some sprouting markets still favour trailing varieties such as PBA Percy$^{\Phi}$ and Parafield. White varieties are rarely grown in WA, therefore 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$^{\Phi}$ 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$^{\Phi}$ produces Kaspa$^{\Phi}$-type dun seeds. It has improved bacterial blight and downy mildew resistance compared with other Kaspa-types. PBA Butler$^{\Phi}$ is available from Seednet (EPR $2.70/t).

WHAT VARIETY SHOULD I GROW?

PBA Butler$^{\Phi}$ and PBA Gunyah$^{\Phi}$ are the top-yielding Kaspa$^{\Phi}$-type field pea varieties in WA. PBA Wharton$^{\Phi}$ also produces high yields in trials but most growers have found PBA Gunyah$^{\Phi}$ and in recent times PBA Butler$^{\Phi}$ to produce superior results on-farm.

For growers wishing to plant trailing field pea types, PBA Percy$^{\Phi}$ reliably out-yields Parafield.

TABLE 1 Grain yield of field pea varieties in Agzone 1 expressed as a per cent of site mean yield for each trial year (2015–18).

Year		2015	2016	2017	2018
Site mean yield (t/ha)		2.33	2.02	0.60	1.48
	No. of trials	(1)	(2)	(2)	(2)
Kaspa$^{\Phi}$	(7)	102	73	100	99
Parafield	(7)	65	70	76	71
PBA Butler$^{\Phi}$	(7)	99	109	102	112
PBA Gunyah$^{\Phi}$	(7)	104	88	105	103
PBA Oura$^{\Phi}$	(7)	82	103	91	94
PBA Pearl$^{\Phi}$	(7)	77	102	76	110
PBA Percy$^{\Phi}$	(7)	85	102	114	93
PBA Twilight$^{\Phi}$	(7)	103	80	99	99
PBA Wharton$^{\Phi}$	(6)	106	94	100	93

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 2 Grain yield of field pea varieties in Agzone 2 expressed as a per cent of site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		1.72	1.70	1.93	1.47	0.66
	No. of trials	(3)	(3)	(2)	(3)	(1)
Kaspa[Φ]	(12)	92	92	59	97	111
Parafield	(7)	-	65	47	79	61
PBA Butler[Φ]	(12)	114	96	107	103	110
PBA Gunyah[Φ]	(11)	98	99	75	100	100
PBA Oura[Φ]	(12)	87	92	93	93	54
PBA Pearl[Φ]	(9)	-	94	103	92	44
PBA Percy[Φ]	(11)	90	83	56	97	48
PBA Twilight[Φ]	(11)	89	101	72	98	92
PBA Wharton[Φ]	(12)	90	110	98	100	91

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 3 Grain yield of field pea varieties in Agzone 3 expressed as a per cent of site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		2.13	0.45	0.46	1.65	1.10
	No. of trials	(1)	(2)	(1)	(1)	(1)
Kaspa[Φ]	(6)	102	65	49	95	71
Parafield	(5)	-	41	33	69	97
PBA Butler[Φ]	(6)	120	81	107	129	104
PBA Gunyah[Φ]	(6)	103	88	68	92	86
PBA Oura[Φ]	(6)	101	100	95	78	117
PBA Pearl[Φ]	(5)	-	94	124	96	110
PBA Percy[Φ]	(6)	99	84	30	63	124
PBA Twilight[Φ]	(6)	96	97	70	78	79
PBA Wharton[Φ]	(6)	84	128	102	73	94

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

TABLE 4 Grain yield of field pea varieties in Agzone 4 expressed as a per cent of site mean yield for each trial year (2014, 2016–18).

Year		2014	2016	2017	2018
Site mean yield (t/ha)		1.35	1.91	1.07	1.92
	No. of trials	(1)	(1)	(1)	(1)
Kaspa[Φ]	(4)	92	64	99	102
Parafield	(3)	-	62	64	61
PBA Butler[Φ]	(4)	98	99	103	104
PBA Gunyah[Φ]	(4)	100	83	106	106
PBA Oura[Φ]	(4)	97	103	88	89
PBA Pearl[Φ]	(3)	-	96	80	98
PBA Percy[Φ]	(4)	103	94	105	88
PBA Twilight[Φ]	(4)	99	79	101	105
PBA Wharton[Φ]	(4)	105	104	102	103

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

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TABLE 5 Grain yield of field pea varieties in Agzone 5 expressed as a per cent of site mean yield for each trial year (2014–18).

Year		2014	2015	2016	2017	2018
Site mean yield (t/ha)		2.30	2.00	1.70	1.55	1.33
	No. of trials	(2)	(3)	(3)	(6)	(5)
Excell[Ф]	(2)	-	-	62	-	-
Kaspa[Ф]	(19)	97	94	104	92	90
Parafield	(11)	-	83	87	85	73
PBA Butler[Ф]	(19)	117	111	116	108	92
PBA Gunyah[Ф]	(19)	99	99	103	95	98
PBA Oura[Ф]	(19)	95	100	93	95	93
PBA Pearl[Ф]	(17)	-	109	98	94	77
PBA Percy[Ф]	(19)	101	103	103	95	103
PBA Twilight[Ф]	(19)	89	93	94	90	98
PBA Wharton[Ф]	(19)	84	91	85	93	110
Sturt	(2)	-	-	96	-	-

SOURCE: NVT ONLINE, NVTONLINE.COM.AU

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[Ф]	Kaspa dun	SD-SL	Moderate	Late	Mid	Fair-good	R: SP	S	S
PBA Butler[Ф]	Kaspa dun	SD-SL	High	Mid-late	Mid	Good	R: SP	S	S
PBA Gunyah[Ф]	Kaspa dun	SD-SL	High	Early-mid	Early	Fair-good	R: SP	S	SMS
PBA Oura[Ф]	Aus dun	SD-SL	Moderate	Early-mid	Early	Fair-good	MR: NSP	MS	S
PBA Pearl[Ф]	White	SD-SL	Moderate	Early-mid	Early-mid	Good	MR: NSP	MS	MS
PBA Percy[Ф]	Aus dun	C	High	Early	Early	Poor	MR: NSP	S	MT
PBA Twilight[Ф]	Kaspa dun	SD-SL	High	Early	Early	Fair-good	R: SP	S	S
PBA Wharton[Ф]	Kaspa dun	SD-SL	Moderate	Early-mid	Early	Fair-good	R: SP	MT	MT
Sturt	White	C	High	Early-mid	Mid	Poor	MR: NSP	S	MS

SOURCE: VICTORIAN WINTER CROP SUMMARY 2019

SD=semi-dwarf, C=conventional, SL= semi-leafless, S=susceptible, MS=moderately susceptible, MR=moderately resistant, R=resistant, SP=sugar pod type pod, NSP=non sugar pod type, I=intolerant, MI=moderately intolerant, MT= moderately tolerant

TABLE 7 Resistance of field pea varieties to diseases commonly found in WA crops.

Variety	Blackspot[a]	Downy mildew		PSbMV[b]	Nematode resistance	
		Kaspa strain	Parafield strain		*Pratylenchus thornei*	*Pratylenchus neglectus*
Excell	MS	S	MR	-	MRMS	MRMS
Kaspa[Ф]	MS	MS	MR	S	MRMS	MRMS
Parafield	MS	S	S	-	MR	MRMS
PBA Butler[Ф]	MS	MS	S	S	MRMS	MRMS
PBA Gunyah[Ф]	MS	S	R	S	MRMS	MR
PBA Oura[Ф]	MS	MRMS*p*	MR*p*	S	MRMS	MRMS
PBA Pearl[Ф]	MRMS*p*	S	MS	S	MRMS	MRMS
PBA Percy[Ф]	MS	S	S	S	RMR	MRMS
PBA Twilight[Ф]	MS	S	R	S	MRMS	MRMS
PBA Wharton[Ф]	MS	S	R*p*	R	MR	MRMS
Sturt	MS	S	MS	-	MR	MRMS

SOURCE: JENNY DAVIDSON (PIRSA–SARDI)

a – also known as Ascochyta blight, b – pea seedborne mosaic virus
Resistance order from best to worst: R > RMR > MR > MRMS > MS > MSS > S > SVS > VS. *p*=provisional assessment, ratings may change

TABLE 8 Resistance of field pea varieties to diseases rarely found in WA crops.

Variety	Powdery mildew	Bacterial blight		Bean leafroll virus
		pv syringae	pv pisi	
Kaspa(Φ)	S	S	S	S
Parafield	S	MS	-	-
PBA Butler(Φ)	S	MRMS	MRMS	S
PBA Gunyah(Φ)	S	S	-	S
PBA Oura(Φ)	S	MRMS	MRMS	R
PBA Pearl(Φ)	S	MS*p*	MS*p*	R
PBA Percy(Φ)	*S*	MR	MR	S
PBA Twilight(Φ)	S	S	-	-
PBA Wharton(Φ)	R	S	S	R
Sturt	S	MS	-	-

SOURCE: JENNY DAVIDSON (PIRSA–SARDI)

Resistance order from best to worst: R > RMR > MR > MRMS > MS > MSS > S > SVS > VS. *p*=provisional assessment, ratings may change

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 per cent 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 120 kg/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 following 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-emergent herbicides

- 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 0.55–1.1kg/ha
- Flumioxazin 500g/kg (Terrain®) at 180g/ha
- Imazethapyr 700g/kg (e.g. Spinnaker® WDG) at 70g/ha
- Metribuzin 750g/kg (e.g. Stacato®) at 180–380g/ha (Use an IBS* application when furrow seeding using knife points and press wheels and PSPE** when application is made to flat surface following harrows and/or rolling of the paddock. 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. Imtrade 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 0.6–1.2kg/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

* IBS = Incorporated by sowing

** PSPE = Post-sowing pre-emergent

Post-emergent herbicides for broadleaf weed control

- Cyanazine 900g/kg (e.g. Bladex®) at 0.55–1.1kg/ha
- Diflufenican 500g/L (e.g. Brodal® Options, Bonanza® Elite) at 100–200mL/ha
- Flumetsulam 800g/kg (Broadstrike®) at 25g/ha
- Imazamox 700g/kg (e.g. Raptor®) at 45g/ha
- 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
- Picolinafen 750g/kg (e.g. Conquest Glocker 750 WG Herbicide, Sniper®) at 33-50g/ha
- Pyraflufen-ethyl 20g/L (e.g. Ecopar®) at 400mL/ha + 200mL/ha Aspect® Options (diflufenican 500g/L) or 400mL/ha + 200g/ha Stacato® 750 (metribuzin 750g/kg) for medium to heavy soils only (see restraints on the Ecopar® label)

Post-emergent herbicides for grass weed control

- Butroxydim 250g/kg (e.g. Factor® WG) at 80–180g/ha
- Clethodim 240g/L (e.g. Select®, Status®) at 150–500mL/ha
- Diclofop-methyl 375g/L (e.g. Rhino®) at 1–2L/ha
- Fluazifop-p 128g/L (e.g. Fusilade® Forte) at 500mL/ha
- Haloxyfop-R 520g/L (e.g. Verdict®) at 50–100mL/ha
- Propaquizafop 100g/L (e.g. Shogun®) at 200–450mL/ha
- Quizalofop-p-ethyl 200g/L (e.g. Elantra® Xtreme®, Leopard® 200) at 65–190mL/ha
- Sethoxydim 186g/L (e.g. Sertin®) at 0.5–1L/ha

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 per cent) have been released.

Marketing

- Field peas finds a ready market as a component in animal feed rations due to its 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 per cent) 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

- 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 per cent. Application before this time may significantly reduce yields (in practice losses in excess of 25 per cent 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 per cent of pods are brown with firm seeds and leathery pods or at 30 per cent 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.

	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 Essential for draper fronts
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 with raised cross auger fitted with paddles
Crop dividing coulters	Useful addition	Most setups will benefit
Drum or rotor speed	Low 300–600rpm	Low 300–600rpm
Engine capacity		More power required
Concave	Easy to thresh 10-25 mm	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 the growth is a lot slower.

Lentil grows best on soils with pH above 5.2 and it is particularly susceptible to transient waterlogging. Growers should expect to see greater crop variability across paddocks than 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 low broadleaf weed burden paddocks. Modern harvester fronts have made harvesting a lot 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 Hallmark XT$^{\Phi}$ was released in 2018 as a mid-season medium red lentil. XT lentil lines have tolerance to imidazolinone herbicides and reduced sensitivity to some sulfonylurea residues. Intercept® (e.g. imazamox + imazapyr) is permitted for use on PBA Hallmark XT$^{\Phi}$, PBA Hurricane XT$^{\Phi}$ and $^{\Phi}$ up to the five-node stage. PBA Hallmark XT$^{\Phi}$ has produced superior growth and yields than PBA Hurricane XT$^{\Phi}$ in WA experiments and has improved tolerance to BGM. Although it is not as highly rated for boron tolerance as the widely grown variety PBA Bolt$^{\Phi}$, PBA Hallmark XT$^{\Phi}$ has produced comparable yields to PBA Bolt$^{\Phi}$ in Agzone 5 where elevated levels of boron are often found in the subsoil. PBA Hallmark XT$^{\Phi}$ has an EPR of $5.40/t and is licensed to PB Seeds.

PBA Highland XT$^{\Phi}$ was released in 2019 as a herbicide tolerant red lentil variety which will complement other tolerant varieties such as PBA Hallmark XT$^{\Phi}$ and PBA Hurricane XT$^{\Phi}$. It is slightly early flowering than the other XT lines, and has performed well in WA trials. PBA Highland XT$^{\Phi}$ has an EPR of $5.94/t and is licensed to PB Seeds.

WHAT VARIETY SHOULD I GROW?

PBA Bolt$^{\Phi}$ 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 sub-soil with elevated levels of boron. PBA Jumbo2$^{\Phi}$ 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$^{\Phi}$ has not produced higher yields than PBA Bolt$^{\Phi}$.

PBA Hallmark XT$^{\Phi}$ is seen as a XT line better suited to WA than PBA Hurricane XT$^{\Phi}$, which often lacks vigour in cooler southern regions. PBA Hallmark XT$^{\Phi}$ produces similar sized grain to PBA Bolt$^{\Phi}$, which is likely to enable co-mingling and easier marketing for WA's newly developing lentil industry. PBA Bolt$^{\Phi}$ growers are encouraged to test PBA Hallmark XT$^{\Phi}$ on their farm in 2020.

Grain yield

TABLE 1 Grain yield of lentil varieties in Agzone 1 expressed as a per cent of site mean yield for each trial year.

Year		2014	2017	2018
Site mean yield (t/ha)		0.66	1.16	1.33
	No. of trials	(1)	(1)	(1)
PBA Ace[Ф]	(3)	139	94	104
PBA Blitz[Ф]	(3)	65	105	95
PBA Bolt[Ф]	(3)	116	95	98
PBA Flash[Ф]	(3)	107	90	113
PBA Greenfield[Ф]	(3)	116	111	74
PBA Hallmark XT[Ф]	(3)	118	113	120
PBA Hurricane XT[Ф]	(3)	111	100	89
PBA Jumbo2[Ф]	(3)	101	100	85

SOURCE: NVT ONLINE, NVTONLINE.COM.AU 2014 AND DPIRD STAGE 4

TABLE 2 Grain yield of lentil varieties in Agzone 4 and Agzone 5 expressed as a per cent of site mean yield for each trial year.

Agzone	Agzone 4				Agzone 5			
Year		2014	2015	2018		2016	2017	2018
Site mean yield (t/ha)		0.34	0.53	1.94		1.74	1.31	1.34
	No. of trials	(1)	(1)	(2)	No. of trials	(3)	(4)	(3)
PBA Ace[Ф]	(4)	111	130	102	(10)	105	105	102
PBA Blitz[Ф]	(4)	80	61	109	(10)	96	87	78
PBA Bolt[Ф]	(4)	112	114	92	(10)	105	107	117
PBA Flash[Ф]	(4)	88	101	87	(10)	102	97	101
PBA Greenfield[Ф]	(2)	92	106	-	(7)	-	92	73
PBA Hallmark XT[Ф]	(4)	135	126	99	(10)	105	113	111
PBA Hurricane XT[Ф]	(4)	113	115	104	(10)	99	106	109
PBA Jumbo2[Ф]	(4)	107	106	99	(10)	110	103	95

SOURCE: NVT ONLINE, NVTONLINE.COM.AU AND DPIRD STAGE 4 TRIALS

TABLE 3 Disease ratings for selected lentil varieties.

Variety	Botrytis grey mould	Foliar Ascochyta blight		Seed Ascochyta blight	Nematode resistance	
		South Australia	Victoria		*Pratylenchus thornei*	*Pratylenchus neglectus*
PBA Ace[Ф]	MRMS	R*p*	R	R	MRMS	MR
PBA Blitz[Ф]	MR	MR	MR	MRMS	MRMS	MR
PBA Bolt[Ф]	S	MR*p*	MR	RMR	MR	MR
PBA Flash[Ф]	MRMS	MS	MS	MS	MRMS	MR
PBA Greenfield[Ф]	MR	MRMS	MRMS	MRMS	MR	MR
PBA Hallmark XT[Ф]	RMR	MRMS	MR	MR	MRMS	MR
PBA Hurricane XT[Ф]	MRMS	MRMS	MR	MR*p*	MRMS	MRMS
PBA Jumbo2[Ф]	RMR	R	R	R	MRMS	MR

SOURCE: JENNY DAVIDSON (PIRSA–SARDI)

Resistance order from best to worst: R > RMR > MR > MRMS > MS > MSS > S > SVS > VS. *p*=provisional assessment, ratings may change

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TABLE 4 Lentil variety traits – seed.

Variety	Grade	Seed coat colour	Seed size* (mg)
PBA Ace(Ф)	Medium red	Grey	43
PBA Blitz(Ф)	Medium red	Grey	49
PBA Bolt(Ф)	Medium red	Grey	43
PBA Flash(Ф)	Medium red	Green	46
PBA Greenfield(Ф)	Medium green	Grey	50
PBA Hallmark XT(Ф)	Medium red	Grey	40
PBA Hurricane XT(Ф)	Small red	Grey	34
PBA Jumbo2(Ф)	Large red	Grey	47

* Mean seed size harvested from DPIRD/PBA experiments 2016–18.

TABLE 5 Lentil variety traits.

Variety	Flowering time	Days to flowering*	Maturity	Lodging	Canopy height (cm)#
PBA Ace(Ф)	Mid	132	Mid	MRMS	30
PBA Blitz(Ф)	Early	117	Early	MR	-
PBA Bolt(Ф)	Early-mid	125	Early-mid	R	29
PBA Flash(Ф)	Early-mid	131	Early-mid	MR	26
PBA Greenfield(Ф)	Mid	130	Mid-late	MS	28
PBA Hallmark XT(Ф)	Mid	126	Mid	MR	30
PBA Hurricane XT(Ф)	Mid	124	Mid	MR	25
PBA Jumbo2(Ф)	Mid-Late	125	Mid	MRMS	27

* Sown April 30 at Merredin in 2018. # Dalwallinu Stage 4, 10 September 2019

TABLE 6 Lentil tolerance soil conditions.

Variety	Salinity	Boron
PBA Ace(Ф)	I	I
PBA Blitz(Ф)	I	I
PBA Bolt(Ф)	MI	MI
PBA Flash(Ф)	MI	MI
PBA Greenfield(Ф)	MI	MI
PBA Hallmark XT(Ф)	MI	I
PBA Hurricane XT(Ф)	I	I
PBA Jumbo2(Ф)	I	MI

I=intolerant, MI=moderately intolerant

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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 broad-leaved weed burden – avoid paddocks with a history of vetch. Avoid paddocks prone to waterlogging.
- XT varieties have improved tolerance to 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

- Lentil may not be your best crop choice as it is very susceptible to waterlogging.
- Delay seeding (late May to 20 June) to reduce disease risk.

Sowing depth

- 4 to 6cm.

Seed dressing

- P-Pickel T (thiram + thiabendzole), let dry then apply Group FE inoculum.

Rolling

- Rolling the paddock after sowing improves harvest efficiency and reduces the risk of damage to harvesters.
- Lentil 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 in order to reduce wind erosion risk and improve crop safety from herbicides applied incorporated by sowing (IBS).

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$^{\phi}$) 35 to 40kg/ha.
- Medium-sized varieties (PBA Bolt$^{\phi}$, PBA Hallmark XT$^{\phi}$) 40 to 50kg/ha.
- Large-seeded varieties (PBA Jumbo2$^{\phi}$) 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 per cent.

Herbicide options

Pre-emergent herbicides

- Cyanazine 900g/kg (Bladex®) 1.1kg/ha
- Diuron 900g/kg (e.g. Diurex®) at 0.83 to 1.1kg/ha (use lowest rate or consider alternatives to avoid damage on lighter soil types)
- 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. Imtrade 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 to 1.2kg/ha

Post-sowing pre-emergent herbicides

- Diuron 900g/kg (e.g. Diurex®) at 0.55 to 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 100g/kg (e.g. Genfarm Imazethapyr) at 70g/ha (varieties: PBA Herald XT$^{\phi}$ and PBA Hurricane XT$^{\phi}$ ONLY) and 70 to 100g/ha (variety: 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. Use lower rate on light sandy soils and higher label rates on heavy clay loam soils. In trials, rolling prior to spraying has shown to improve crop safety.

Post-emergent herbicides

- Diflufenican 500g/L (e.g. Brodal®) at 100–200mL/ha
- Flumetsulam 800g/kg (e.g. Broadstrike®) at 25g/ha
- Imazamox 33g/L and imazapyr 15g/L (e.g. Intercept®) – XT (IMI tolerant) varieties only: under permit PER87417

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
- Clethodim 240g/L (e.g. Select®, Status®) at 150–500mL/ha

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- Haloxyfop-R 520g/L (e.g. Verdict®) at 50–100mL/ha
- Propaquizafop 100g/L (e.g. Shogun®) at 200–450mL/ha
- Quizalofop-p-ethyl 200g/L (e.g. Elantra® Xtreme®, Leopard® 200) at 65–190mL/ha
- Sethoxydim 186g/L (e.g. Sertin®) at 0.5–1L/ha

Aphid threshold

- More than 30 per cent 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 past two years.
- Varieties vary in their susceptibility to BGM. Ranging from susceptible (e.g. PBA Bolt(I)) to resistant–moderately resistant (RMR) (e.g PBA Jumbo2(I)).
- 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. Spin Flo®
- 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)

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®

* Visit Pulse Australia website to find latest fungicide product information: http://www.pulseaus.com.au/growing-pulses/crop-protection-products

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 per cent) 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 per cent 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 physiologically mature and less than 15 per cent 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. Common vetch varieties' (Morava$^{\Phi}$, Rasina$^{\Phi}$, Volga$^{\Phi}$ and Timok$^{\Phi}$) versatility 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 and their grain yields have been similar to pea yields.

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 per cent. Modern varieties such as Morava$^{\Phi}$, Rasina$^{\Phi}$, Volga$^{\Phi}$ and Timok$^{\Phi}$ possess less toxin in grain (<0.65 per cent) compared with older varieties such as Blanchefleur (0.95 per cent) and Languedoc (1.65 per cent).

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$^{\Phi}$). 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$^{\Phi}$, which produce greater levels of vegetative growth and 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 VARIETIES SHOULD I GROW?

Rasina$^{\Phi}$, Volga$^{\Phi}$ and Timok$^{\Phi}$ are resistant to rust and are the preferred varieties for grain in areas prone to rust infections. Morava$^{\Phi}$'s late flowering/maturity causes more variable results than other vetch varieties and it is best suited to long seasons.

See Table 2 for suggested grain varieties and Table 3 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 a per cent of site mean yield for each trial year.

Agzone	Agzone 2				Agzone 3			Agzone 5		
Year		2016	2017	2018		2015	2016		2016	2017
Site mean yield (t/ha)		1.7	2.5	1.2		1.4	1.2		1.8	2.3
	No. of trials	(1)	(1)	(1)	No. of trials	(1)	(1)	No. of trials	(1)	(1)
Morava[Φ]	(3)	97	109	59	(2)	80	125	(2)	101	33
Timok[Φ]	(3)	110	107	118	(2)	136	96	(2)	93	103
Volga[Φ]	(3)	118	114	123	(2)	101	95	(2)	96	116
Rasina[Φ]	(2)	95	118	-	-	-	-	(1)	-	109

SOURCE: PBA AND DPIRD

TABLE 2 Suggested vetch grain variety by WA rainfall zones.

Low	Medium	High	Very high
Volga[Φ]	Rasina	Timok	Morava
Timok[Φ]	Timok	Rasina	Timok
Rasina[Φ]	Volga	Morava	

TABLE 3 Suggested vetch varieties by WA rainfall 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[Φ]	RM4[Φ]	RM4[Φ]	RM4[Φ]
April sown – green manure	RM4[Φ]	RM4[Φ]	RM4[Φ]	RM4[Φ]
	Morava[Φ]	Morava[Φ]	Morava[Φ]	Morava[Φ]
April sown graze and grain	Volga[Φ]	Timok[Φ]	Morava[Φ]	Morava[Φ]
	Timok[Φ]	Volga[Φ]	Timok[Φ]	Timok[Φ]
	Rasina[Φ]	Rasina[Φ]	Volga[Φ]	
		Morava[Φ]		

TABLE 4 Characteristics of selected vetch varieties.

Variety	Maturity	Grain yield	Dry matter yield	Flower colour	% of pod shatter	% of hard seed	Rust	Ascochyta	Botrytis	BCN %
Common vetch varieties (*Vicia sativa*)										
Morava[Φ]	Late	High	High	Purple	0	0	R	S	VS	0.65
Rasina[Φ]	Early-mid	High	Mod	Purple	0–2	0	R	MS	S	0.6
Timok[Φ]	Mid	High	Very high	Purple	0–2	0–2	R	MS	S	0.57
Volga[Φ]	Early	Very high	High	Purple	0–2	2–5	R	MS	S	0.54
Purple vetch (*Vicia villosa ssp. 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 vetches (*Vicia villosa ssp. dasycarpa*)										
Capello[Φ]	Late	Low	Very high	Purple	5–10	15–20	R	S	VS	NS
Haymaker[Φ]	Late	Low	Very high	Purple	5–10	20–30	R	S	VS	NS
RM4[Φ]	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

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Weed control

The following herbicides are registered on vetch 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

- Trifluralin 480g/L (e.g. TriflurX®) at 1.7L/ha
- Diuron 900g/kg (e.g. Diurex WG) at 0.830–1.1kg/ha

Post-sowing pre-emergent

- Diuron 900g/kg (e.g. Diurex® WG) at 550–830g/ha
- Metribuzin 750g/kg (e.g. Stacato®) at 180–380g/ha

Post-emergent herbicides for broadleaf weed control

- Flumetsulam 800g/kg (e.g. Broadstrike®) at 25g/ha at three fully expanded leaves onwards (purple or Popany vetch only)
- Pyraflufen-ethyl 20g/L (e.g. Ecopar®) at 800mL/ha

Post-emergent herbicides for grass weed control

- Butroxydim 250g/kg (e.g. Factor® WG) at 80–180g/ha
- Fluazifop-P 128g/L (e.g. Fusilade® Forte) at 820mL/ha
- Haloxyfop-R 520g/L (e.g. Verdict®) at 50–100mL/ha
- Propaquizafop 100g/L (e.g. Shogun®) at 200–450mL/ha
- Quizalofop-p-ethyl 200g/L (e.g. Elantra® Xtreme®) at 65–190mL/ha

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 per cent) 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

NOTES

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

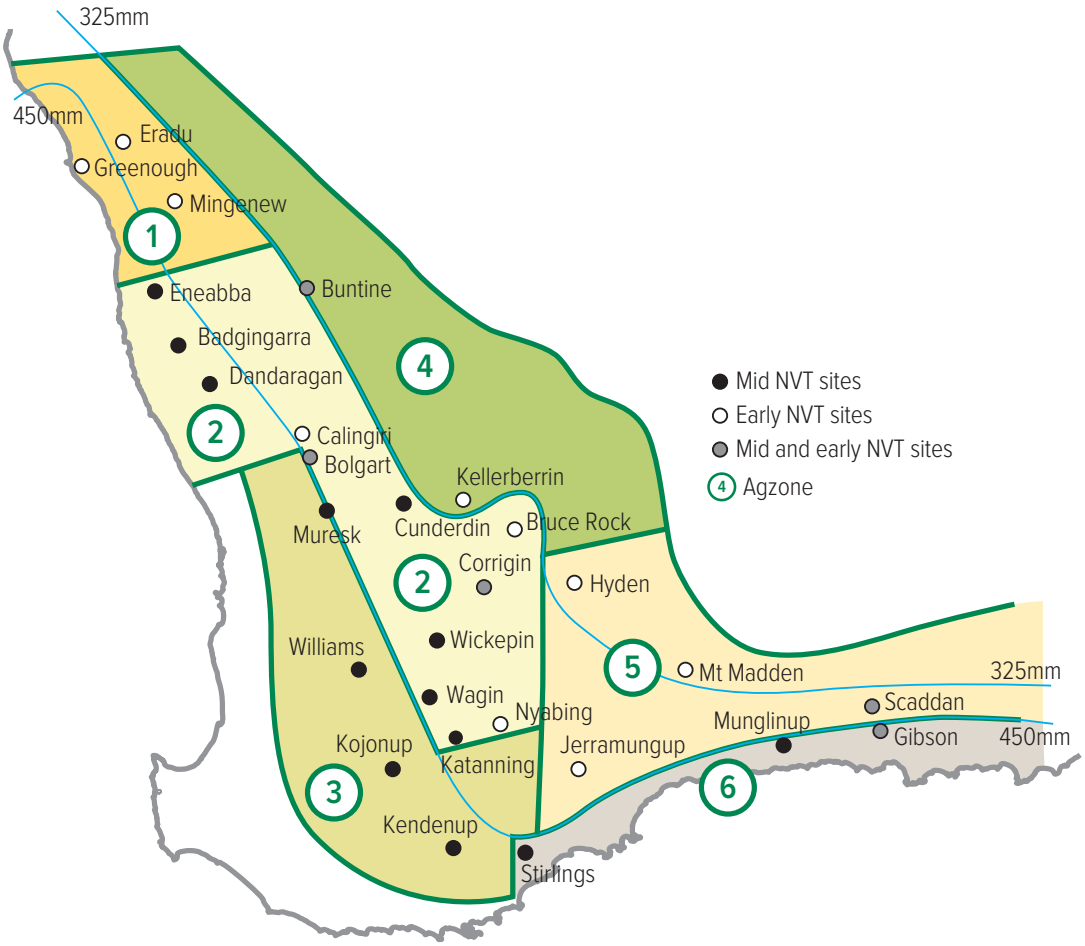

FIGURE 2 Lupin agzone map for Western Australia.