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2019 Barley variety sowing guide for Western Australia

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

WESTERN AUSTRALIA

National Variety Trials
A GRDC INITIATIVE

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Company and industry abbreviations:

- CCDM – Centre for Crop and Disease Management
- DAFWA – Department of Agriculture and Food Western Australia
- DPIRD – Department of Primary Industries and Regional Development
- GIWA – Grain Industry Association of Western Australia
- GRDC – Grains Research and Development Corporation
- NFI – National Frost Initiative
- NVT – National Variety Trials

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Edited by

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Introduction

Blakely Paynter, Jeremy Curry, Georgia Trainor, Raj Malik and Stacey Hansch, DPIRD

This bulletin 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, agronomic information and herbicide tolerance ratings 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 11; Figures 1 to 16).

The decision 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 that grain of a malt variety will meet malt barley receival specifications.

(5) Location of receival segregations for malt barley varieties.

Identifying which option will lead to the greatest returns for a grower is complex. In some instances, the price premium paid for malt will offset the yield difference between malt and feed varieties. In other situations, the substantially 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.

Clearly, barley varieties differ in their agronomic fit for different port zones and different environments. Additionally, market demand for malt barley varieties varies with port zone as a result of the markets that each port zone generally services. That demand will influence the choice of malt variety that is sown regionally. No one malt or feed variety matches all the different farming systems in which barley is grown or the brewing, distilling and shochu markets we service.

In 2017, four varieties, La Trobe, Scope CL, Spartacus CL and Bass (in order of decreasing popularity) occupied three in every four hectares sown to barley. In 2018, the area sown to RGT Planet and Spartacus CL is expected to increase significantly. Between them they could occupy nearly half the WA barley acreage. This will result in a decreasing area sown to the market accepted malt varieties Bass, Flinders, La Trobe and Scope CL.

Growers should be watchful for increasing net type net blotch (NTNB) with a new aggressive pathotype, named Oxford virulent, being detected across the south coast. Efforts are underway to determine the adult resistance of commercial varieties in the presence of this new pathotype. Seedling resistance data suggests most varieties are susceptible, with the exception of Banks, Granger and LG Maltstar. Growers finding higher than expected levels of NTNB on varieties with good resistance to the Beecher virulent and avirulent pathotypes should collect leaf samples (placed into paper envelopes) and send them to the Department of Primary Industries and Regional Development (DPIRD), Locked Bag 4, Bentley Delivery Centre WA 6983, 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. See the disease section of this bulletin for more information on barley diseases and reporting.

What's new?

New barley lines that may be of interest to Western Australian growers include Banks (tested as IGB1305), Buff (tested as IGB1506) and LG Maltstar (tested as SMBA11-1771). Why consider purchasing seed of these new varieties?

Banks

Banks (WABAR2312/WABAR2332) is a short height, semi-dwarf, medium spring, two row barley bred by InterGrain and registered in February 2018. It has been sown in the WA barley National Variety Trials (NVT) since 2015 and is a competitor to Bass, Flinders, Granger, La Trobe, LG Maltstar and RGT Planet in medium to higher rainfall areas of Western Australia.

Banks has a similar plant type and phenology to Flinders, being 1-2cm taller than Bass at maturity. As a seedling it has good tolerance to all leaf diseases except barley leaf rust. As an adult plant, scald, spot type net blotch (STNB) and barley leaf rust may need management. WA barley NVT (2015-2017) suggests that Banks has a similar grain yield to La Trobe and is higher yielding than Bass, Flinders and Granger. The hectolitre weight and grain brightness of Banks appears to be comparable to Flinders, but its overall screenings risk is higher than both Bass and Flinders and similar to that of La Trobe.

Relative to RGT Planet, Banks is shorter (7-10cm), later to flower (around 4-5 days later with April and May sowing and similar with June and July sowing), has improved tolerance to Oxford virulent NTNB as a seedling (MRMS vs S) and has improved tolerance to Beecher virulent NTNB as an adult (MS vs SVS*p*). It has poorer resistance to scald (S vs MRMS*p*) and barley leaf rust as an adult (S vs MRMS). In head to head comparisons with RGT Planet for grain yield, Banks was similar in one out of every two trials and lower in two in every five trials. Banks appears to have a slight yield advantage over RGT Planet at sites yielding below 3t/ha. The physical grain quality package of Banks appears to be better than that offered by RGT Planet, with a higher hectolitre weight, lower screenings (especially at screenings closer to the receival limit of 20%) and a slightly higher grain brightness. However, more years of data are required to confirm these grain yield and grain quality observations.

Banks has passed Stage 1 of Barley Australia's malting and brewing accreditation program and is currently undergoing Stage 2 testing during 2018. An accreditation decision is possible in March 2019. Banks is at the same stage of evaluation as RGT Planet.

Seed is available for planting in 2019 from Seedclub members and resellers. As with any new variety being evaluated by Barley Australia, malt accreditation and market acceptance (and possible associated malt premiums) are not guaranteed. We recommend caution in adopting them or sowing large areas to them with the expectation of future segregations unless there is a clear agronomic or grain yield advantage as a feed barley.

Buff

Buff (tested as IGB1506) is a medium height, early spring, two row barley bred by InterGrain and registered in September 2018. It has been sown in the WA barley NVT since 2016 and is a direct competitor to Litmus on acidic soils and Fathom, La Trobe, Rosalind and Spartacus CL (where an imidazolinone herbicide is not planned for use or there are no imidazolinone residues) on non-acidic soils.

Buff has similar aluminium (Al) tolerance genetics to Litmus but unlike Litmus it has a white aleurone. This means receival of Buff will not be restricted due to aleurone colour like it is for Litmus. The Al tolerance genetics increase the production of citrate from the roots of barley,

allowing increased root growth and higher yields in soil with a low soil pH and increased levels of soluble Al. Al is toxic to barley's roots, hence barley's reduced productivity on acid soils.

Buff has displayed a consistent yield advantage over Litmus when averaged across 18 WA barley NVT trials (2016-2017). Being higher yielding than Litmus in three out of every five trials. The NVT MET analysis (2016-2017) also suggests that Buff has a yield potential at least equivalent to La Trobe on non-acidic soils and higher than La Trobe on soils with an acidic profile. The overall disease resistance profile of Buff is similar to Litmus (except for powdery mildew) with improvements in its tolerance to scald and NTNB. Fungicides may be required to manage STNB, powdery mildew and barley leaf rust.

Buff has been accepted by Barley Australia into its malting and brewing accreditation program and is planned to start Stage 1 accreditation in 2019 (subject to the availability of sufficient tonnage within malt specification).

Seed is available for planting in 2019 from Seedclub members and resellers. As with any new variety being evaluated by Barley Australia, malt accreditation and market acceptance (and possible associated malt premiums) are not guaranteed. We recommend caution in adopting them or sowing large areas to them with the expectation of future segregations unless there is a clear agronomic or grain yield advantage as a feed barley.

LG Maltstar

LG Maltstar (Henley/Sebastian) is a short height, semi-dwarf, medium spring, two row barley developed by Elders through its breeding partner Edstar Genetics. It has been sown in the WA barley NVT since 2011 and is a competitor to Bass, Flinders, Granger, Lockyer, Oxford and RGT Planet in higher rainfall areas of Western Australia. It has a similar plant type to Granger with durable resistance to powdery mildew (based on the *mlo* gene), good tolerance to both Beecher pathotypes of NTNB but has a lower resistance rating to barley leaf rust than Granger as an adult plant. LG Maltstar has good straw strength combined with a low head loss risk. WA barley NVT (2011-2017) suggests that LG Maltstar has an equivalent grain yield relative to Flinders and Granger in WA, having a similar yield in 59% and 70% of 96 NVT trials sown since 2011, respectively.

LG Maltstar has been accepted by Barley Australia for inclusion in their malting and brewing accreditation program. Stage 1 assessment has been delayed until 2019. The earliest possible accreditation date is March 2021.

Seed of LG Maltstar is now free to trade between farmers. As with any new variety being evaluated by Barley Australia, malt accreditation and market acceptance (and possible associated malt premiums) are not guaranteed. We recommend caution in adopting them or sowing large areas to them with the expectation of future segregations unless there is a clear agronomic or grain yield advantage as a feed barley.

What should I grow?

The following varieties should be high on the list of what to grow – Bass, Flinders, La Trobe, RGT Planet, Rosalind, Scope CL and Spartacus CL. There are also other options for specific agronomic situations like the sowing of Litmus on soils with a sub-soil pH_{Ca} below 4.8 or Fathom where stubble-borne STNB is a high risk. Oxford was previously suggested as a variety to consider but the increased prevalence of NTNB and powdery mildew infection, along with its susceptibility to STNB, mean Oxford is now a higher cost option for the south coast. As plans for malt segregations for both Compass and Granger are not being supported at the 2019/20 harvest, their planted area will reduce where they are not yield competitive with other varieties being grown for delivery as feed or there are varieties with better tolerance to leaf disease available at the same yield. Why consider Bass, Fathom, Flinders, La Trobe, Litmus, RGT Planet, Rosalind, Scope CL and Spartacus CL?

Bass

Bass is an established malt variety with strong market demand due to its high malt quality profile. From a grower's perspective, Bass has had a higher selection rate as malt over the last three seasons than any other malt variety. The development of a new barley leaf rust pathotype (from 5453 P- to 5457 P-) has meant Bass is now susceptible to very susceptible (SVS) to that disease. As a seedling it is rated as VS to the new Oxford virulent pathotype of NTNB that is increasing in its prevalence on the south coast. The prevalence of powdery mildew infection on Bass is also increasing. Whilst future opportunities may be limited if Banks and RGT

Planet are successful in their Barley Australia accreditation, market demand for Bass will still be very positive in the short term. Bass's overall physical grain quality, especially grain plumpness, is better than that displayed by both Banks and RGT Planet.

Best suited:

- To environments with a potential above 3 tonnes per hectare (t/ha).
- Where crown rot is a low risk.
- Where barley leaf rust is a low risk.
- To rotations in which low grain protein may be a problem.
- Where high grain plumpness is important.

Fathom

Fathom is a feed barley with the best tolerance to STNB of the currently grown barley varieties but is rated as MSS or below to both Beecher pathotypes of NTNB and VS to the new Oxford pathotype of NTNB (as a seedling). For the period 2014-2017, the grain yield of Fathom across 61 trials was around 0.15t/ha lower than that achieved by La Trobe and 0.35t/ha lower than Rosalind across a range of environments and yield potentials. Overall, the grain yield of Fathom was lower than Rosalind in three in every five WA barley NVT (2014-2017) and similar in the rest.

Fathom, along with Compass, is a variety to consider for paddocks where early weed competition is critical. In direct comparisons, Compass and Fathom have achieved a similar grain yield in three out of every five WA barley NVT (2014-2017), but Fathom has the advantage of better straw strength, improved resistance to STNB (but not NTNB) and better tolerance to barley leaf rust.

Best suited:

- To environments with a yield potential below 3t/ha where there is a high risk of STNB.
- To paddocks with a higher weed burden as it is one of the more competitive barley varieties.

Flinders

Flinders has gradually increased in acreage since its release, with the greatest adoption being undertaken by growers in the south west corner of the Albany Port Zone who like its short straw, agronomic performance and strong grain quality credentials. It appears to be 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. Whilst Flinders displays adult plant resistance (APR) to barley leaf rust, it will still need spraying when infection occurs before early grain fill. Future opportunities for Flinders may be limited if Banks and RGT Planet are successful in their Barley Australia accreditation, largely driven by growers phasing out Flinders in favour of those two emerging and higher yielding varieties.

Best suited:

- To environments with a potential above 3t/ha.
- Where crown rot is a low risk.
- Where both late season barley leaf rust and powdery mildew are a risk.
- Where short, stiff straw and good head retention are important.

La Trobe

La Trobe is now recognised in international malting and brewing markets. Whilst La Trobe has good market demand, it is not recognised as a premium variety and in years of adequate supply is likely to be priced below varieties like Bass and Baudin. The area sown to La Trobe will come under pressure from Banks (if it becomes accredited), Spartacus CL and RGT Planet (especially in environments which can yield more than 4t/ha) over coming seasons. La Trobe is still a critical variety for the trade given it is the only variety received in Japan (aside from Baudin) for the manufacture of shochu. The shochu market, whilst small compared to the malt barley market, pays above the market price and supports the market price for La Trobe barley which meets malt specifications.

Best suited:

- To environments with a potential below 4t/ha.
- Where STNB and barley leaf rust are a low risk.
- Where frost is a low risk.
- If every seed is treated with a good quality smuticide.

Litmus

Litmus is a feed barley with enhanced tolerance to soil acidity and aluminium toxicity. Litmus is proving popular with growers in the Geraldton and Kwinana Port Zones who have acidic soils, as Litmus allows them an alternative cereal in the rotation. Litmus has also performed well when crown rot is present, having the lowest yield loss of the commercial barley varieties evaluated. On non-acidic soils the yield of Litmus is inferior to La Trobe and Rosalind. InterGrain has withdrawn Litmus from Barley Australia's malt and brewing accreditation process, meaning it can only be received as a feed barley where active stack management of blue aleurone in feed barley is occurring.

The release of the white aleurone, acid tolerant variety Buff will put pressure on the area sown to Litmus and Litmus is likely to be quickly superseded by the new variety. This will be driven by the greater yield stability of Buff across paddocks with both less-acidic and acidic soil profiles. Buff has also been submitted to Barley Australia for malting and brewing accreditation.

Best suited:

- To environments where the sub-soil (10-30cm) has a pH_{Ca} below 4.8.
- Where leaf diseases are a low risk or can be easily managed.

RGT Planet

RGT Planet is a direct introduction from Europe and is undergoing malt accreditation when grown in Australian conditions under the guidance of Barley Australia. A decision is possible by March 2019, subject to it completing Stage 2 of the accreditation process.

RGT Planet was first grown in NVT trials in 2016 and has already jumped to an estimated 15% of the barley acreage in 2018. RGT Planet is a competitor to Banks, Bass, Flinders, Granger, La Trobe and Rosalind in medium to higher rainfall areas of Western Australia. It is a semi-dwarf variety that is taller than La Trobe with a phenology pattern like that of Bass except for April sowing. In late April it appears to flower earlier than Bass and around 4 days later than La Trobe. WA barley NVT (2016-2017) suggests that RGT Planet is the new yield benchmark in high yielding environments or situations (i.e. where La Trobe yields at least 4t/ha). Below 4t/ha RGT Planet appears to be similar to or lower yielding than La Trobe and Rosalind. More data is needed to confirm those observations, especially in seasons with a drier and/or shorter grain filling period as the last two seasons have generally had long durations of grain filling with mild day time temperatures.

Whilst there are only two years of grain quality data available (2016 and 2017), with limited observations from the 2016 season due to frost, the data collected suggests that RGT Planet has a higher risk of producing lower hectolitre weight grain than current malt varieties. Grain plumpness data suggests that where there is a drier or tighter finish to the season, screenings levels in RGT Planet are likely to be higher than Bass, Flinders, La Trobe and Spartacus CL. Head loss risk however appears to be low and its grain brightness looks to be between that of Flinders and La Trobe.

Best suited:

- To environments with a yield potential above 4t/ha, and more specifically paddocks with a year-in year-out potential above 5t/ha.
- To mixed farms where grain and graze is practiced.
- Where STNB, Beecher virulent NTNB and Oxford virulent NTNB are a low risk.
- Where both late season barley leaf rust and powdery mildew are a risk.

Rosalind

Rosalind is a feed barley released in 2015 with broad adaptation that was developed from a cross between the feed varieties Dash and Lockyer. It has a La Trobe type plant architecture and flowers at a similar time to La Trobe. It is the yield benchmark for barley in WA based on its overall agronomic performance from 2014 to 2017. In that period (2014-2017) the state-wide grain yield of Rosalind was 9% (~0.3t/ha) higher than La Trobe in the WA barley NVT. Despite this yield advantage the area sown to Rosalind is still less than 2% of the state's barley acreage.

Rosalind appears to be better suited than RGT Planet to the less than 3t/ha environments whilst RGT Planet appears to be better suited than Rosalind in the greater than 4t/ha environments, but more data is needed to confirm this.

Best suited:

- To environments where there is a low probability of delivering malt grade barley.
- Where STNB and Oxford virulent NTNB are a low risk.
- If every seed is treated with a good quality smuticide.

Scope CL

Scope CL is an established malt variety with declining market demand. In 2017, the popularity of Scope CL decreased due to the emergence of the new imidazolinone tolerant barley Spartacus CL. However, it still accounted for nearly one in every three barley hectares in the Kwinana and Geraldton Port Zones in 2017. The area sown to Scope CL will be challenged further in 2018 by Spartacus CL, which has shown an overall grain yield advantage over Scope CL of 12% (~0.35t/ha) in WA barley NVT (2014-2017). It is worth noting that Spartacus CL has not shown the same advantage relative to Scope CL over the past two seasons. The advantage of Spartacus CL state-wide in 2014 and 2015 was 19% and 17% respectively but only 0% and 6% in 2016 and 2017. It is possible this is due to the long and mild grain filling period experienced in the last two seasons which benefited grain size development of Scope CL more so than Spartacus CL.

Best suited:

- To environments with a potential below 3t/ha.
- To April sowing opportunities when sowing into non-Clearfield® wheat stubble (so the in-crop wheat volunteers can be controlled).
- Where crown rot is a low risk.
- Where an imidazolinone herbicide was used last year or Sentry® / Intercept® / Intervix® is planned for use this year.
- When sowing in April and/or in paddocks with a higher frost risk as an alternative to sowing the shorter season Spartacus CL.
- Where prompt harvesting once the crop is mature is possible (due to a high head loss risk).

Spartacus CL

Spartacus CL is a new imidazolinone tolerant, malt barley with a similar grain yield, improved grain quality (slightly plumper grain, higher grain protein and slightly brighter grain), similar phenology and some improved agronomic features (largely stiffer straw and lower head loss risk) relative to La Trobe. In 2017, it increased to being planted on one in eight barley hectares in the state and appears likely to double in popularity to just under one in every three barley hectares in 2018. It lacks the anthocyanin pigment (purple colouration) on its flag leaf auricle and head that is present in La Trobe and Hindmarsh. Like Scope CL, Spartacus CL can be sprayed with a registered imidazolinone herbicide (Intercept®, Intervix® and Sentry®) to control barley grass and brome grass in-crop.

Best suited:

- To environments where Scope CL does not meet grain quality targets allowing it be delivered as malt.
- Where an imidazolinone herbicide was used last year or Sentry® / Intercept® / Intervix® is planned for use this year.
- Where STNB and barley leaf rust are not a risk.
- To May plantings in areas with a reduced frost risk due to early phenology.
- If every seed is treated with a good quality smuticide.

Best management agronomy

Blakely Paynter, Jeremy Curry, Raj Malik and Georgia Trainor, DPIRD

Over the last 20 years the barley agronomy team at DPIRD with co-investment from the Grains Research and Development Corporation (GRDC) has been assessing best management practices for barley production in WA. The aim of this research being to assist barley growers grow the right variety in the right environment with appropriate management to meet market demand.

In recent years research has focused on:

- Options to increase grain protein concentration without applying more nitrogen, and
- Determining the target density that optimises barley production (yield and quality).

Grain protein management

The malt barley protein window for receival as Malt1 is between 9.5% and 12.5%.

How often is your barley intended for delivery as malt inside this window? Do you know what you can do about decreasing or increasing it? The first consideration is to review your total nitrogen (N) application rate as low protein is usually the result of low N and forgone yield, which could be viewed as a missed opportunity. More N can be in the form of either fertiliser N or from the soil through establishing legume-based crops and pastures on your farm. It must also be noted that as the potential yield of barley increases with the release of newer varieties, better agronomy and earlier sowing, more fertiliser N will be required to produce these yields and still meet Malt1 protein specifications.

If you typically deliver malt barley varieties with less than 10% protein or get rejected because your malt barley is less than 9.5% protein then there are two management options that can help increase your grain protein concentration (without requiring the addition of more fertiliser N). The options are:

- Variety choice – sow a higher protein variety like Bass or even Flinders or Spartacus CL (where suitable), and
- N timing – apply only a starter N at seeding and follow up with at least ⅔ (if not more) of your recommended N fertiliser rate at stem elongation.

Managing grain protein concentration with variety choice

Data from NVT trials and DPIRD-GRDC funded barley agronomy trials (2005-2017) were combined 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

Table 1 Malt barley varietal rankings for grain protein concentration when differences in their grain yield are reduced/removed

Ranking malt barley varieties for their grain protein deviation				
Lower	**Slightly Lower**	**Normal**	**Slightly Higher**	**Higher**
-0.6 to -0.3%	**-0.3 to -0.1%**	**-0.1 to +0.1%**	**+0.1 to +0.3%**	**+0.3 to +0.6%**
Commander	Buloke	Baudin	Flinders	Bass
Compass	La Trobe	Flagship	Gairdner	Stirling
Henley		Scope CL	Granger	
			Hamelin	
			Spartacus CL	
			Vlamingh	
			Wimmera	
Undergoing malt accreditation with Barley Australia				
LG Maltstar	RGT Planet	LG Alestar	Banks	

for their grain protein deviation (Table 1) and determine relative levels of inherent grain protein concentration.

Varietal differences in grain protein deviation is around 1%. So, if low protein is an issue then sowing Bass or even Flinders or Spartacus CL may increase your chances of meeting Malt1 grain protein specifications.

Managing grain protein concentration with N timing

The other way in which grain protein concentration can be increased is to delay top up N applications until stem elongation. A common N fertiliser practice is to apply the bulk of the N fertiliser recommendation at seeding. Whilst this might be logistically the easiest, it is not necessarily the most effective strategy for producing both yield and protein.

Research from 30 DPIRD-GRDC funded barley agronomy trials (2013-2016) show that the strategy of applying some fertiliser N at seeding and the rest (at least two thirds) at stem elongation caused little or no reduction in grain yield with only minor negative effects on hectolitre weight and grain plumpness. This strategy, however, was shown to boost grain protein concentration by up to 0.5% compared to applying the same rate of top up N at mid-tillering or splitting the top up application over two applications (mid-tillering and stem elongation). Compared to the strategy of applying all of the N up-front, the delayed N strategy at stem elongation boosted grain protein concentration by nearly 1%. It is worth noting that in very dry seasons, the effect of the delayed N magnifies the effects on grain protein and other grain quality traits. In those situations, however, grain plumpness is likely to be the factor that causes a downgrade to feed regardless of N management strategy.

A benefit of deferring N fertiliser decisions until later in the season is that it can allow growers to make better decisions about N application rates because they will then know more about the season and can better assess the status of the crop and respond to nutrient losses from waterlogging or leaching. This also reduces the risk of over-fertilisation.

Applying higher rates of N fertiliser usually results in increased grain protein concentration in both barley and wheat (unless there is a significant grain yield increase). However, unlike in wheat, increasing N in barley significantly increases the risk of delivering grain with high screenings (largely due to the different screen width used on receival). Where the fertiliser recommendation is for high rates of N fertiliser, choosing a variety with plump grain (for example Bass) will increase the probability of meeting protein targets while staying inside the Malt1 limit for screenings (maximum of 20% through a 2.5mm slotted sieve).

Target plant density

Seeding rates, or more importantly plant density, is a widely discussed subject. It is important that everyone moves on from talking in terms of what seeding rate they sow at, to what plant density they should target (and calculating seeding rate based on target plant density). While plant density (plants per square metre) is a fixed target, a fixed seeding rate in kg/ha will see a variable plant density across seasons due to seed size (varies with variety and season), seed viability and establishment conditions.

Positives from lower plant densities include storage and seeding logistics and lower seed treatment and seed costs. However, if the game is yield and resulting profitability, why wouldn't you target higher plant densities? What is there to lose? So the question should be, are my target plant densities for barley high enough? Do I actually establish enough plants? If I increased my plant density, what is to be gained? To know what your plant density is, you need to do in-crop counts at 2 weeks after establishment (if the crop is sown into moisture).

One advantage of increasing your plant density is greater weed competition (especially in-row), resulting in less weeds and reduced competition for the crop. Even in the absence of weed competition, greater establishment gives greater potential for yield. The perceived negative effect of increased plant densities is on grain quality, and in particular, more screenings. Recent research has highlighted that in environments targeting greater than 1.5t/ha yields, higher plant densities equate to higher yields and improved weed control, without jeopardising grain quality.

Across 75 DPIRD-GRDC barley agronomy trials (1996-2017) where plant density was a management factor the following was observed:

- Barley cannot compensate from being sown at low plant densities (<100 plants/m^2).
- A yield response to increasing plant density was observed in 85% of trials.
- Barley establishing at densities of 50 plants/m^2 will be lower yielding by around 10-12% than barley sown at 150 plants/m^2.
- Negative yield responses to increasing plant density can occur but are uncommon. When it did occur (in only 5 out of 75 trials), the average reduction in grain yield was less than 0.1t/ha.
- The actual decrease in hectolitre weight and increase in screenings associated with increasing plant density is much smaller than most growers think.
- Varieties react similarly to increasing plant density for grain yield, but differ in how their grain quality responds.
- Knowing how a variety responds to increasing N does not tell us how a variety might respond to increasing plant density.
- Yield potential does not alter the target plant density for barley crops at sites with a potential above 1.5t/ha.
- Delays in seeding by two to three weeks do not change the target plant density.
- Plant density in plants/m^2 is fixed by variety, while seed rate in kg/ha varies with variety, seed size and germination.

As an example of the small change in grain quality observed with increasing plant density, increasing the plant density from 50 to 150 plants/m^2 across 24 trials (2012-2013) resulted in a grain yield increase of 0.39t/ha (or 13% more yield), a hectolitre weight decrease of <0.1kg/hL, a screenings increase of <1%, a grain protein decrease of 0.4% and a grain brightness increase of 0.2'L*'.

Based on the plant density trials conducted since 2010 with current varieties (focusing on varieties with a malt classification), different variety specific target density recommendations have been developed. The target densities suggested for barley varieties currently received in WA are (Table 2):

Table 2 Recommended target density (plants/m^2) for each malt barley variety segregated in WA and for any feed barley variety, and the likely seed rate (kg/ha) required to establish that density. Seed rate in kg/ha is presented for different kernel weights between 30g and 50g assuming 98% germination and 80% crop establishment

Target density	110 – 130 plants/m^2	150 – 180 plants/m^2	180 – 220 plants/m^2
Varieties	Baudin, Scope CL	Bass, Flinders, La Trobe, Spartacus CL	Feed barley
1000 kernel weight	Seed rate (kg/ha) range for each variety/density group		
30g	42 – 50kg/ha	57 – 69kg/ha	69 – 84kg/ha
35g	49 – 58kg/ha	67 – 80kg/ha	80 – 98kg/ha
40g	56 – 66kg/ha	77 – 92kg/ha	92 – 112kg/ha
45g	63 – 75kg/ha	86 – 103kg/ha	103 – 126kg/ha
50g	70 – 83kg/ha	96 – 115kg/ha	115 – 140kg/ha

- Baudin and Scope CL = 110-130 plants/m^2
- Bass, Flinders, La Trobe and Spartacus CL = 150-180 plants/m^2
- Any feed barley variety = 180-220 plants/m^2 (where weeds present) or 150-180 plants/m^2 (in weed-free situations)

For feed barley, a higher target density is suggested to improve the competitiveness of the crop against weeds. Denser crops have a lower yield loss in the presence of weeds and a higher reduction in weed seed set. If growing feed barley in paddocks without weeds then the target density can be adjusted down to 150-180 plants/m^2.

It is important to note that the target density is fixed by variety, but the actual seeding rate in kg/ha you will use on-farm will vary due to variety, the kernel weight of the variety, its germination per cent and your likely establishment per cent. To determine the seed rate in kg/ha use 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 barley with a germination of 94%, a kernel weight of 42g per 1000 kernels at a target density of 150 plants/m^2 with an expected establishment of 80%, then the seed rate in kg/ha required to establish 150 plants/m^2 is:

$$\text{seed rate in kg/ha} = 84 \text{ kg/ha} = \frac{\text{42g x 150 plants/m}^2}{\text{94\% x 80\% x 100}}$$

It is important that 1000 kernel weight and germination per cent are calculated for each variety and seed source as they can vary significantly depending on growing and storage conditions. Those factors have a large impact on the actual plant density. Establishment per cent is an estimate of actual germination under field conditions; 80% can be used as a general rule, with an adjustment (+/- 10%) under particularly harsh or kind seeding conditions or if consistent over or under establishment is occurring. Seeding bar type, bar setup, seeding depth, soil moisture status and soil texture can also influence the level of establishment.

Market feedback

GIWA Barley Council

As with previous advice from the Western Australian barley industry, there is a long term aim to support 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 who are unwilling to risk buying small, unsaleable parcels.

At the 2019/20 harvest, the following observations are relevant:

- Bass, La Trobe and to a lesser extent Flinders 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 is now the main malt barley variety sought for the manufacture of shochu in Japan and production of La Trobe is critical to maintain supply to this premium market. Whilst Spartacus CL is being assessed for the shochu market we would have to wait until after the 2019/20 harvest before any significant volumes of Spartacus CL would be purchased by that market (assuming it was deemed suitable in commercial trials conducted over the next 18 months).
- The decline in the planting of Scope CL coincides with a reduced demand from the international trade for its malt quality profile.
- There has been rapid grower adoption of Spartacus CL but production is likely to exceed market demand in the short term. International customers are not yet fully familiar with its malting and brewing profile or its relevance for shochu production.
- Baudin is in phase out mode as customers are comfortable with alternate varieties like Bass that can provide a similar quality profile for malting and brewing purposes. The 2019/20 harvest is likely to be the last harvest that segregations will be offered for Baudin in Western Australia.
- Segregation opportunities for Bass, Baudin, Flinders, La Trobe, Scope CL and Spartacus CL vary by port zone and within a port zone (Table 3).

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 2019 barley cropping program. This plan will be reviewed in autumn next year and any changes in demand presented to growers.

As both Banks and RGT Planet are still undergoing malting and brewing accreditation for Australian growing conditions through Barley Australia they are not included in the current 2019/20 variety receival recommendation plan.

Accreditation as a malt variety does not guarantee segregation opportunities in Western Australia. Compass is a case in point; whilst Compass is an accredited malt variety there is a lack of customer demand for Western Australian grown Compass. The outcome being that no malt barley segregation will be offered for Compass barley in Western Australia, even though segregations will be offered in eastern Australia. Production of Compass in 2019 will be directed into feed stacks.

Accreditation as a malt variety also does not guarantee market success. There is no guarantee that every international market will pay a premium for an accredited malt variety compared to a non-accredited variety, but most of our international customers place value on the accreditation provided by Barley Australia. Granger is a case in point; whilst Granger has been an accredited malt variety since 2013, very limited market demand has resulted with Granger being removed from the list of varieties that will be segregated in Western Australia after the 2018/19 harvest. Production of Granger in 2019 will be directed into feed stacks.

It is worth noting that GIWA facilitates industry wide consultation on an annual basis but has no control over the actual segregations provided by Bunge or CBH. Through the rationalisation process, GIWA is working with Bunge and CBH to help provide guidance to growers as to what segregations might be offered within each port zone at an area and a site scale, rather than just at a port zone scale. This document, however, only reflects the port zone guidance.

In order for industry to manage whole of site harvest receival planning (i.e. segregation allocation), it remains very important for growers to submit their annual planted hectares estimate to CBH on time or inform Bunge of their intended plantings. Attending pre-harvest meetings is also

important to confirm varieties to be segregated at a site level at subsequent harvests based on the port zone recommendations in this document. Some sites can only offer a single malt barley segregation, whereas other sites may be able to offer two or more malt barley segregations.

Barley Australia and the GIWA Barley Council do not support the co-binning of segregated malt varieties, even if the varieties concerned have similar agronomic traits. The Australian barley industry works hard to uphold Australian malt variety traits to the end customer and the reputation and integrity of Australian malt barley is at risk from co-binning and cannot in any way be condoned. 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 mis-declaration is a breach of the Bulk Handling Act 1967.

When developing agronomic management plans for each of the malt barley varieties listed growers should be aware of international market signals indicating that Australian barley is generally too low in its grain protein concentration. Growers are encouraged to target producing malt barley grain between 10.5-11.0% protein, a maximum of 20% 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

Each malt barley variety grown in Western Australia has unique and different malting attributes. As a consequence 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 in this document to assist them when deciding on which malt variety or varieties to sow in 2019. 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 updated malt barley recommendations for the 2019 season are as follows:

Bass

- Bass is suitable for export as grain and as malt.
- Not suitable for the manufacture of shochu in Japan.
- Bass is well recognised in the international malt barley market with stable demand.
- Can be malted without use of the growth hormone gibberellic acid, a market preferred trait.
- Bass malt has excellent extract and filterability and is suited to markets where high levels of starch-adjuncts are used in the brewing process.
- Target production zone in 2019 is Kwinana-West with limited segregation opportunities in the Albany Port Zone (subject to production volumes).

Baudin

- Baudin is the ‘market leader’ for malt quality, but has inferior grain yield, grain plumpness and disease resistance to alternative malt varieties being grown in Western Australia.
- There is international market demand for export as both grain and malt.
- Accepted for shochu production in Japan.
- Customers are now comfortable with alternative malt varieties in the market like Bass and are phasing out their demand for Baudin.
- Growers in the Esperance Port Zone looking to grow Baudin for malt in 2019 should talk to their preferred acquirer to determine opportunities for contract production into a niche segregation before planting any seed.
- The 2019/20 harvest is likely to be the last harvest that segregations will be offered for Baudin in Western Australia.

Flinders

- Flinders is suitable for export as grain and as malt.
- Not suitable for the manufacture of shochu in Japan.
- Can be malted without use of the growth hormone gibberellic acid, a market preferred trait.
- Flinders malt has excellent malt extract and filterability but at a lower enzyme potential than Bass malt.

- Flinders is performing well in markets where sugar-adjunct brewing is undertaken and when blended post-malting with varieties like Bass and La Trobe for starch-adjunct brewing.
- Production volumes haven't grown enough to support widespread segregations. Grower interest in Banks and RGT Planet is likely to block further growth of the variety.
- Target production zone in 2019 is Albany-South, with limited segregations in Albany-North (subject to production volumes) and potential niche segregation opportunities in Kwinana-West and the Esperance Port Zone (subject to production and demand).

La Trobe

- La Trobe is suitable for export as grain and as malt.
- Suitable for the manufacture of shochu in Japan; aside from Baudin, La Trobe is the only Western Australian grown variety accepted into the Japanese shochu market.
- La Trobe malt has excellent extract with a high enzyme potential and is suitable for brewers where starch-adjunct brewing is undertaken.
- Growers should not ruin the integrity of La Trobe malt stacks by contaminating them with either Hindmarsh or Spartacus CL barley.
- Growers should be careful not to contaminate La Trobe seed stocks with Hindmarsh or Spartacus CL or any other barley variety.
- Target production zones in 2019 are Kwinana, Albany and Esperance Port Zones.

Scope CL

- Scope CL is suitable for export as grain and as malt.
- Not suitable for the manufacture of shochu in Japan.
- Scope CL malt has good extract with moderate enzyme activity but can suffer from variable filterability. Since the last rationalisation plan customer demand for Scope CL has declined due to the availability of improved malt quality in other exported malt varieties.
- Whilst Scope CL has a better production fit than Spartacus CL with April sowing opportunities, Scope CL is in phase out mode by growers and the trade alike.
- Growers should not ruin the integrity of Scope CL malt stacks by contaminating them with Buloke or Spartacus CL barley.
- Do not use imidazolinone herbicides other than Intercept®, Intervix® or Sentry®.
- Target production zones in 2019 are Kwinana and Albany Port Zones with limited segregation opportunities (subject to production volumes).

Spartacus CL

- Spartacus CL is suitable for export as grain and as malt, but limited volumes of grain have been processed to date. First indications from customers are positive, suggesting it has a 'La Trobe-like' profile. More work is still required though to gain full international acceptance.
- Being assessed for its suitability for the manufacture of shochu in Japan.
- Growers should not ruin the integrity of Spartacus CL malt stacks by contaminating them with Scope CL barley or any other variety.
- Growers should be careful not to contaminate Spartacus CL seed stocks with Hindmarsh, La Trobe, Scope CL or any other barley variety.
- Do not use imidazolinone herbicides other than Intercept®, Intervix® or Sentry®.
- Target production zones in 2019 are Geraldton, Kwinana and Albany Port Zones with limited segregation opportunities (subject to production volumes) in the Esperance Port Zone.

Table 3 Western Australian malt barley industry variety recommendations by Port Zone for the 2019/20 harvest

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

Port Zone	Geraldton	Kwinana		Albany		Esperance	Comment
(% total barley area)	~5%	~40%		~30%		~25%	
		Western	Eastern	Northern	Southern		
MALTING VARIETIES							
Bass(Ⓘ)	NO	YES	NO	Limited	Limited	NO	Stable market demand with an excellent malt quality profile
Baudin(Ⓘ)	NO	NO	NO	NO	NO	Niche	Preferred variety with stable market demand but low production volume
Flinders(Ⓘ)	NO	Niche	NO	Limited	YES	Niche	Works well as a variety for post-malt blending and for sugar-adjunct brewing
La Trobe(Ⓘ)	NO	YES	YES	YES	YES	YES	Stable market demand with recognised quality profile
Scope CL(Ⓘ)	NO	Limited	Limited	Limited	NO	NO	Declining production and declining market demand
Spartacus CL(Ⓘ)	YES	YES	YES	YES	YES	YES	Market development for brewing and shochu end use continuing

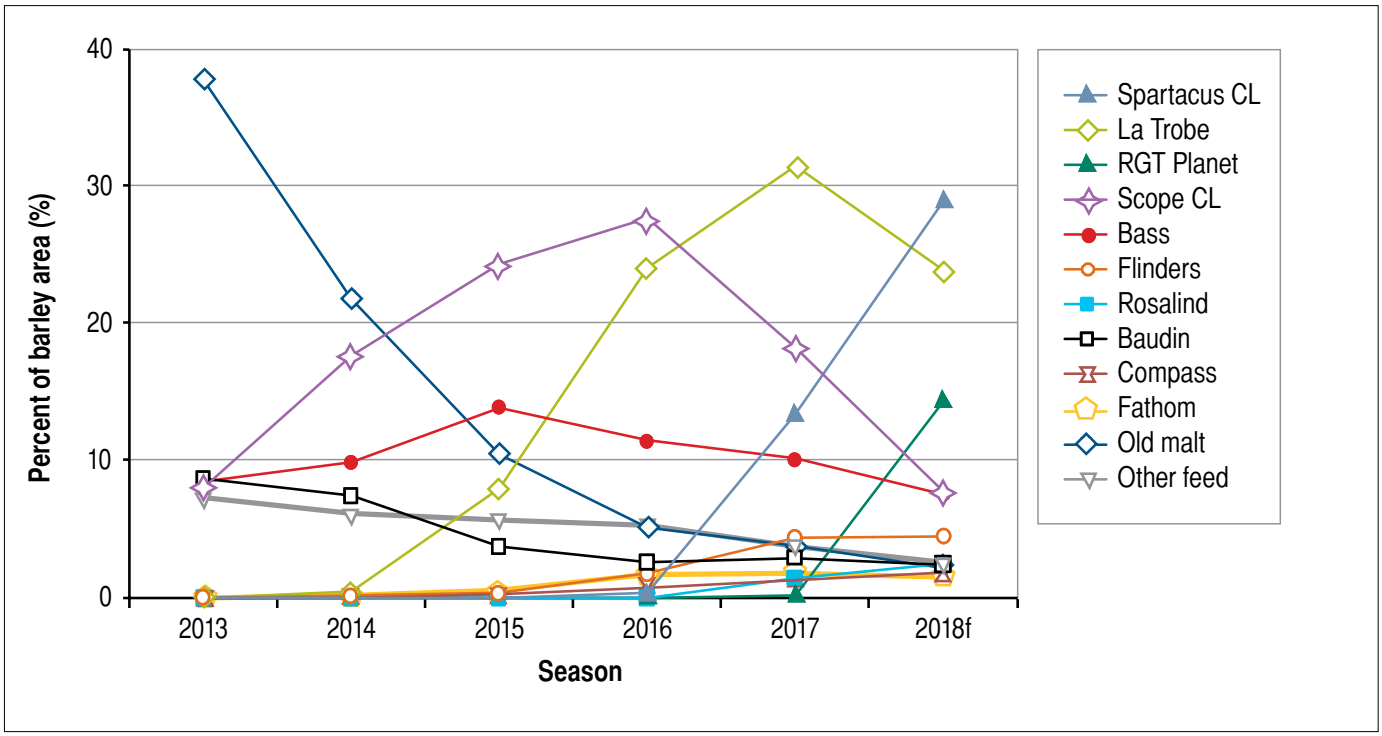

Figure 1 Popularity (per cent of barley area) of top 10 barley varieties (ranking based on forecast area sown in 2018 season) grown in WA over the last five seasons plus forecast for the 2018 season. "Old" malt includes Buloke, Commander, Gairdner, Hamelin, Stirling and Vlamingh. (source: figure based on grower estimates as provided to CBH for 2013-2017 and forecast area for 2018 estimated by Blakely Paynter, DPIRD)

Grain yield comparisons

Blakely Paynter and Jeremy Curry DPIRD

Variety trials are conducted across Australia under the funding and oversight of the GRDC. The NVT program was established in 2005 to provide a nationally independent means of assessing varietal performance to enable growers to select the best variety for their environment. The results of NVT trials are available as individual site reports or as multi-environment (MET) long term summaries. The MET analysis generates a table of performance values for each variety in comparison to the mean of the NVT site at which it was included. 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 individual and multi-year analyses are available at nvtonline.com.au. Growers and consultants can also download a version of the MET summaries on their portable devices for both Apple (via the iTunes app store) and Android (via Google play) devices.

For this sowing guide, additional analysis is presented to that available on the NVT website. Table 4 re-works the NVT long term MET analysis and presents the data against a reference variety, La Trobe, rather than against the site mean yield. It also presents the data based on Agzones (Figure 2). Agzones were developed by DPIRD through statistical analysis to group together environmental regions that give similar crop performance in WA. Data is presented for each year from 2013 to 2017 and as an overall MET for the period 2013-2017. Multi-year averages are only presented where there are four or more observations.

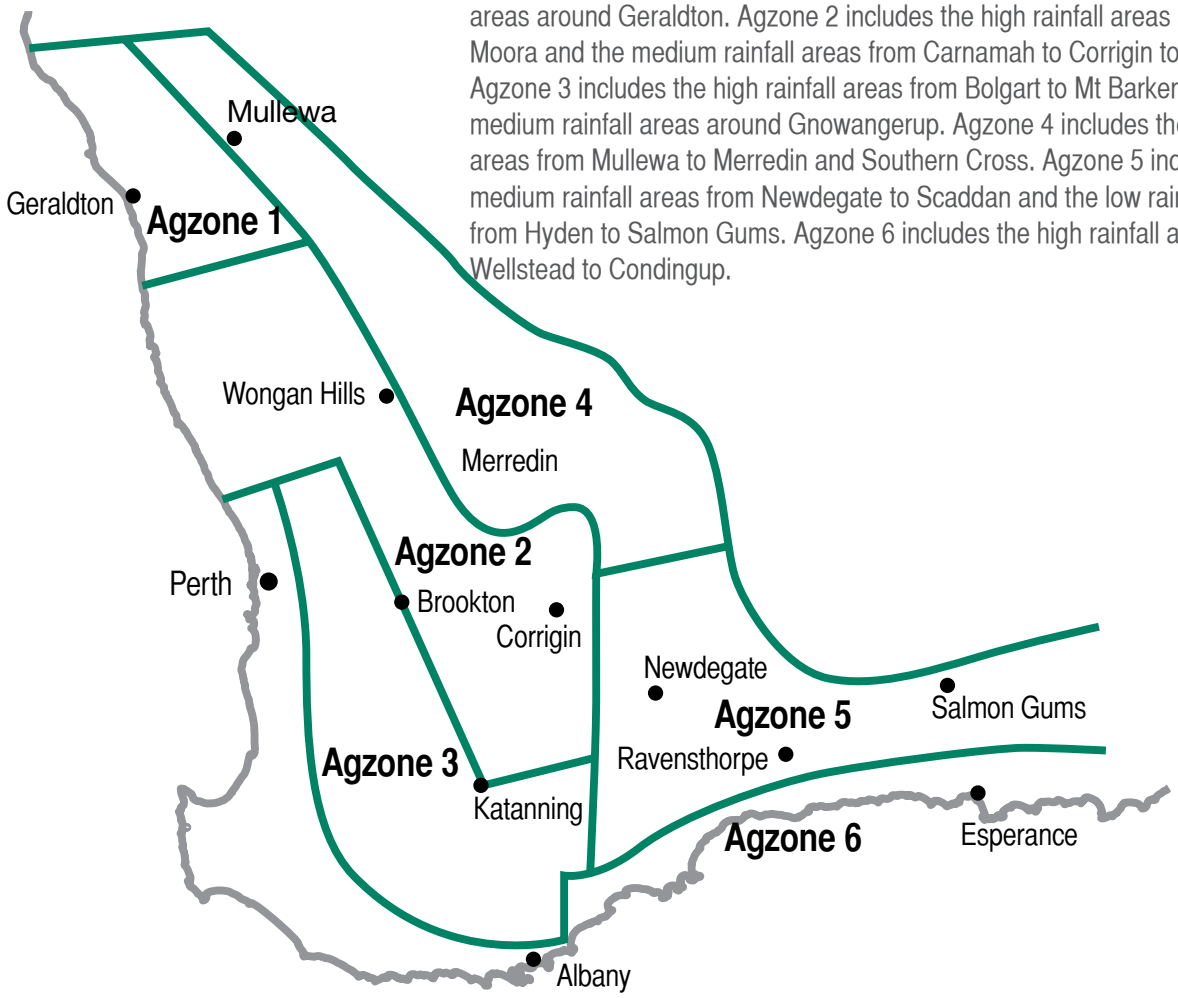

Figure 2. Agzone map of the south west corner of WA. Agzones have been developed through statistical analysis of long term crop variety trials and group together environmental regions that give similar crop performance. There are six cereal Agzones in WA. Agzone 1 includes the medium and high rainfall areas around Geraldton. Agzone 2 includes the high rainfall areas around Moora and the medium rainfall areas from Carnamah to Corrigin to Pingrup. Agzone 3 includes the high rainfall areas from Bolgart to Mt Barker and the medium rainfall areas around Gnowangerup. Agzone 4 includes the low rainfall areas from Mullewa to Merredin and Southern Cross. Agzone 5 includes the medium rainfall areas from Newdegate to Scaddan and the low rainfall areas from Hyden to Salmon Gums. Agzone 6 includes the high rainfall areas from Wellstead to Condingup.

Table 4 Grain yield of barley varieties in Agzones 1 to 6 expressed as a per cent of La Trobe. Data presented for each year (2013-2017) and as an overall MET analysis (where there are four or more observations)
(source: NVT Online nvtonline.com.au)

Table 4a Grain yield in Agzone 1 expressed as a per cent of La Trobe

Agzone 1	Single year (% La Trobe)					Multi year (% La Trobe)	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**1**	**1**	**1**	**2**	**2**	**7**	
Malt varieties							
Bass(Ⓑ)	81	91	84	92	88	**88**	*7*
Baudin(Ⓑ)	92	91	79	97	95	**92**	*7*
Flinders(Ⓑ)	100	94	92	–	94	**95**	*5*
La Trobe(Ⓑ)	100	100	100	100	100	**100**	*7*
Scope CL(Ⓑ)	96	88	94	99	102	**97**	*7*
Spartacus CL(Ⓑ)	–	104	102	98	98	**100**	*6*
Stage 2 malt accreditation							
Banks(Ⓑ)	–	–	102	101	102	**102**	*5*
RGT Planet(Ⓑ)	–	–	–	103	97	**102**	*4*
Feed varieties							
Buff(Ⓑ)	–	–	–	112	113	**106**	*4*
Fathom(Ⓑ)	101	94	96	107	109	**103**	*7*
LG Maltstar(Ⓑ)	–	–	–	–	88	–	*2*
Litmus(Ⓑ)	109	80	116	102	113	**105**	*7*
Lockyer(Ⓑ)	113	103	88	–	108	**106**	*5*
Mundah	97	93	100	–	100	**97**	*5*
Oxford	102	93	80	95	87	**91**	*6*
Rosalind(Ⓑ)	–	108	110	108	110	**111**	*6*
La Trobe yield (t/ha)	**1.77**	**1.26**	**1.95**	**4.32**	**2.16**	**2.58**	*7*

Table 4b Grain yield in Agzone 2 expressed as a per cent of La Trobe

Agzone 2	Single year (% La Trobe)					Multi year (% La Trobe)	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**5**	**5**	**6**	**3**	**5**	**24**	
Malt varieties							
Bass(Ⓑ)	85	94	82	92	94	**89**	*23*
Baudin(Ⓑ)	88	89	78	104	93	**89**	*24*
Flinders(Ⓑ)	99	97	92	100	97	**96**	*24*
La Trobe(Ⓑ)	100	100	100	100	100	**100**	*24*
Scope CL(Ⓑ)	94	86	89	106	97	**93**	*23*
Spartacus CL(Ⓑ)	–	102	103	96	99	**101**	*19*
Stage 2 malt accreditation							
Banks(Ⓑ)	–	–	101	104	101	**102**	*14*
RGT Planet(Ⓑ)	–	–	–	109	101	**104**	*8*
Feed varieties							
Buff(Ⓑ)	–	–	–	121	109	**102**	*8*
Fathom(Ⓑ)	96	97	93	111	105	**99**	*24*
LG Maltstar(Ⓑ)	100	96	86	99	94	**94**	*24*
Litmus(Ⓑ)	108	75	105	111	99	**99**	*24*
Lockyer(Ⓑ)	101	101	91	–	103	**101**	*21*
Mundah	96	79	96	–	89	**92**	*21*
Oxford	98	99	83	–	94	**94**	*21*
Rosalind(Ⓑ)	–	105	113	110	104	**109**	*19*
La Trobe yield (t/ha)	**3.38**	**2.70**	**2.61**	**3.92**	**4.32**	**3.33**	***24***

Table 4 Grain yield of barley varieties in Agzones 1 to 6 expressed as a per cent of La Trobe. Data presented for each year (2013-2017) and as an overall MET analysis (where there are four or more observations) (source: NVT Online nvtonline.com.au)
Table 4c Grain yield in Agzone 3 expressed as a per cent of La Trobe

Agzone 3	Single year (% La Trobe)					Multi-year (% La Trobe)	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**5**	**5**	**5**	**1**	**2**	**18**	
Malt varieties							
Bass(b)	98	93	91	90	89	**93**	*18*
Baudin(b)	92	88	81	91	96	**88**	*18*
Flinders(b)	98	97	96	98	100	**98**	*18*
La Trobe(b)	100	100	100	100	100	**100**	*18*
Scope CL(b)	93	89	86	96	95	**90**	*18*
Spartacus CL(b)	–	102	102	99	99	**101**	*13*
Stage 2 malt accreditation							
Banks(b)	–	–	102	104	105	**101**	*8*
RGT Planet(b)	–	–	–	108	115	**–**	*3*
Feed varieties							
Buff(b)	–	–	–	–	–	**–**	*0*
Fathom(b)	100	95	96	100	98	**97**	*18*
LG Maltstar(b)	96	97	93	98	104	**97**	*18*
Litmus(b)	89	88	88	104	100	**90**	*18*
Lockyer(b)	98	96	92	–	108	**97**	*17*
Mundah	85	86	78	–	98	**85**	*17*
Oxford	97	98	94	98	104	**97**	*18*
Rosalind(b)	–	105	106	109	112	**105**	*13*
La Trobe yield (t/ha)	**5.90**	**5.46**	**4.11**	**3.69**	**4.38**	**5.00**	***18***

Table 4d Grain yield in Agzone 4 expressed as a per cent of La Trobe

Agzone 4	Single year (% La Trobe)					Multi-year (% La Trobe)	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**2**	**2**	**2**	**0**	**1**	**7**	
Malt varieties							
Bass(b)	87	64	85	–	79	**77**	*7*
Baudin(b)	88	40	80	–	68	**66**	*7*
Flinders(b)	93	65	90	–	80	**81**	*7*
La Trobe(b)	100	100	100	–	100	**100**	*7*
Scope CL(b)	92	70	88	–	82	**82**	*7*
Spartacus CL(b)	–	117	104	–	107	**108**	*5*
Stage 2 malt accreditation							
Banks(b)	–	–	98	–	92	**–**	*3*
RGT Planet(b)	–	–	–	–	72	**–**	*1*
Feed varieties							
Buff(b)	–	–	–	–	79	**–**	*1*
Fathom(b)	101	79	92	–	98	**91**	*7*
LG Maltstar(b)	89	–	–	–	64	**–**	*3*
Litmus(b)	94	101	99	–	93	**97**	*7*
Lockyer(b)	104	60	90	–	88	**83**	*7*
Mundah	91	100	97	–	86	**95**	*7*
Oxford	89	25	81	–	61	**61**	*7*
Rosalind(b)	–	116	109	–	111	**112**	*5*
La Trobe yield (t/ha)	**1.86**	**0.53**	**3.11**	**–**	**1.78**	**1.96**	***7***

Table 4 Grain yield of barley varieties in Agzones 1 to 6 expressed as a per cent of La Trobe. Data presented for each year (2013-2017) and as an overall MET analysis (where there are four or more observations) (source: NVT Online nvtonline.com.au)
Table 4e Grain yield in Agzone 5 expressed as a per cent of La Trobe

Agzone 5	Single year (% La Trobe)					Multi-year (% La Trobe)	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**4**	**4**	**4**	**1**	**4**	**17**	
Malt varieties							
Bass(b)	93	92	88	93	92	**91**	*17*
Baudin(b)	92	89	79	96	92	**88**	*17*
Flinders(b)	99	96	92	–	98	**97**	*16*
La Trobe(b)	100	100	100	100	100	**100**	*17*
Scope CL(b)	90	86	82	94	90	**87**	*17*
Spartacus CL(b)	–	102	105	99	101	**102**	*13*
Stage 2 malt accreditation							
Banks(b)	–	–	97	109	101	**100**	*9*
RGT Planet(b)	–	–	–	128	108	**105**	*5*
Feed varieties							
Buff(b)	–	–	–	109	98	**95**	*5*
Fathom(b)	99	99	91	92	97	**96**	*17*
LG Maltstar(b)	100	94	88	115	99	**96**	*17*
Litmus(b)	85	75	79	99	84	**82**	*17*
Lockyer(b)	104	105	91	102	105	**101**	*17*
Mundah	83	80	82	–	88	**84**	*16*
Oxford	103	98	88	–	101	**98**	*16*
Rosalind(b)	–	108	107	110	109	**108**	*13*
La Trobe yield (t/ha)	**3.84**	**3.61**	**3.79**	**2.53**	**3.70**	**3.66**	***17***

Table 4f Grain yield in Agzone 6 expressed as a per cent of La Trobe

Agzone 6	Single year (% La Trobe)					Multi-year (% La Trobe)	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**2**	**2**	**2**	**2**	**1**	**9**	
Malt varieties							
Bass(b)	91	95	93	91	108	**94**	*9*
Baudin(b)	77	97	88	91	99	**89**	*9*
Flinders(b)	103	105	102	104	116	**105**	*9*
La Trobe(b)	100	100	100	100	100	**100**	*9*
Scope CL(b)	76	88	85	90	93	**85**	*9*
Spartacus CL(b)	–	98	102	98	98	**100**	*7*
Stage 2 malt accreditation							
Banks(b)	–	–	104	109	113	**107**	*5*
RGT Planet(b)	–	–	–	128	138	**–**	*3*
Feed varieties							
Buff(b)	–	–	–	–	–	**–**	0
Fathom(b)	85	101	89	96	84	**92**	*9*
LG Maltstar(b)	110	112	107	111	132	**112**	*9*
Litmus(b)	72	72	81	91	92	**80**	*9*
Lockyer(b)	88	114	96	103	88	**99**	*9*
Mundah	64	73	83	–	87	**76**	*7*
Oxford	114	119	109	114	134	**116**	*9*
Rosalind(b)	–	109	108	111	97	**108**	*7*
La Trobe yield (t/ha)	**3.58**	**2.49**	**3.95**	**4.14**	**2.74**	**3.44**	***9***

Table 4 Grain yield of barley varieties in Agzones 1 to 6 expressed as a per cent of La Trobe. Data presented for each year (2013-2017) and as an overall MET analysis (where there are four or more observations) (source: NVT Online nvtonline.com.au)
Table 4g Grain yield in Agzone 1-6 expressed as a per cent of La Trobe

Agzone 1-6	Single year (% La Trobe)					Multi year (% La Trobe)	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**2**	**2**	**2**	**2**	**1**	**9**	
Malt varieties							
Bass(D)	90	89	87	92	91	**90**	*81*
Baudin(D)	88	83	80	97	91	**86**	*82*
Flinders(D)	98	93	94	101	97	**96**	*79*
La Trobe(D)	100	100	100	100	100	**100**	*82*
Scope CL(D)	90	85	86	98	94	**90**	*81*
Spartacus CL(D)	–	104	103	98	100	**101**	*63*
Stage 2 malt accreditation							
Banks(D)	–	–	100	105	101	**101**	*44*
RGT Planet(D)	–	–	–	114	104	**103**	*24*
Feed varieties							
Buff(D)	–	–	–	115	104	**98**	*18*
Fathom(D)	97	94	93	104	101	**97**	*82*
LG Maltstar(D)	99	89	90	102	95	**94**	*73*
Litmus(D)	92	83	94	102	96	**92**	*82*
Lockyer(D)	100	96	92	109	103	**99**	*76*
Mundah	87	84	88	–	90	**88**	*73*
Oxford	100	90	89	103	96	**94**	*77*
Rosalind(D)	–	108	109	110	107	**108**	*63*
La Trobe yield (t/ha)	**3.92**	**3.40**	**3.38**	**3.87**	**3.64**	**3.62**	***82***

The main problem with single site analyses are that they only represent varietal performance under one specific set of seasonal and site conditions. The main problem with MET results based on Agzones is that they average varietal performance and 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 2013 to 2017 assists with understanding the variability in relative varietal performance across seasons (Table 4). Until an alternate representation of environmental regions is available, Agzones is the simplest way to group trials across environments but may not accurately reflect your location in every season.

Table 5 is an alternative way of looking at longer term yield performance, by directly comparing the grain yield of two selected varieties when they have occurred side by side in barley NVT trials in WA. The yield of variety B is compared against variety A using the least significant difference for the site. Essentially Table 5 highlights the probability of one variety yielding less, the same or more than another variety when grown with the same agronomy.

Another way to look at the grain yield data is to plot the grain yield of one variety relative to the site mean as the site mean yield increases (Figures 3 to 7). The site mean yield is the average grain yield of the five or six barley varieties being compared. Figures 3 to 7 firstly assess the grain yield deviation of a variety relative to the site mean yield. Is the deviation quadratic or linear? If the quadratic regression is significant ($p<0.05$) a quadratic polynomial is fitted to the data. If the linear regression (but not the quadratic regression) is significant ($p<0.05$) a linear polynomial is fitted to the data. If neither the quadratic or linear regression is significant the grain yield response of a variety runs parallel to the site mean yield at the average deviation for that variety. A Student's t-test (paired, 2 sided) is then used to determine if the average yield of a variety is different to another variety in the comparison or is different to the site mean yield averaged across all sites. The data used for this analysis includes GRDC NVT barley

grain yield data and DPIRD-GRDC (DAW00190 and DAW00224) barley agronomy grain yield data. In some trials where La Trobe or Scope CL is absent, their data has been replaced with Hindmarsh or Buloke data respectively due to the closeness of their relationships with each other. **It is worth noting that depending on which datasets are included in the analysis (years and locations), the relative performance of varieties may change.** 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.

Being the most widely planted variety, with at least three years of commercial production in WA, La Trobe is the benchmark for varietal comparisons. When leaf diseases are controlled, the only varieties that consistently out yield La Trobe in WA are RGT Planet and Rosalind (Tables 4 and 5, Figures 3 to 7). Rosalind and RGT Planet have each out-yielded La Trobe in at least half of the NVT trials that they have been sown in together, and rarely are out-yielded by La Trobe. Over the last two seasons (2016-2017), this average fitted yield advantage over La Trobe was 0.22t/ha ($p<0.001$) for Rosalind, and 0.37t/ha ($p<0.001$) for RGT Planet (Figure 4). In those comparisons Rosalind and RGT Planet maintained their advantage regardless of the site's yield potential. The average fitted grain yield of Rosalind and RGT Planet, however, did not differ from each other across the 26 sites in 2016 and 2017 (Figure 4).

In comparison to other feed variety options, La Trobe has shown a similar grain yield to Compass and Lockyer in over half of trials for the period 2014-2017 (Table 5) and has out-yielded Oxford in almost half of trials. In the period 2014-2017, La Trobe has had a slightly higher fitted grain yield than Fathom across 61 sites, but a similar fitted yield when looking at just the last two seasons (2016-2017) (Figures 3 and 4). Across 111 NVT trials (2011-2017), Fathom achieved the same yield as La Trobe in three out of five trials (Table 5).

In comparisons with varieties accredited for malting, La Trobe generally produced the highest fitted grain yield (Figures 5, 6 and 7), although the yield advantage of La Trobe over Bass and Flinders decreased as yield potential increased over a nine-year period from 2009-2017 (Figure 5). Across 107 NVT (2011-2017), Bass was lower yielding in three out of five trials relative to La Trobe, whilst Flinders was lower yielding in one in three trials (Table 5). Spartacus CL had a comparable yield to La Trobe over the four-year period 2014-2017 (Figure 6), having the same yield in four out of every five trials across 60 NVT (Table 5).

Against the new varieties being considered by Barley Australia, the performance of Banks in 2016 and 2017 was slightly better than La Trobe over a range of yield potentials and superior to Bass and Flinders (Figure 7). In 42 NVT comparisons (2015-2017), Banks and La Trobe yielded the same in four of every five trials (Table 5), but Banks was higher yielding than Bass in nearly three out of every four trials and higher yielding than Flinders in one in every two trials (Table 5).

In those same comparisons (more sites than in Figure 4), RGT Planet had a comparable fitted yield below 4t/ha to Banks and La Trobe, but clearly showed a fitted yield advantage above 4t/ha. Over 34 NVT and agronomy trials in 2016-2017, RGT Planet had a similar yield to Banks and La Trobe in nearly 50% of trials and out-yielded Banks in one in three trials and La Trobe in two in five trials (Table 5).

When deciding on which barley variety to sow, grain yield results needs to be balanced with knowledge of the agronomy, disease resistance, grain quality, segregation opportunities and market demand. Commonly grown varieties differ from each other in their disease resistance, agronomy, genetics and phenology (Tables 6 to 11), clearly demonstrating that there are many ways in which grain yield can be achieved. These phenotypic differences may favour one variety over another variety in some seasons but not in other seasons, so to reiterate an earlier point it is important to look over seasons and across sites when assessing which variety to sow.

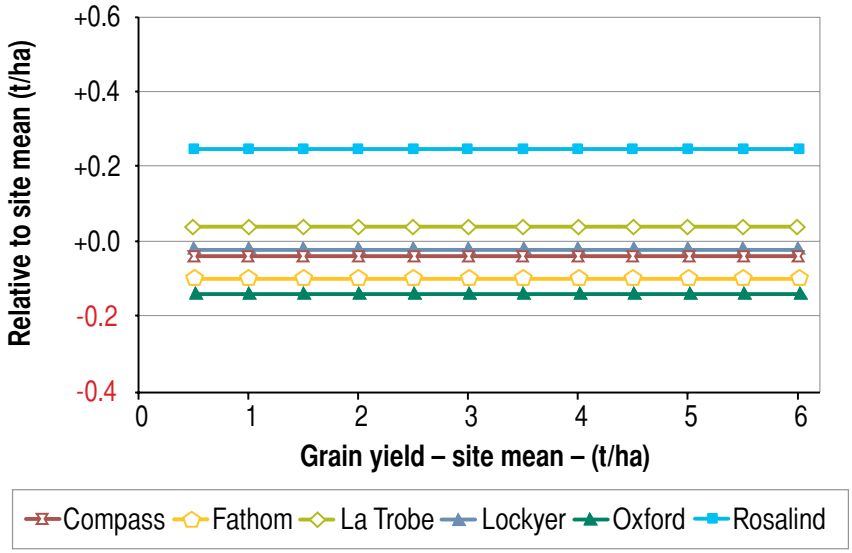

Figure 3 Fitted grain yield of Compass, La Trobe, Fathom, Lockyer, Oxford and Rosalind at different site mean yields (2014-2017) and the Student's t-test comparison between the average grain yield of each variety across sites and their average grain yield relative to the average site mean yield of all sites. Site mean is the average yield of all varieties at a site (source: data from 2014-2016 DPIRD-GRDC barley agronomy and 2014-2017 GRDC NVT trials. Each variety is sown in all 61 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties						Grain yield (t/ha)	Relative to site mean (t/ha)	t-test relative to site mean
	Compass	Fathom	La Trobe	Lockyer	Oxford	Rosalind			
Compass		n.s.	n.s.	n.s.	p<0.001	p<0.001	**3.48**	-0.04	n.s.
Fathom	n.s.		p<0.01	n.s.	p<0.001	p<0.001	**3.42**	-0.10	p<0.001
La Trobe	n.s.	p<0.01		n.s.	p<0.001	p<0.001	**3.56**	+0.04	n.s.
Lockyer	n.s.	n.s.	n.s.		p<0.001	p<0.001	**3.50**	-0.02	n.s.
Oxford	p<0.001	p<0.001	p<0.001	p<0.001		p<0.001	**3.03**	-0.49	p<0.01
Rosalind	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001		**3.77**	+0.25	p<0.001
Grain yield (t/ha)	**3.48**	**3.42**	**3.56**	**3.50**	**3.03**	**3.77**	**site mean (t/ha)**	**3.52**	

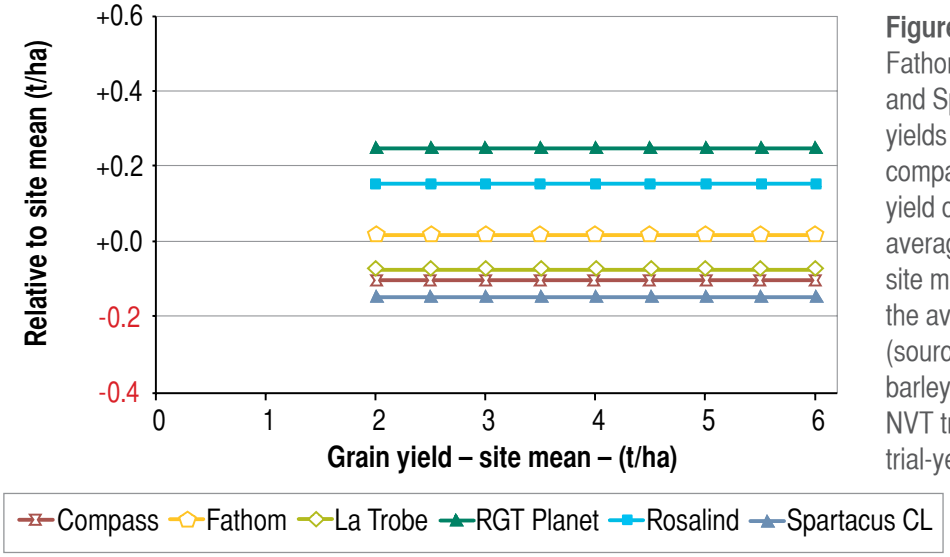

Figure 4 Fitted grain yield of Compass, Fathom, La Trobe, RGT Planet, Rosalind and Spartacus CL at different site mean yields (2016-2017) and the Student's t-test comparison between the average grain yield of each variety across sites and their average grain yield relative to the average site mean yield of all sites. Site mean is the average yield of all varieties at a site (source: data from 2016 DPIRD-GRDC barley agronomy and 2016-2017 GRDC NVT trials. Each variety is sown in all 26 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties						Grain yield (t/ha)	Relative to site mean (t/ha)	t-test relative to site mean
	Compass	Fathom	La Trobe	RGT Planet	Rosalind	Spartacus CL			
Compass		n.s.	n.s.	p<0.01	p<0.001	n.s.	**3.68**	-0.10	p<0.05
Fathom	n.s.		n.s.	p<0.05	p<0.05	p<0.05	**3.80**	+0.02	n.s.
La Trobe	n.s.	n.s.		p<0.01	p<0.001	n.s.	**3.71**	-0.07	p<0.05
RGT Planet	p<0.01	p<0.05	p<0.01		n.s.	p<0.001	**4.03**	+0.25	p<0.05
Rosalind	p<0.001	p<0.05	p<0.001	n.s.		p<0.001	**3.93**	+0.16	p<0.001
Spartacus CL	n.s.	p<0.05	n.s.	p<0.001	p<0.001		**3.63**	-0.15	p<0.01
Grain yield (t/ha)	**3.68**	**3.80**	**3.71**	**4.03**	**3.93**	**3.63**	**site mean (t/ha)**	**3.78**	

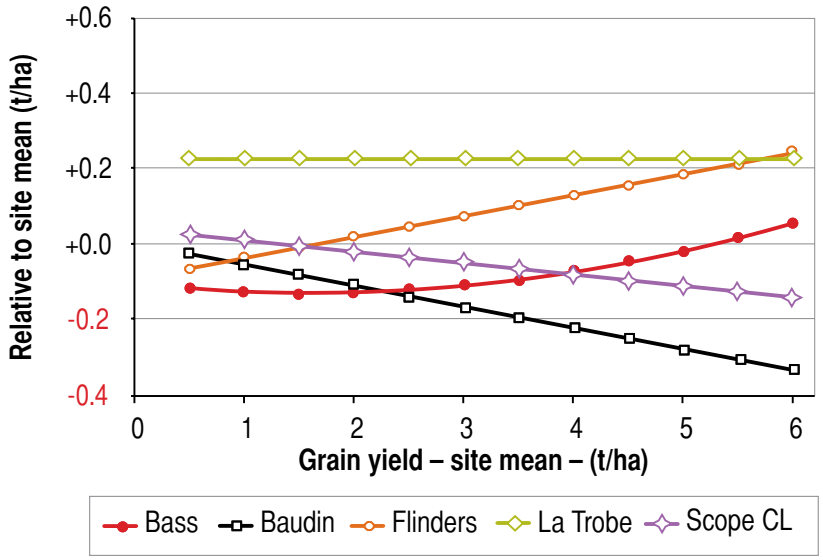

Figure 5 Fitted grain yield of Bass, Baudin, Flinders, La Trobe and Scope CL at different site mean yields (2009-2017) and the Student's t-test comparison between the average grain yield of each variety across sites and their average grain yield relative to the average site mean yield of all sites. Site mean is the average yield of all varieties at a site (source: data from 2009-2016 DPIRD-GRDC barley agronomy and 2010-2017 GRDC NVT trials. Each variety is sown in all 336 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Grain yield (t/ha)	Relative to site mean (t/ha)	t-test relative to site mean
	Bass	Baudin	Flinders	La Trobe	Scope CL			
Bass		p<0.001	p<0.001	p<0.001	n.s	**3.15**	-0.09	p<0.001
Baudin	p<0.001		p<0.001	p<0.001	p<0.001	**3.06**	-0.18	p<0.001
Flinders	p<0.001	p<0.001		p<0.001	p<0.001	**3.32**	+0.09	p<0.001
La Trobe	p<0.001	p<0.001	p<0.001		p<0.001	**3.46**	+0.23	p<0.001
Scope CL	n.s	p<0.001	p<0.001	p<0.001		**3.18**	-0.06	p<0.001
Grain yield (t/ha)	**3.15**	**3.06**	**3.32**	**3.46**	**3.18**	**site mean (t/ha)**	**3.23**	

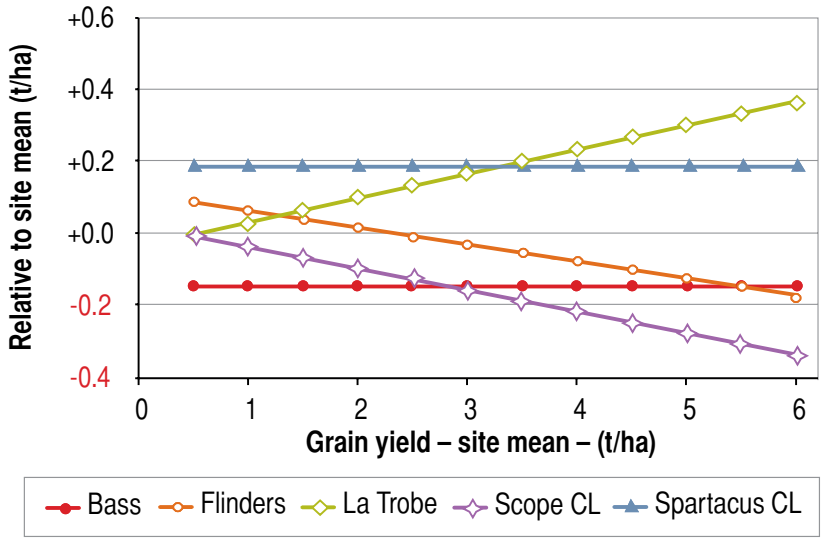

Figure 6 Fitted grain yield of Bass, Flinders, La Trobe, Scope CL and Spartacus CL at different site mean yields (2014-2017) and the Student's t-test comparison between the average grain yield of each variety across sites and their average grain yield relative to the average site mean yield of all sites. Site mean is the average yield of all varieties at a site (source: data from 2015-2016 DPIRD-GRDC barley agronomy and 2014-2017 GRDC NVT trials. Each variety is sown in all 88 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Grain yield (t/ha)	Relative to site mean (t/ha)	t-test relative to site mean
	Bass	Flinders	La Trobe	Scope CL	Spartacus CL			
Bass		p<0.05	p<0.001	n.s.	p<0.001	**3.47**	-0.15	p<0.001
Flinders	p<0.05		p<0.001	p<0.01	p<0.001	**3.56**	-0.06	p<0.05
La Trobe	p<0.001	p<0.001		p<0.001	n.s.	**3.83**	+0.21	p<0.001
Scope CL	n.s.	p<0.01	p<0.001		p<0.001	**3.42**	-0.19	p<0.001
Spartacus CL	p<0.001	p<0.001	n.s.	p<0.001		**3.80**	+0.19	p<0.001
Grain yield (t/ha)	**3.47**	**3.56**	**3.83**	**3.42**	**3.80**	**site mean (t/ha)**	**3.62**	

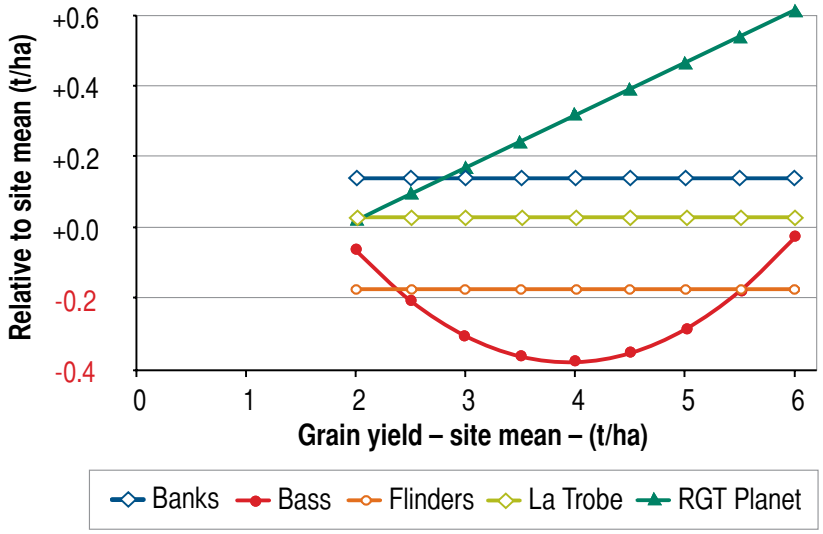

Figure 7 Fitted grain yield of Banks, Bass, Flinders, La Trobe and RGT Planet at different site mean yields (2016-2017) and the Student's t-test comparison between the average grain yield of each variety across sites and their average grain yield relative to the average site mean yield of all sites. Site mean is the average yield of all varieties at a site (source: data from 2016-2017 DPIRD-GRDC barley agronomy and GRDC NVT trials. Each variety is sown in all 44 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Grain yield (t/ha)	Relative to site mean (t/ha)	t-test relative to site mean
	Banks	Bass	Flinders	La Trobe	RGT Planet			
Banks		p<0.001	p<0.001	p<0.05	p<0.05	**4.01**	+0.17	p<0.001
Bass	p<0.001		p<0.05	p<0.001	p<0.001	**3.55**	-0.30	p<0.001
Flinders	p<0.001	p<0.05		p<0.01	p<0.001	**3.67**	-0.17	p<0.001
La Trobe	p<0.05	p<0.001	p<0.01		p<0.001	**3.88**	+0.03	n.s.
RGT Planet	p<0.05	p<0.001	p<0.001	p<0.001		**4.14**	+0.30	p<0.001
Grain yield (t/ha)	**4.01**	**3.55**	**3.67**	**3.88**	**4.14**	**site mean (t/ha)**	**3.85**	

Table 5 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) when sown together in WA barley NVT? (source: NVT Online nvtonline.com.au)

		Per cent of trials					
Variety A	**Variety B**	**Variety A is lower yielding than Variety B**	**Variety A and B yield the same**	**Variety A is higher yielding than Variety B**	**Comparison Years**	**Number of trials**	**Comparison**
Comparisons with La Trobe							
Banks[Ⓑ]	La Trobe[Ⓑ]	7%	81%	12%	2015-2017	42	Banks = La Trobe
Bass[Ⓑ]	La Trobe[Ⓑ]	56%	44%	0%	2011-2017	110	Bass ≤ La Trobe
Baudin[Ⓑ]	La Trobe[Ⓑ]	61%	35%	4%	2011-2017	105	Baudin ≤ La Trobe
Buff[Ⓑ]	La Trobe[Ⓑ]	0%	59%	41%	2016-2017	17	Buff ≥ La Trobe
Compass[Ⓑ]	La Trobe[Ⓑ]	17%	66%	17%	2012-2017	94	Compass = La Trobe
Fathom[Ⓑ]	La Trobe[Ⓑ]	29%	60%	11%	2011-2017	111	Fathom = La Trobe
Flinders[Ⓑ]	La Trobe[Ⓑ]	33%	56%	11%	2011-2017	107	Flinders ≤ La Trobe
Granger[Ⓑ]	La Trobe[Ⓑ]	34%	56%	10%	2011-2017	107	Granger ≤ La Trobe
LG Maltstar[Ⓑ]	La Trobe[Ⓑ]	43%	46%	11%	2011-2017	100	LG Maltstar ≤ La Trobe
Litmus[Ⓑ]	La Trobe[Ⓑ]	43%	40%	16%	2011-2017	92	Litmus ≤ La Trobe
Lockyer[Ⓑ]	La Trobe[Ⓑ]	26%	58%	16%	2011-2017	98	Lockyer = La Trobe
Mundah	La Trobe[Ⓑ]	66%	31%	3%	2011-2017	102	Mundah < La Trobe
Oxford	La Trobe[Ⓑ]	48%	41%	11%	2011-2017	95	Oxford ≤ La Trobe
RGT Planet[Ⓑ]	La Trobe[Ⓑ]	4%	43%	52%	2016-2017	23	RGT Planet ≥ La Trobe
Rosalind[Ⓑ]	La Trobe[Ⓑ]	3%	47%	50%	2014-2017	60	Rosalind ≥ La Trobe
Scope CL[Ⓑ]	La Trobe[Ⓑ]	55%	43%	3%	2011-2017	110	Scope CL ≤ La Trobe
Spartacus CL[Ⓑ]	La Trobe[Ⓑ]	7%	78%	15%	2014-2017	60	Spartacus CL = La Trobe

Table 5 (continued) 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) when sown together in WA barley NVT? (source: NVT Online nvtonline.com.au)

		Per cent of trials					
Variety A	Variety B	Variety A is lower yielding than Variety B	Variety A and B yield the same	Variety A is higher yielding than Variety B	Comparison Years	Number of trials	Comparison
Comparisons with Bass							
Banks(Ф)	Bass(Ф)	0%	29%	71%	2015-2017	41	Banks > Bass
Baudin(Ф)	Bass(Ф)	25%	60%	15%	2011-2017	104	Baudin = Bass
Flinders(Ф)	Bass(Ф)	3%	56%	42%	2011-2017	106	Flinders ≥ Bass
Granger(Ф)	Bass(Ф)	5%	50%	45%	2011-2017	106	Granger ≥ Bass
LG Maltstar(Ф)	Bass(Ф)	9%	54%	37%	2011-2017	99	LG Maltstar ≥ Bass
RGT Planet(Ф)	Bass(Ф)	0%	32%	68%	2016-2017	22	RGT Planet > Bass
Rosalind(Ф)	Bass(Ф)	2%	24%	75%	2014-2017	59	Rosalind > Bass
Spartacus CL(Ф)	Bass(Ф)	2%	44%	54%	2014-2017	59	Spartacus CL ≥ Bass
Comparisons with Flinders							
Banks(Ф)	Flinders(Ф)	5%	49%	46%	2015-2017	39	Banks ≥ Flinders
Baudin(Ф)	Flinders(Ф)	50%	42%	8%	2011-2017	101	Baudin ≤ Flinders
Granger(Ф)	Flinders(Ф)	14%	70%	15%	2011-2017	105	Granger = Flinders
LG Maltstar(Ф)	Flinders(Ф)	27%	59%	14%	2011-2017	97	LG Maltstar = Flinders
RGT Planet(Ф)	Flinders(Ф)	5%	30%	65%	2016-2017	20	RGT Planet > Flinders
Rosalind(Ф)	Flinders(Ф)	4%	28%	68%	2014-2017	57	Rosalind > Flinders
Spartacus CL(Ф)	Flinders(Ф)	7%	54%	39%	2014-2017	57	Spartacus CL ≥ Flinders
Comparisons with RGT Planet							
Banks(Ф)	RGT Planet(Ф)	48%	48%	4%	2016-2017	23	Banks ≤ RGT Planet
Compass(Ф)	RGT Planet(Ф)	48%	43%	9%	2016-2017	23	Compass ≤ RGT Planet
Fathom(Ф)	RGT Planet(Ф)	43%	43%	13%	2016-2017	23	Fathom ≤ RGT Planet
LG Maltstar(Ф)	RGT Planet(Ф)	57%	30%	13%	2016-2017	23	LG Maltstar ≤ RGT Planet
Lockyer(Ф)	RGT Planet(Ф)	38%	57%	5%	2016-2017	21	Lockyer ≤ RGT Planet
Oxford	RGT Planet(Ф)	50%	50%	0%	2016-2017	18	Oxford ≤ RGT Planet
Rosalind(Ф)	RGT Planet(Ф)	26%	48%	26%	2016-2017	23	Rosalind = RGT Planet
Spartacus CL(Ф)	RGT Planet(Ф)	48%	48%	4%	2016-2017	23	Spartacus CL ≤ RGT Planet
Comparisons with Spartacus CL							
Banks(Ф)	Spartacus CL(Ф)	14%	71%	14%	2015-2017	42	Banks = Spartacus CL
Compass(Ф)	Spartacus CL(Ф)	17%	72%	12%	2014-2017	60	Compass = Spartacus CL
Fathom(Ф)	Spartacus CL(Ф)	32%	53%	15%	2014-2017	60	Fathom ≤ Spartacus CL
RGT Planet(Ф)	Spartacus CL(Ф)	4%	48%	48%	2016-2017	23	RGT Planet ≥ Spartacus CL
Rosalind(Ф)	Spartacus CL(Ф)	5%	50%	45%	2014-2017	60	Rosalind ≥ Spartacus CL
Scope CL(Ф)	Spartacus CL(Ф)	61%	34%	5%	2014-2017	59	Scope CL ≤ Spartacus CL

Disease resistance

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Foliar disease abbreviations:

- NTNB = net-type net blotch.
- STNB = spot-type net blotch.
- APR = adult plant resistance.

Disease resistance abbreviations:

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

Fungicide abbreviations:

- DMI = demethylation inhibitor.
- SDHI = succinate dehydrogenase.

Seedling and adult resistance

Disease, virus and nematode resistance data is presented in Tables 6 to 8. Leaf disease ratings in this guide include both seedling and adult stage resistance ratings for the foliar leaf diseases NTNB, STNB, powdery mildew and barley leaf rust. There is no seedling data for scald so only the adult stage resistance is tabulated. As there is no adult data yet available for Oxford virulent NTNB, only the seedling data is presented. Whilst the seedling data for Oxford virulent NTNB is useful, it is best when considered in combination with the adult ratings (under development), so caution is suggested until the adult ratings become available.

Seedling ratings are applicable at early growth stages (two to three leaf stage) and are important for making decisions on use of seed or fertiliser applied fungicide treatments and to know the likely response of a variety if there is early disease pressure. Seedling ratings are also important when assigning varieties to paddocks. 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. Variation between the seedling and adult rating of a variety is most likely due to the presence or absence of resistance genes.

The ratings of varieties may vary over time. Seasonal changes occur with time mainly due to differences in disease pressure, 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 number of the varieties listed since the last sowing guide, usually up or down one resistance score, but there have been no major changes in resistance score as the result of a new pathotype.

Disease surveillance

Growers and consultants observing barley varieties rated as MRMS, MR or R to scald, NTNB, STNB, powdery mildew or barley leaf rust carrying significantly greater levels of disease than expected should collect infected material for pathotype identification. Samples should be collected before spraying the crop with fungicide to ensure sample viability.

Infected scald, NTNB, STNB and barley leaf rust leaf material must be sent in paper envelopes marked with 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 necessary for powdery mildew infected individual leaves to be placed into agar tubing to maintain a live culture for pathotyping. This means sample collection kits for powdery mildew need to be arranged before sampling and therefore before spraying can be done.

Scald, NTNB and STNB infected leaf material (sent in paper envelopes) should be sent to the Department of Primary Industries and Regional Development, 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.

Samples of powdery mildew infected leaf material (placed into agar tubing) should be forwarded to the Centre for Crop and Disease Management, 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.

Barley leaf rust samples should be sent 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 powdery mildew have been detected in Western Australia. In situations of concern over disease response to fungicide control in barley crops, samples from any disease can be sent to the Centre for Crop and Disease Management (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.

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 will increase the prevalence of scald, especially with early sowing opportunities. A severe early infection can reduce head number and grain number. Yield losses of up to 45% are possible with associated quality defects. Scald can survive between seasons on infested stubble and barley grass and be carried through infected seed.

The varieties with the highest scald risk are Banks, LG Maltstar, Litmus 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% and impact on the quality of the grain produced.

The CCDM has reported that it had 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 current 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 has become evident, particularly in the Albany and Esperance port zones. This pathotype, known as the Oxford virulent pathotype, is virulent on seedlings of most varieties except Banks, Granger and LG Maltstar. This pathotype is now relatively common on the south coast and therefore seedlings of most varieties may be at an increased risk when sown onto NTNB infected barley stubble. There are currently no resistance ratings for adult plants against the Oxford virulent pathotype, but research is underway to determine if varietal variability exists.

Baudin and Fathom are susceptible to all three major NTNB pathotypes present in WA as seedlings, whilst Baudin and Litmus are susceptible as adults to NTNB. It is worth noting that RGT Planet is very sensitive to the Beecher virulent pathotype as an adult. The other varieties grown in WA can differ in their response to NTNB depending on which isolate is present in the paddock. The key message is that there are different pathotypes of NTNB present in WA. As a consequence, varietal response will vary accordingly. If the Oxford virulent pathotype moves further north and becomes the dominant pathotype, then fungicide and rotation will become key tools in reducing the annual risk of NTNB due the lack of seedling resistance in commercially grown varieties. Adult resistance status is unknown at this stage but several varieties may also show increased susceptibility.

Spot-type net blotch

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

The CCDM has reported the discovery of a STNB DMI resistant population in the South Stirlings region. 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 current resistance issues in the South Stirling area and reduce future development regionally, will increasingly require the use of fungicide mixtures and alternation of products including effective DMI ingredients and alternate modes of action including strobilurins (for example azoxystrobin and pyraclostrobin) and SDHI (for 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 (MR as a seedling and MRMS as an adult) has the best combined seedling and adult resistance to STNB of the current varieties. Baudin has some tolerance to STNB, rated as MRMS as a seedling and MSS as an adult.

Some varieties susceptible at the adult plant stage have some tolerance at the seedling stage (i.e. Bass has intermediate resistance at the seedling stage but is susceptible at the adult stage). This reduces the likelihood of severe early infection but STNB can still infect varieties at the adult stage. Under high disease pressure, such as being sown onto barley stubble, these varieties may still exhibit significant levels of seedling disease.

Powdery mildew

Powdery mildew 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%, whereas yield losses at the end of stem elongation reduce yield by around 10%.

The variety with the highest risk of powdery mildew is Baudin, although Oxford may now be susceptible in the lower great southern in the presence of the *MI(St)* virulent pathotype.

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

tebuconazole, triadimefon, flutriafol) in controlling powdery mildew at label rates. Higher value DMI fungicides and alternative modes of action, such as strobilurins (for example azoxystrobin and pyraclostrobin), SDHI (for example, fluxapyroxad) and amines (spiroxamine) have uncompromised activity against powdery mildew.

Varieties grown in WA with intermediate resistance or above (MRMS, MR and R) to powdery mildew can be categorised into nine broad groups based on the postulated or known effective genes that control their resistance to powdery mildew. Only those varieties carrying the *mlo* gene like Granger, LG Maltstar and RGT Planet have durable resistance to powdery mildew. The rest of the widely grown varieties in WA are vulnerable to mutations of the powdery mildew fungus, but 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 more widespread. Testing by the CCDM for powdery mildew virulence on Oxford, suggests that the *Ml(St)* gene in Oxford may be compromised, rendering a susceptible reaction in the presence of this mutation. Further research is in progress to determine the extent of this new pathotype, but it is believed to be restricted to the south coast at the present time.

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

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

Virulence to the *MlLa* gene has been detected in barley growing in northern NSW and Queensland resulting in varieties such as Compass, Hindmarsh and La Trobe being more susceptible to mildew than in previous years. Field screening of varieties with different genes, however, has not yet found any significant regional variation in the field resistance of varieties to powdery mildew in WA, except for Oxford.

Barley leaf rust

Barley leaf rust appears as small, circular to oval pustules with light brown powdery spores on 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. Barley leaf rust can reduce grain yield by over 30% in severe infections.

Since the detection of new barley leaf rust pathotypes in WA with virulence for the major resistance gene *Rph3* (5457 P- in 2013, 5457 P+ in 2014 and 5656 P+ in 2016), none of the barley varieties grown in WA have total resistance to barley leaf rust. Only varieties that carry an APR gene or genes have some resistance when those pathotypes are present. APR genes usually provide moderate levels of resistance and are not pathotype specific so should not be impacted by any future pathotype changes. APR resistance only develops fully at the adult plant stage (generally after flag leaf emergence), so there may still be a need to protect those varieties at early growth stages from early infection. The effectiveness of the *Rph20* gene is also influenced by temperature and varietal background. Even though Flinders, Granger, LG Maltstar, Oxford and RGT Planet 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 only protects it late in the season, so it is still vulnerable to rust infection prior to heading.

Pathotype 5457 P- is now the dominant barley leaf rust pathotype across WA. The new pathotype 5656 P+ migrated from eastern Australia, where it was first detected 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 usually not noticed until after heading when white heads are visible. Symptoms can include white heads

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, white heads 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 have 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 good grass weed control in break crops and between crops. Varietal resistance and tolerance to crown rot is limited. Recent research in WA suggests that varietal differences in barley do exist but most barley varieties are susceptible and suffer yield loss to crown rot. Litmus has the lowest yield loss of the varieties tested in the presence of high crown rot.

Barley and cereal yellow dwarf

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

Varietal resistance reduces the impact of the virus on plant growth but does not reduce the impact of aphid feeding on plant growth. Varietal resistance to BYD and CYD therefore does not reduce the need to spray for aphids to prevent yield loss from feeding damage once they reach threshold levels in the crop (50% of tillers with 15 or more aphids).

Russian wheat aphid

Russian wheat aphid (*Diuraphis noxia*) (RWA) is a major pest of over 140 grasses worldwide. Wheat and barley are the most susceptible cereals, whilst triticale, rye and oats are less susceptible. In May 2016 RWA was detected in South Australia for the first time. Subsequent surveillance has found the species across much of the eastern half of South Australia and western and central Victoria. As of September 2018, RWA had not been detected in Western Australia but it is highly likely that RWA will arrive here at some time in the future. Around the world, the distribution of RWA is primarily associated with cereal production regions characterised by warmer, drier climates. It is generally less prevalent or non-existent in higher rainfall areas.

Unlike other cereal aphids that damage plants by removing nutrients, RWA also injects salivary toxins during feeding. These toxins can retard crop growth resulting in reduced grain yield and can even kill the plant with heavy infestations. Economic damage is mainly caused by direct feeding. Affected plants often show white, yellow and red leaf markings and rolling leaves. The aphid is spread easily by the wind and on live plant material. There is no varietal resistance to RWA in commercial barley varieties currently grown in Australia.

Chemical control is the main cultural means of reducing damage from RWA until varieties with resistance are developed. An APVMA permit (PER81133) has been issued for the use of products containing 500g/L chlorpyrifos applied at 1.2L/ha with an LI700 surfactant applied at 240ml/ha; and products containing 500g/kg pirimicarb applied at 200-250g/ha to control RWA in cereals. High water volume (100-120L/ha) at seven bar pressure is advised to maximise coverage. It is important everyone adopts best-practice farm hygiene procedures to retard the spread of the pest between paddocks and adjacent properties. This includes keeping machinery out of affected areas and minimising movement in adjacent areas.

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

Root lesion nematode

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

Cereal yield losses due to RLN are seasonally dependant and are in the order of 5-30% but can be higher. RLN species *Pratylenchus neglectus* and *P. quasitereoides* can cause losses of up to 18% 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 (Table 8).

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* (3 trials) and 2015 for *P. neglectus* (3 trials). Provisional ratings are given to varieties with fewer than three observations, or where there has been no field trial verification of the glasshouse rating.

Cereal cyst nematode

Cereal cyst nematode (*Heterodea avenae*) (CCN) is present in cropping regions around Geraldton and in 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 infection does occur. The planting of CCN resistant varieties retards nematode development, leading to lower nematode levels in the soil for subsequent crops.

Table 6 Seedling (two to three leaf stage) leaf disease resistance profiles when grown in WA - 2018. Bold font indicates resistance levels are intermediate or above. (source: Sanjiv Gupta and NVT Online nvtonline.com.au)

Disease[1]	Scald	Net-type net blotch[4]	Net-type net blotch[4]	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
Malt varieties							
Bass(ϕ)	–	**MR**	S	VS	**MRMS**	MSS	SVS
Baudin(ϕ)	–	S	S	VS	**MRMS**	VS	SVS
Flinders(ϕ)	–	**MRMS**	MSS	SVS	MS	**R**	MS
La Trobe(ϕ)	–	MS	**MRMS**	S	S	MSS	MS
Scope CL(ϕ)	–	**MR**	**MR**	S	MS	**R**	S
Spartacus CL(ϕ)	–	MS	MSS	S	SVS	MS	MS
Stage 2 malt accreditation							
Banks(ϕ)	–	**MRMS**	**MRMS**	**MRMS**	MS	**MRMS**	S
RGT Planet(ϕ)	–	**MRMS**	**MRMS**	S	MSS	**R**	S
Feed varieties							
Buff(ϕ)	–	**MRMS**	**MRMS**	MS	MS	S	SVS
Fathom(ϕ)	–	S	S	VS	**MR**	MS	S
LG Maltstar(ϕ)	–	**MR**	**MR**	MS	MS	**R**	S
Litmus(ϕ)	–	MSS	S	S	S	MS	S
Lockyer(ϕ)	–	**MR**	**MR**	S	S	MS	S
Mundah	–	S	MS	S	MSS	SVS	S
Oxford	–	**RMR**	**MR**	S	S	**R***	S
Rosalind(ϕ)	–	**MR**	**MR**	S	MS	MS	**MRMS**

[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 three leaf stage (use data cautiously after four leaf stage). The adult resistance score reflects resistance after flag leaf emergence. Varieties with a VS or S rating at the seedling stage are at a greater risk of early infection. Appropriate cultural (i.e. rotation) and/or chemical (i.e. fungicide) disease management strategies should be considered to minimise the risk when planting those varieties.

[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 particularly north of Great Eastern Highway, while in the Southern regions of WA a new pathotype (Oxford) is present. The Oxford virulent pathotype was identified from Oxford barley and its increased virulence is affecting reactions of many varieties at the seedling stage (compared to other pathotypes). Adult resistance scores are not yet available for the Oxford virulent pathotype.

[5]Powdery mildew: varieties with a VS or S rating at the seedling stage (Baudin and Mundah) should be treated with a seed dressing active against powdery mildew to prevent early infection during the tillering stage. *Virulence against the *Ml*(*St*) mildew gene present in Oxford has been detected in the Stirlings to Coast area. This means that Oxford may show a susceptible reaction where this virulence exists. Growers should closely monitor Oxford crops for powdery mildew. Where detected, infected leaf samples should be collected and sent to CCDM before spraying the crop with a fungicide.

Table 7 Adult (after flag leaf emergence) leaf disease resistance profiles when grown in WA - 2018. Bold font indicates resistance levels are intermediate or above. (source: Sanjiv Gupta and NVT Online nvtonline.com.au)

Disease[1]	Scald	Net-type net blotch[4]	Net-type net blotch[4]	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
Malt varieties							
Bass(Ф)	**MRMS**	**MRMS**	MSS	–	S	MSS	SVS
Baudin(Ф)	MSS	S	S	–	MSS	VS	SVS
Flinders(Ф)	MSS	**MRMS**	MS	–	S	**R**	**MRMS** (late APR)
La Trobe(Ф)	**MR**	MS	**MRMS**	–	SVS	MS	S
Scope CL(Ф)	MS	**MRMS**	**MRMS**	–	S	**R**	S
Spartacus CL(Ф)	**MR**	**MRMS**	**MRMS**	–	SVS	**MR**	S
Stage 2 malt accreditation							
Banks(Ф)	S	MS	MS	–	S	**MR**	S
RGT Planet(Ф)	**MRMS*p***	SVS*p*	**MRMS**	–	S	**R**	**MRMS** (late APR)
Feed varieties							
Buff(Ф)	MS	**MRMS*p***	**MRMS**	–	S	S	S
Fathom(Ф)	**MR**	MSS	MSS	–	**MRMS**	**MRMS**	**MRMS** (late APR)
LG Maltstar(Ф)	S	**MRMS*p***	**MR**	–	S	**R**	MSS (late APR)
Litmus(Ф)	SVS	S	S	–	S	**MR**	S
Lockyer(Ф)	**MRMS**	MS	**MRMS**	–	S	MS	S
Mundah	S	S	MS	–	S	MSS	S
Oxford	MS	**MRMS**	**MR**	–	S	**MR***	**MR** (APR)
Rosalind(Ф)	MSS	MS	**MR**	–	S	**MRMS**	**MR**

[1]Resistance rating: VS = very susceptible, S = susceptible, MS = moderately susceptible, MRMS = intermediate, MR = moderately resistant, R = resistant, *p* = provisional rating, - = no data availab le.

[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. Varieties with a VS or S rating at the seedling stage are at a greater risk of early infection. Appropriate cultural (i.e. rotation) and/or chemical (i.e. fungicide) disease management strategies should be considered to minimise the risk when planting those varieties.

[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 particularly north of Great Eastern Highway, while in the Southern regions of WA a new pathotype (Oxford) is present. The Oxford virulent pathotype was identified from Oxford barley and its increased virulence is affecting reactions of many varieties at the seedling stage (compared to other pathotypes). Adult resistance scores are not yet available for the Oxford virulent pathotype.

[5]Powdery mildew: varieties with a VS or S rating at the seedling stage (Baudin and Mundah) should be treated with a seed dressing active against powdery mildew to prevent early infection during the tillering stage. *Virulence against the *Ml*(*St*) mildew gene present in Oxford has been detected in the Stirlings to Coast area. This means that Oxford may show a susceptible reaction where that virulence exists. Growers should closely monitor Oxford crops for powdery mildew. Where detected, infected leaf samples should be collected and sent to CCDM before spraying the crop with a fungicide.

Table 8 Adult (after flag leaf emergence) leaf disease resistance profiles when grown in WA - 2018. Bold font indicates resistance levels are intermediate or above. (source: Sanjiv Gupta and NVT Online nvtonline.com.au)

Disease[1]	Crown rot yield loss	Barley and cereal yellow dwarf[3]	Root lesion nematode[4]	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	Seedling & Adult
Malt varieties					
Bass(D)	High	MS	MSS	MS	S
Baudin(D)	Moderate	**MRMS**	MSS	S	S
Flinders(D)	High	**MRMS**	MS*p*	MSS	S
La Trobe(D)	Moderate	S	MS	MSS	**R**
Scope CL(D)	High	**MRMS**	MSS	MS	S
Spartacus CL(D)	Moderate	MSS	–	–	**R**
Stage 2 malt accreditation					
Banks(D)	–	MS	–	–	–
RGT Planet(D)	–	MS	–	–	**R***p*
Feed varieties					
Buff(D)	–	**MRMS**	–	–	–
Fathom(D)	Moderate	**MRMS**	MS*p*	MSS*p*	**R**
LG Maltstar(D)	–	**MS**	–	–	–
Litmus(D)	Low	S	–	–	MS
Lockyer(D)	–	MS	–	–	–
Mundah	Moderate	MS	–	**MRMS***p*	S
Oxford	–	**MRMS**	–	–	S
Rosalind(D)	Moderate	MSS	–	–	**R**

[1]Crown rot yield loss: Low = <10% yield loss, Moderate = 10-20% yield loss, High = >20% yield loss, - = no data available. Nematode and virus resistance rating: VS = very susceptible, S = susceptible, MS = moderately susceptible, MRMS = intermediate, MR = moderately resistant, R = resistant, *p* = provisional rating, - = no data available.

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

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

[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.

Agronomic attributes

Blakely Paynter and Ben Biddulph DPIRD

Table 9 describes agronomic characteristics (e.g. coleoptile length, frost ranking based on floret sterility, straw strength and plant height). Table 10 provides visual guides as to how one might use plant traits to separate varieties. Table 11 covers information about who bred the variety, who to see about buying seed, how much you will pay when you deliver the grain (end point royalties) and what the pedigree of the variety is (if publicly released). Figures 8 to 16 provide direct comparisons between a number of varieties for hectolitre weight, screenings and grain brightness.

Frost risk

Frost risk based on frost induced sterility (FIS) has been included and is an interpretation of the National Frost Initiative (NFI) frost graphs which can be found at nvtonline.com.au/frost. According to the NFI, frost values (FV) have been developed for wheat and barley varieties to rank their relative susceptibility to reproductive frost. This information can be used to manage frost risk and fine tune variety selection after first selecting for local adaptation, grain yield, flowering time, and other key target traits.

The relative ranking of frost susceptibility has been expressed as a FV for each variety in each environment. FV's are presented as positive or negative differences relative to the average floret sterility of all varieties in the current data-set for a given year and site. When comparing varieties, it is the difference between FV's that is critical, with lower values indicating less frost induced sterility. When using FV's for selection decisions it is recommended that growers and advisors consider not just a single environment/year, but several relevant environments. This allows examination of the stability of a variety over a range of environments which are prone to frost. FV's are displayed graphically for the chosen varieties at nvtonline.com.au/frost. As these graphs are difficult to present in this sowing guide the graphs have been interpreted to provide a rating as either:

- lower risk (less floret sterility under frost),
- normal (standard floret sterility under frost), and
- higher risk (more floret sterility under frost).

FV's are based on varietal variation in the ability to maintain grain number under minor reproductive frosts. Under reproductive/floret or head frosts this is the main component of yield affected when yield is a function of grain size and grain number. This may not be the case however if there is variation in the length of season and the ability of varieties to compensate due to late tillers, synchronisation of flowering time and plasticity of grain number. Further research is ongoing within the GRDC NFI to validate the yield relationship with floret sterility (DAW00234) and also compensation ability (UA00162).

Growers and consultants are advised to use the rankings in Table 9 as a guide but should consult the graphs available at nvtonline.com.au/frost to compare the sensitivity levels of varieties over different seasons relative to one another.

Varietal appearance and purity

It can be very difficult to distinguish between varieties once they are sown in the paddock. Table 10 attempts to provide some visual guides as to how one might use plant traits to separate varieties or to identify contaminated seed. Some of the questions you might ask include:

- What did the crop look like at 8-10 weeks after seeding (prostrate or erect)?
- Does it have red auricles at the base of the leaf blade where it wraps around the stem?
- Does the head have red awns?
- How long are the awns?
- Is the head near maturity fanned (tapered) or straight (parallel) in shape?
- When you look at the furrow at the germ end of the grain through a magnifying glass, what length is the rachilla (white, rod-shaped organ) and how long are the hairs on the rachilla?

For more advice on what differences to look for consult DAFWA Bulletin 4765 "Maintaining variety purity in the WA malting barley industry" by Jeff Russell and Blakely Paynter. If visual cues are not enough then the grain will need to be tested at an accredited laboratory for varietal purity. The most common method used to determine varietal purity is based on mass spectrometry analysis of protein profiles in grains, but newer methods such as deoxyribonucleic acid (DNA) microsatellites and diversified array technology (DArT) are also available and being used.

DDLS Seed Testing and Certification (agric.wa.gov.au/n/1766) offers a mass spectrometry test that compares the protein profile of a combined sample of 30 seeds or of 30, 100 or 150 individual seeds. Higher levels of accuracy can be obtained by analysing individual seeds and then more seeds, but the price also increases as more seeds are done. The mass spectrometry tests range from $139 to $712. They also offer a DNA microsatellite test for $306 and a Scope CL barley DNA test (yes/no) for $111. For more information or access to forms, contact DDLS Seed Testing & Certification on +61 (0)8 9368 3721 or email: DDLS-STAC@dpird.wa.gov.au.

Grain quality

As with the grain yield data, the physical grain quality (hectolitre weight, screenings through a 2.5mm slotted sieve and grain brightness) of each variety is plotted relative to the site mean as the site mean grain quality increases (Figures 8 to 16). The site mean quality is the average grain quality of the five or six barley varieties being compared. A Student's t-test (paired, 2 sided) is then used to determine if the average grain quality of a variety is different to another variety in the comparison or is different to the site mean grain quality averaged across all sites. Figures 8 to 10 compare the hectolitre weight of varieties accredited for malting or in Stage 2 of malt accreditation, Figures 11 to 13 present grain plumpness (per cent through a 2.5mm sieve) and Figures 14 to 16 present grain brightness comparisons.

In these tables the p values mean:
n.s – varieties re not significantly different
$p<0.05$ – 95% confident that variety means are different
$p<0.001$ – 99.9% confident that variety means are different.

The data used for this analysis includes GRDC NVT barley grain quality data and DPIRD-GRDC (DAW00190 and DAW00224) barley agronomy grain quality data. Due the similarity of their responses, where La Trobe or Scope CL quality data is missing at a site it has been replaced with Hindmarsh or Buloke quality data respectively.

Flinders and La Trobe are the benchmark varieties for hectolitre weight of the current malt varieties segregated in WA (Figure 8). The hectolitre weight of Spartacus CL is equivalent to Flinders and La Trobe and better than Scope CL (Figure 9). The hectolitre weight of Banks is similar to Flinders and La Trobe. The hectolitre weight of RGT Planet appears to be significantly lower (around 2-3kg/hL) than current commercially grown malt varieties sown in WA (Figure 10).

The benchmark malt variety for grain plumpness is Bass (Figure 11 to 13), showing lower screenings (per cent through a 2.5mm sieve). Conversely, Baudin exhibits the highest risk of exceeding screenings limits, particularly in a tight finish. Flinders, La Trobe, Scope CL and Spartacus CL have a grain plumpness which is better than Baudin, but not as good as Bass (when screenings in Bass are 30% or less). Flinders is generally less plump than Bass, but slightly plumper than La Trobe (up to 20% screenings). Scope CL is generally not as plump as La Trobe, whilst Spartacus CL is generally plumper than both La Trobe and Scope CL (Figure 12). It appears that the grain plumpness of the new variety Banks is similar that of La Trobe, but not as good as Bass or Flinders (Figure 13). RGT Planet appears to be behave more like Baudin than Bass, Flinders or La Trobe for its grain plumpness risk. Relative differences at very high or very low screenings levels will not necessarily reflect differences when screenings are near to Malt1 receival limits.

At grain brightness levels between 54 and 62 'L*', the benchmark malt variety is Baudin (Figure 14). Within this range the grain brightness of Bass and Flinders is similar to or slightly darker than Baudin. La Trobe is about 0.6 to 0.7'L*' darker and Scope CL 0.7 to 0.9'L*' darker. The grain brightness of Spartacus CL is an improvement over both La Trobe and Scope CL (Figure 15). The grain brightness of the new variety Banks appears to be similar to that of Flinders, whilst RGT Planet appears to have a grain brightness between Flinders and La Trobe (Figure 16).

Table 9 Agronomic characteristics of a range of barley varieties when grown in WA. (source: Blakely Paynter, Raj Malik, Jeremy Curry, Ben Biddulph and David Moody)

Agronomic trait	Coleoptile length[1]	Maturity with late May sowing[2]	Frost risk (floret sterility)[3]	Boron leaf	Straw strength	Head loss risk[5]	Plant height at maturity[6]	Grain plumpness
Malt varieties								
Bass (Ф)	Medium	Medium	Normal	Medium	Very good	Medium	Short	Good
Baudin (Ф)	Medium	Medium	Normal	Medium	Very good	Low	Short	Fair
Flinders (Ф)	Short	Medium	Lower	Medium	Very good	Low	Short	Mod. good
La Trobe (Ф)	Short	Early	Higher	Medium	Mod. good	Medium	Medium	Mod. good
Scope CL (Ф)	Short	Medium	Normal	Low	Fair	High	Tall	Fair
Spartacus CL (Ф)	Short	Early	Higher*	Medium	Good	Low	Medium	Mod. good
Stage 2 malt accreditation								
Banks (Ф)	Short	Medium	–	Medium	Mod. good	–	Short	Fair
RGT Planet (Ф)	–	Medium	Normal*	Low	Mod. good	Low	Medium	Fair
Feed varieties								
Buff (Ф)	–	Early	Higher*	High*	–	–	Medium	–
Fathom (Ф)	Medium	Medium	Normal	Medium	Fair	Low	Tall	Good
LG Maltstar (Ф)	–	Medium	Normal*	Low	Good	Low	Short	–
Litmus (Ф)	Short	Early	Normal	Medium	Fair	Medium	Tall	Mod. good
Lockyer (Ф)	Medium	Late	–	Medium	Mod. good	Low	Short	Poor
Mundah	Medium	Very early	Normal	Medium	Fair	Medium	Medium	Very good
Oxford	Medium	Late	Higher	Low	Very good	Low	Short	Very poor
Rosalind (Ф)	Short	Early	Normal*	Medium	Good	Low	Medium	Mod. good

[1]Coleoptile length: short (40-60mm), medium (60-80mm) and long (80-100mm).

[2]Maturity: very early (-15 to -4 days), early (-3 to +3 days), medium (+4 to +10 days) and late (+11 to +17 days) maturity (days to awn emergence) relative to Stirling when sown in late May. Maturity ranking with a late May sowing differs to the maturity ranking when sown in April or after mid June.

[3]Frost risk: ratings based on graphs produced by NFI available at nvtonline.com.au/frost/. Varieties are rated as being lower risk (less floret sterility under frost), normal (standard floret sterility under frost) and higher risk (more floret sterility under frost) based on floret sterility which is separate from potential loss in grain yield. The asterisk (*) indicates a provisional rating that is based on only one year of data. Some varieties may be able to compensate more than others depending on the severity and timing of the frost, plasticity of their growth and synchronicity of their flowering. For more detailed analysis, growers and consultants should consult the NFI graphs when comparing varieties.

[4]Boron leaf symptoms: Leaf symptoms represent the level of physical leaf symptoms (dark brown irregular lesions first appear between the margin and mid-vein in the middle of young leaves. This extends rapidly to the leaf tip and irregular grey lesions develop between the margin and mid-vein and may join grey dead leaf margins) observed after stem elongation. Their presence does not necessarily indicate low tolerance to boron. Elevated boron in solution is likely to occur when the soil pH_{Ca} is above 7.5. The asterisk (*) indicates a provisional rating that is based on only one year of data.

[5]Head loss risk: under adverse conditions barley varieties differ in their risk of shedding. Head loss risk is based on counting heads post-harvest at sites where high levels of head loss has been recorded in high risk varieties.

[6]Plant height at maturity: very short (<45 cm), short (45-55cm), medium (55-65cm) and tall (65-75cm) relative to Stirling, Buloke and Scope CL at sites where their straw (ground to base of ear) was between 65-75cm long.

Table 10 Visual characteristics of a range of barley varieties when grown in WA. (source: DAFWA Bulletin 4765, breeding companies and IP Australia Plant Breeders Rights database pericles.ipaustralia.gov.au/pbr_db/search.cfm)

Characteristic	Early growth habit	Redness of flag leaf auricle	Redness of awns during grain fill	Awn length	Ear shape	Rachilla length	Rachilla hair length
Malt varieties							
Bass(Ⓑ)	Prostrate	Present	Weakly present	Long	Parallel	Short-medium	Long
Baudin(Ⓑ)	Prostrate	Strongly present	Present	Medium	Parallel	Short-medium	Long
Flinders(Ⓑ)	Prostrate	Strongly present	Present	Medium	Parallel	Medium-long	Short
La Trobe(Ⓑ)	Erect	Present	Present	Medium	Parallel	Medium-long	Short
Scope CL(Ⓑ)	Semi-erect	Weakly present	Absent	Medium	Tapering	Medium	Long
Spartacus CL(Ⓑ)	Erect	Absent	Absent	Medium	Parallel	–	Short
Stage 2 malt accreditation							
Banks (Ⓑ)	Prostrate	Weakly present	Present	Medium	Parallel	–	Short
RGT Planet(Ⓑ)	Prostrate	Strongly present	Present	Long	Parallel	Medium	Short
Feed varieties							
Buff(Ⓑ)	Erect	–	–	–	–	–	–
Fathom(Ⓑ)	Erect	Weakly present	Weakly present	Very long	Parallel	Medium	Long
LG Maltstar(Ⓑ)	Prostrate	Present	Present	Long	Tapering	–	Short
Litmus(Ⓑ)	Erect	Weakly present	Weakly present	Long	Parallel	Medium	Long
Lockyer(Ⓑ)	Prostrate	Weakly present	Present	Long	Parallel	Medium	Long
Mundah	Erect	Weakly present	Weakly present	Long	Parallel	Medium	Short
Oxford	Prostrate	Present	Present	Long	Parallel	Medium	Long
Rosalind(Ⓑ)	Erect	Present	Present	Medium	Tapering	–	Long

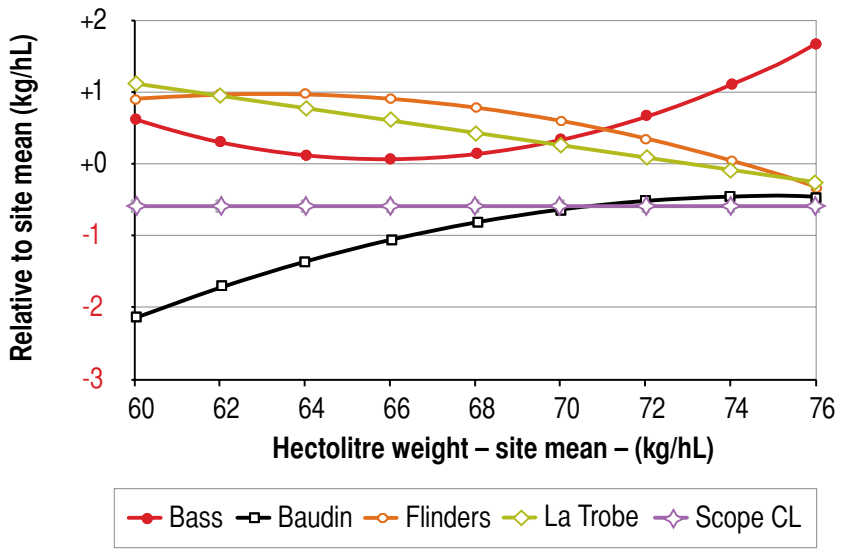

Figure 8 Fitted hectolitre weight of Bass, Baudin, Flinders, La Trobe and Scope CL at different site mean weights (2009-2017) and the Student's t-test comparison between the average hectolitre weight of each variety across sites and their average hectolitre weight relative to the average site mean weight of all sites. Site mean is the average weight of all varieties at a site (source: data from 2009-2016 DPIRD-GRDC barley agronomy and 2010-2017 GRDC NVT trials. Each variety is sown in all 336 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Hectolitre wt (kg/hL)	Relative to site mean (kg/hL)	t-test relative to site mean
	Bass	Baudin	Flinders	La Trobe	Scope CL			
Bass		p<0.001	n.s	n.s	p<0.001	**69.8**	+0.6	p<0.001
Baudin	p<0.001		n.s	n.s	p<0.001	**68.5**	-0.7	p<0.001
Flinders	n.s	p<0.001		p<0.05	p<0.001	**69.9**	+0.7	p<0.001
La Trobe	n.s	p<0.001	p<0.05		p<0.001	**69.6**	+0.4	p<0.001
Scope CL	p<0.001	p<0.05	p<0.001	p<0.001		**68.8**	-0.4	p<0.001
Hectolitre wt (kg/hL)	**69.8**	**68.5**	**69.9**	**69.6**	**68.8**	**site mean (kg/hL)**	**69.2**	

Table 11 Breeding, seed trading and end point royalty status for barley varieties when grown in WA. (source: breeding companies and Variety Central varietycentral.com.au)

Licence information	Variety owner or licensee	Year released	Seed distribution	Farmer to farmer trading	End point royalty[2]	Pedigree
Malt varieties						
Bass (Ф)	InterGrain	2012	Free to trade	Yes	$3.50	WABAR2023/Alexis
Baudin(Ф)	InterGrain	2003	Free to trade	Yes	$3.00/$1.00	Stirling/Franklin
Flinders(Ф)	InterGrain	2014	Free to trade	Yes	$3.80	Baudin/Cooper
La Trobe(Ф)	InterGrain	2013	Free to trade	Yes	$4.00	Dash/VB9409
Scope CL(Ф)	AgVic Services	2010	SeedNet	No	$3.50	Franklin/VB9104//VB9104
Spartacus CL(Ф)	InterGrain	2015	Seedclub members	No	$4.00	Scope/4*Hindmarsh//HMVB0325-106
Stage 2 malt accreditation						
Banks(Ф)	InterGrain	2018	Seedclub members	No	$4.00	WABAR2312/WABAR2332
RGT Planet(Ф)	RAGT Semences	2017	Seed Force	No	$4.00	Tamtam/Concerto
Feed varieties						
Buff(Ф)	InterGrain	2018	Seedclub members	No	$3.50	–
Fathom(Ф)	University of Adelaide	2011	SeedNet	No[1]	$2.00	JE013D-020/WI3806-1
LG Maltstar(Ф)	Limagrain	2017	Free to trade	Yes	$3.00	Henley/Sebastian
Litmus(Ф)	InterGrain	2013	Free to trade	Yes	$3.80	WB229/2*Baudin//WABAR2238
Lockyer(Ф)	InterGrain	2007	Free to trade	Yes	$1.50	Tantangara/VB9104
Mundah	InterGrain	1995	Free to trade	Yes	–	Yagan/O'Connor
Oxford	Limagrain	2010	Free to trade	Yes	$2.50	Tavern/Chime
Rosalind(Ф)	InterGrain	2015	Free to trade	Yes	$3.50	Lockyer/Dash

[1]Fathom may be included in the SeedNet Authorised Grower Distribution Scheme from the 2018-19 harvest. Growers looking to purchase Fathom should check with SeedNet closer to harvest before purchasing any seed.

[2]End point royalties (EPR) ($/t) are quoted excluding GST. EPR for Baudin received as malt is $3/t and as feed is $1/t.

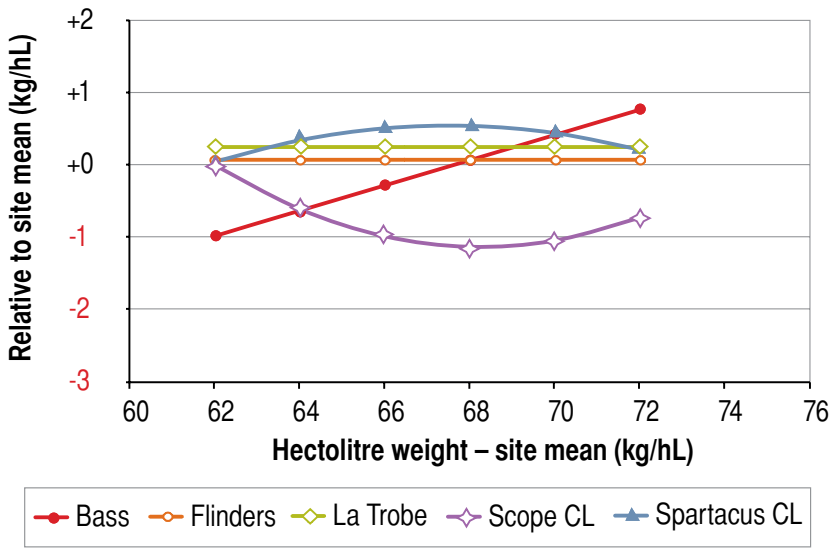

Figure 9 Fitted hectolitre weight of Bass, Flinders, La Trobe, Scope CL and Spartacus CL at different site mean weights (2014-2017) and the Student's t-test comparison between the average hectolitre weight of each variety across sites and their average hectolitre weight relative to the average site mean weight of all sites. Site mean is the average weight of all varieties at a site (source: data from 2015-2016 DPIRD-GRDC barley agronomy and 2014-2017 GRDC NVT trials. Each variety is sown in all 88 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Hectolitre wt (kg/hL)	Relative to site mean (kg/hL)	t-test relative to site mean
	Bass	Flinders	La Trobe	Scope CL	Spartacus CL			
Bass		n.s.	n.s.	p<0.01	n.s.	**68.7**	+0.2	n.s.
Flinders	n.s.		n.s.	p<0.01	n.s.	**68.6**	+0.1	n.s.
La Trobe	n.s.	n.s.		p<0.001	n.s.	**68.8**	+0.3	n.s.
Scope CL	p<0.01	p<0.01	p<0.001		p<0.001	**67.7**	-0.8	p<0.001
Spartacus CL	n.s.	n.s.	n.s.	p<0.001		**68.9**	+0.4	p<0.01
Hectolitre wt (kg/hL)	**68.7**	**68.6**	**68.8**	**67.7**	**68.9**	**site mean (kg/hL)**	**68.5**	

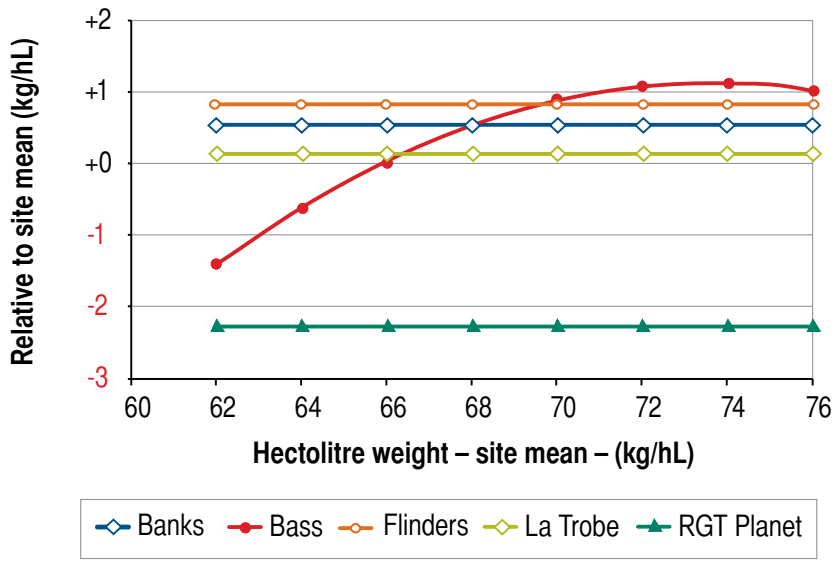

Figure 10 Fitted hectolitre weight of Banks, Bass, Flinders, La Trobe and RGT Planet at different site mean weights (2016-2017) and the Student's t-test comparison between the average hectolitre weight of each variety across sites and their average hectolitre weight relative to the average site mean weight of all sites. Site mean is the average weight of all varieties at a site (source: data from 2016-2017 DPIRD-GRDC barley agronomy and GRDC NVT trials. Each variety is sown in all 44 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Hectolitre wt (kg/hL)	Relative to site mean (kg/hL)	t-test relative to site mean
	Banks	Bass	Flinders	La Trobe	RGT Planet			
Banks		n.s.	n.s.	n.s.	p<0.001	**71.7**	+0.3	p<0.05
Bass	n.s.		n.s.	p<0.05	p<0.001	**71.9**	+0.6	p<0.001
Flinders	n.s.	n.s.		p<0.05	p<0.001	**71.9**	+0.6	p<0.001
La Trobe	n.s.	p<0.05	p<0.05		p<0.001	**71.2**	-0.1	n.s.
RGT Planet	p<0.001	p<0.001	p<0.001	p<0.001		**68.8**	-2.5	p<0.001
Hectolitre wt (kg/hL)	**71.7**	**71.9**	**71.9**	**71.2**	**68.8**	**site mean (kg/hL)**	**71.3**	

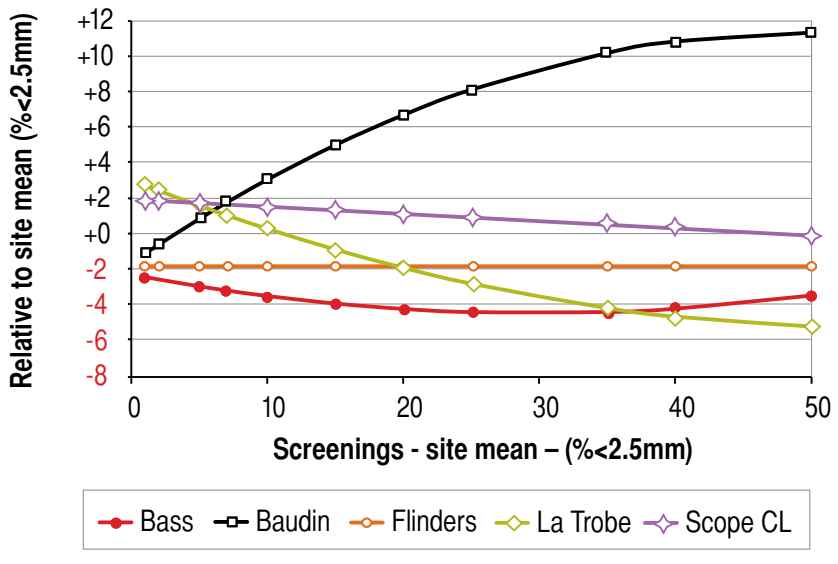

Figure 11 Fitted screenings of Bass, Baudin, Flinders, La Trobe and Scope CL at different site mean screenings (2009-2017) and the Student's t-test comparison between the average screenings of each variety across sites and their average screenings relative to the average site mean screenings of all sites. Site mean is the average screenings of all varieties at a site (source: data from 2009-2016 DPIRD-GRDC barley agronomy and 2010-2017 GRDC NVT trials. Each variety is sown in all 336 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Screenings (%<2.5mm)	Relative to site mean (%<2.5mm)	t-test relative to site mean
	Bass	Baudin	Flinders	La Trobe	Scope CL			
Bass		p<0.001	p<0.001	p<0.001	p<0.001	**16.7**	-3.2	p<0.001
Baudin	p<0.001		p<0.001	p<0.001	p<0.001	**24.3**	+4.5	p<0.001
Flinders	p<0.001	p<0.001		n.s	p<0.001	**18.4**	-1.5	p<0.001
La Trobe	p<0.001	p<0.001	n.s		p<0.001	**18.8**	-1.1	n.s.
Scope CL	p<0.001	p<0.001	p<0.001	p<0.001		**21.1**	+1.2	p<0.001
Screenings (%<2.5mm)	**16.7**	**24.3**	**18.4**	**18.8**	**21.1**	**site mean (%<2.5mm)**	**19.9**	

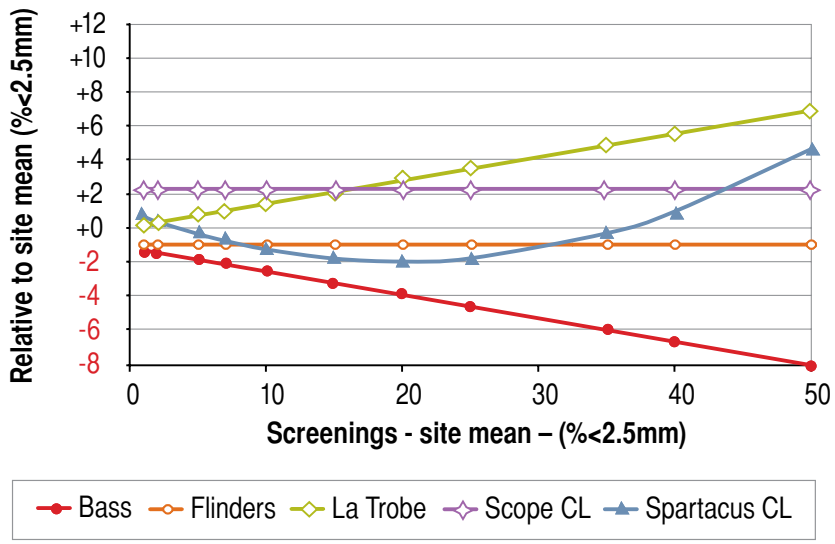

Figure 12 Fitted screenings of Bass, Flinders, La Trobe, Scope CL and Spartacus CL at different site mean screenings (2014-2017) and the Student's t-test comparison between the average screenings of each variety across sites and their average screenings relative to the average site mean screenings of all sites. Site mean is the average screenings of all varieties at a site (source: data from 2015-2016 DPIRD-GRDC barley agronomy and 2014-2017 GRDC NVT trials. Each variety is sown in all 88 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Screenings (%<2.5mm)	Relative to site mean (%<2.5mm)	t-test relative to site mean
	Bass	Flinders	La Trobe	Scope CL	Spartacus CL			
Bass		p<0.05	p<0.001	p<0.001	p<0.01	**12.0**	-3.2	p<0.001
Flinders	p<0.05		p<0.001	p<0.01	n.s.	**14.3**	-0.9	n.s.
La Trobe	p<0.001	p<0.001		n.s.	p<0.001	**17.4**	+2.2	p<0.001
Scope CL	p<0.001	p<0.01	n.s.		p<0.01	**17.6**	+2.4	p<0.001
Spartacus CL	p<0.01	n.s.	p<0.001	p<0.01		**14.8**	-0.4	n.s.
Screenings (%<2.5mm)	**12.0**	**14.3**	**17.4**	**17.6**	**14.8**	**site mean (%<2.5mm)**	**15.2**	

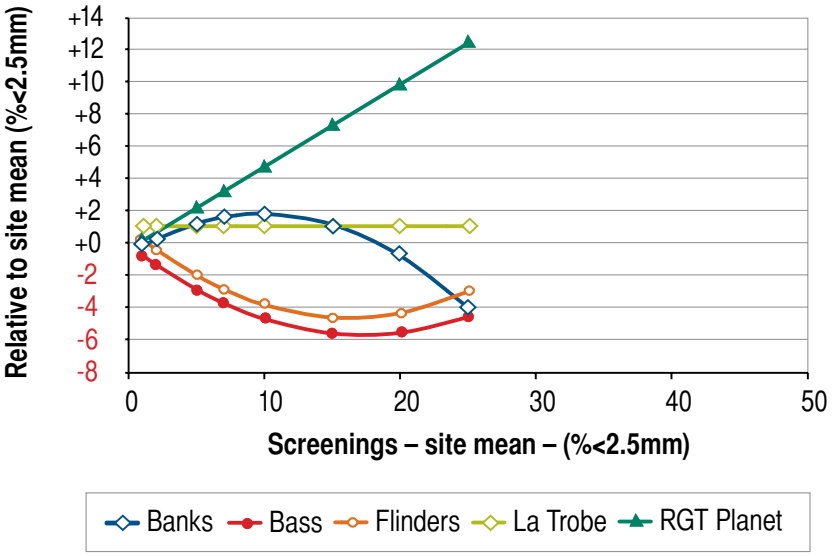

Figure 13 Fitted screenings of Banks, Bass, Flinders, La Trobe and RGT Planet at different site mean screenings (2016-2017) and the Student's t-test comparison between the average screenings of each variety across sites and their average screenings relative to the average site mean screenings of all sites. Site mean is the average screenings of all varieties at a site (source: data from 2016-2017 DPIRD-GRDC barley agronomy and GRDC NVT trials. Each variety is sown in all 44 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Hectolitre wt (kg/hL)	Relative to site mean (kg/hL)	t-test relative to site mean
	Banks	Bass	Flinders	La Trobe	RGT Planet			
Banks		p<0.001	p<0.001	n.s.	p<0.01	**8.1**	+0.4	n.s.
Bass	p<0.001		n.s.	p<0.001	p<0.001	**5.2**	-2.5	p<0.001
Flinders	p<0.001	n.s.		p<0.001	p<0.001	**5.5**	-2.2	p<0.001
La Trobe	n.s.	p<0.001	p<0.001		n.s.	**8.8**	+1.1	p<0.05
RGT Planet	p<0.01	p<0.001	p<0.001	n.s.		**11.0**	+3.2	p<0.001
Screenings (%<2.5mm)	**8.1**	**5.2**	**5.5**	**8.8**	**11.0**	**site mean (%<2.5mm)**	**7.7**	

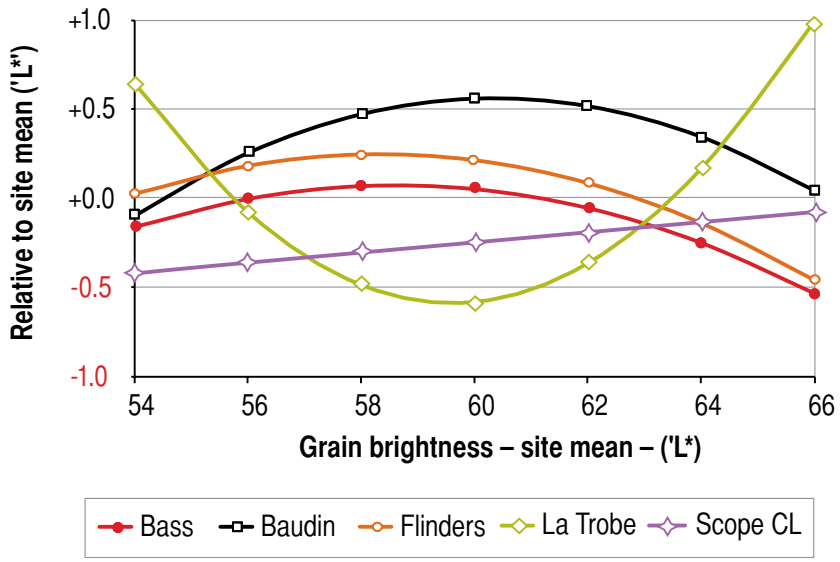

Figure 14 Fitted grain brightness of Bass, Baudin, Flinders, La Trobe and Scope CL at different site mean brightness (2009-2017) and the Student's t-test comparison between the average grain brightness of each variety across sites and their average grain brightness relative to the average site mean brightness of all sites. Site mean is the average brightness of all varieties at a site (source: data from 2009-2016 DPIRD-GRDC barley agronomy and 2010-2017 GRDC NVT trials. Each variety is sown in all 325 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Brightness ('L*')	Relative to site mean ('L*')	t-test relative to site mean
	Bass	Baudin	Flinders	La Trobe	Scope CL			
Bass		p<0.001	p<0.001	n.s	p<0.01	**60.0**	-0.1	n.s.
Baudin	p<0.001		p<0.001	n.s	p<0.01	**60.5**	+0.4	p<0.001
Flinders	p<0.001	p<0.001		p<0.001	p<0.001	**60.2**	+0.1	p<0.01
La Trobe	n.s	p<0.001	p<0.001		n.s	**59.9**	-0.2	p<0.001
Scope CL	p<0.01	p<0.001	p<0.001	n.s		**59.8**	-0.3	p<0.001
Brightness ('L*')	**60.0**	**60.5**	**60.2**	**59.9**	**59.8**	**site mean ('L*')**	**60.1**	

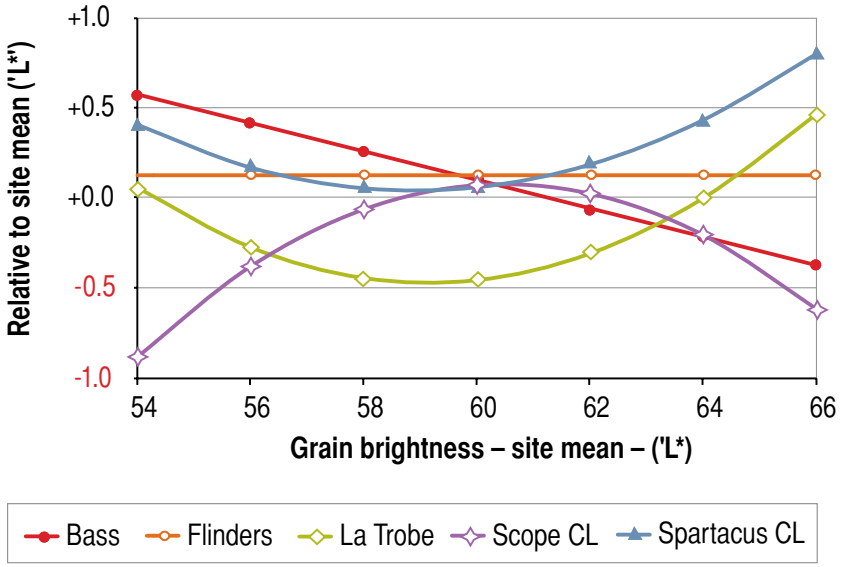

Figure 15 Fitted grain brightness of Bass, Flinders, La Trobe, Scope CL and Spartacus CL at different site mean brightness (2014-2017) and the Student's t-test comparison between the average grain brightness of each variety across sites and their average grain brightness relative to the average site mean brightness of all sites. Site mean is the average brightness of all varieties at a site (source: data from 2015-2016 DPIRD-GRDC barley agronomy and 2014-2017 GRDC NVT trials. Each variety is sown in all 87 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Brightness ('L*')	Relative to site mean ('L*')	t-test relative to site mean
	Bass	Flinders	La Trobe	Scope CL	Spartacus CL			
Bass		n.s.	p<0.01	p<0.05	n.s.	**60.0**	+0.1	n.s.
Flinders	n.s.		p<0.001	p<0.05	n.s.	**60.0**	+0.1	p<0.05
La Trobe	p<0.01	p<0.001		n.s.	p<0.001	**59.6**	-0.3	p<0.001
Scope CL	p<0.05	p<0.05	n.s.		p<0.05	**59.8**	-0.1	n.s.
Spartacus CL	n.s.	n.s.	p<0.001	p<0.05		**60.1**	+0.2	p<0.05
Brightness ('L*')	**60.0**	**60.0**	**59.6**	**59.8**	**60.1**	**site mean ('L*')**	**59.9**	

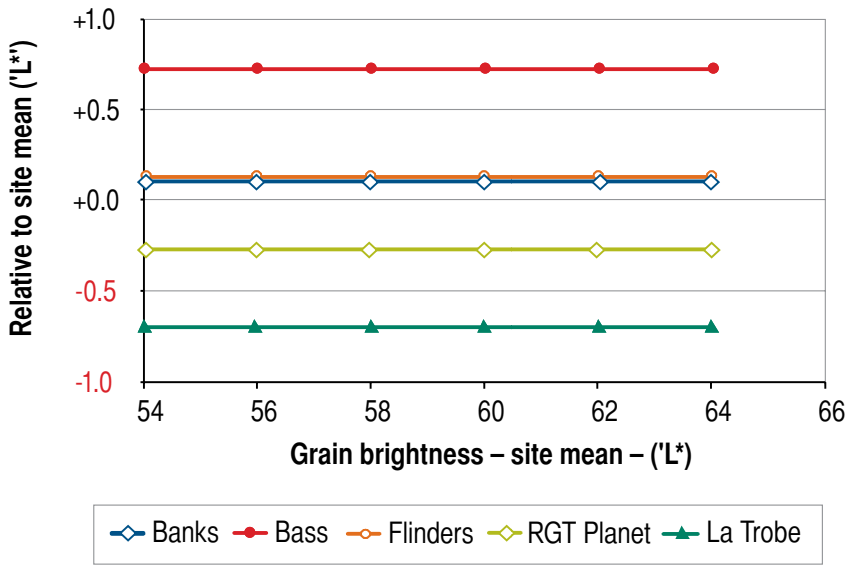

Figure 16 Fitted grain brightness of Banks, Bass, Flinders, La Trobe and RGT Planet at different site mean brightness (2016-2017) and the Student's t-test comparison between the average grain brightness of each variety across sites and their average grain brightness relative to the average site mean brightness of all sites. Site mean is the average brightness of all varieties at a site (source: data from 2016-2017 DPIRD-GRDC barley agronomy and GRDC NVT trials. Each variety is sown in all 43 trial-years of data)

	Student's t-test (paired, 2 sided) comparison between varieties					Brightness ('L*')	Relative to site mean ('L*')	t-test relative to site mean
	Banks	Bass	Flinders	La Trobe	RGT Planet			
Banks		p<0.001	n.s.	p<0.001	p<0.001	**59.6**	+0.1	n.s.
Bass	p<0.001		p<0.001	p<0.001	p<0.001	**60.2**	+0.7	p<0.001
Flinders	n.s.	p<0.001		p<0.001	p<0.01	**59.6**	+0.1	n.s.
La Trobe	p<0.001	p<0.001	p<0.001		p<0.05	**58.8**	-0.7	p<0.001
RGT Planet	p<0.001	p<0.001	p<0.01	p<0.05		**59.2**	-0.3	p<0.01
Brightness ('L*')	**59.6**	**60.2**	**59.6**	**58.8**	**59.2**	**site mean ('L*')**	**59.5**	

Herbicide tolerance

Harmohinder Dhammu and Blakely Paynter, DPIRD

Herbicide timing abbreviations:

- IBS = incorporated by seeding
- PSPE = post sowing pre-emergent.
- Z12 = Zadoks growth score 12, 2 leaves emerged on the mainstem.
- Z13 = Zadoks growth score 13, 3 leaves emerged on the mainstem.
- Z14 = Zadoks growth score 14, 4 leaves emerged on the mainstem.
- Z15 = Zadoks growth score 15, 5 leaves emerged on the mainstem.
- Z16 = Zadoks growth score 16, 6 leaves emerged on the mainstem.

Herbicide tolerance trials conducted between 2009 and 2016 in WA indicate that some barley varieties are more susceptible to damage from certain herbicides than others. The variation in tolerance may be due to differences in morphological or physiological characters and/or internal ear development stages among the varieties. The level of tolerance amongst varieties varies with the rate of herbicide, the environmental conditions when the herbicide is applied, and the stage of the crop growth. The sensitivity of important malt and feed barley varieties to herbicides registered for use on barley can be found in the factsheets at the end of this sowing guide. The full list of varieties tested in herbicide tolerance trials can be found at nvtonline.com.au/herbicide-tolerance .

Seasonal variability makes it essential to test herbicide and variety interactions over several seasons and locations. The risk of crop damage from a herbicide should be balanced against the potential yield loss from both the weed competition and the number of weed seeds returning to the soil seed bank. Small yield reductions due to herbicide damage in sensitive varieties may not be easily detected at the paddock level, but over larger areas can be of great economic importance.

From 2009-2016 advanced breeding lines and commercial varieties were tested for herbicide tolerance in small plot (1.6m x 1.5m) screening trials at Katanning. In those (screening) trials the following herbicides (which consistently caused damage to barley or were commonly used by WA barley growers) were tested at higher than label rates:

- Axial® (pinoxadin).
- Achieve® (tralkoxydim).
- Affinity® + MCPA (carfentrazone-ethyl + MCPA).
- Ally® (metsulfuron).
- Boxer Gold® (s-metolachlor + prosulfocarb).
- Broadside® (bromoxynil + MCPA + dicamba).
- Decision® (diclofop + sethoxydim) [2015 only].
- Diuron + MCPA (diuron + MCPA).
- Hoegrass® (diclofop-methyl) [2009-2014 only].
- Triflur® X (trifluralin).
- Triflur® 400 + Lexone® (trifluralin + metribuzin).
- Tigrex® (diflufenican + MCPA) [2009-2014 only].
- Triathlon® (diflufenican + bromoxynil + MCPA) [2015 only].
- 2,4-D LVE 680 (2,4-D).

Any variety by herbicide combination that caused a significant yield reduction in the screening trial was then further tested in larger plot (10m x 1m) advanced trials. In the advanced trials, the varieties were assessed against label and higher than label rates for at least two years to validate the results and to minimise seasonal influences on the herbicide tolerance responses. Since 2017 herbicide tolerance trials at labels rates have not been conducted in WA.

While several barley varieties have shown some sensitivity (yield loss) to at least one herbicide at label rate in the herbicide tolerance trials, no barley variety tested to date has demonstrated consistent yield loss due to herbicide application. However, Diuron + MCPA and Hoegrass® (diclofop-methyl) at higher than label rates consistently reduced the grain yield of Flinders and La Trobe, respectively. Of the recommended varieties, only Baudin and Lockyer have shown sensitivity to two or more herbicides at label rates.

Several of the herbicides tested have caused a yield loss in two or more varieties. Growers should be cautious when using those products with new varieties. Sensitivity at label rates has been noted in at least two varieties for the following products:

- Achieve® (tralkoxydim) at Z13-Z15.
- Diuron + MCPA (diuron + MCPA) at Z13-Z15.
- Tigrex® at Z13-Z15.

A narrow safety margin was also noted for the following products, given at least two varieties showed sensitivity when applied at above labels rates, but not at label rates:

- Ally® (metsulfuron) at Z13-Z14.
- Barrel® / Broadside® (bromoxynil + MCPA + dicamba) at Z13-Z14.
- Boxer Gold® (s-metolachlor + prosulfocarb) IBS.
- Hoegrass® (diclofop-methyl) at Z13-Z15.
- Velocity® (bromoxynil + pyrasulfotole) at Z12-Z15.

When using pre-emergent herbicides like trifluralin, Boxer Gold® (s-metolachlor + prosulfocarb) and Diuron + Dual Gold® (diuron + s-metolachlor) ensure the sown seed is placed below the herbicide treated soil band as the crop safety is mainly due to seed placement. If sowing with knife points, and using higher label rates, ensure that treated soil does not get thrown, blown or washed into the furrows.

All the varieties tested (Compass, La Trobe, Flinders and Spartacus CL) tolerated well with crop safety margin a commonly used herbicide brew of Diuron 900 (diuron) at 0.2kg/ha + Metribuzin 750 (metribuzin) at 120g/ha + TriflurX® (trifluralin) at 2L/ha + Avadex® Xtra (tri-allate) at 1L/ha during 2016 at Katanning on a loamy sand soil.

Pre-emergent split application (IBS + PSPE) and post-emergent use of Boxer Gold® (s-metolachlor + prosulfocarb) is now registered on barley for control of ryegrass. Boxer Gold® (s-metolachlor + prosulfocarb) can cause yield loss but it is not consistent with varieties or application timing. The following comments should be noted:

- Boxer Gold® (s-metolachlor + prosulfocarb) at 1.75L/ha IBS followed by 0.75L/ha PSPE caused significant yield loss in Compass on a loamy sand soil at Katanning during 2015.
- In 2015, pre-emergent TriflurX® (trifluralin) at 3L/ha followed by Boxer Gold® (s-metolachlor + prosulfocarb at 2.5 L/ha at Z12-Z13 and Boxer Gold® (s-metolachlor + prosulfocarb) at 2.5L/ha alone applied at Z12-Z13 was tolerated well by Bass, Compass, La Trobe and Scope CL at Katanning.
- In 2016, Boxer Gold® (s-metolachlor + prosulfocarb) at 2.5L/ha applied at Z12-Z13 caused significant yield loss in Spartacus CL at Katanning, but it was tolerated well by Compass, La Trobe and Flinders.

The new herbicides Terbyne® Xtreme® (terbuthylazine) applied before seeding and Aptitude® (metribuzin + carfentrazone-ethyl) + MCPA (amine) at Z13-Z14 at the label rates were tolerated well by all the varieties tested (Bass, Compass, La Trobe and Scope CL) with good crop safety margin. For crop safety when using Terbyne® Xtreme® (terbuthylazine), target a seed depth of at least 3-4cm and maintain slow to moderate seeding speed to avoid leaving deep furrows and avoid throwing soil into adjacent furrows.

Terbyne® Xtreme® (terbuthylazine) at 1.2kg/ha + TriflurX® (trifluralin) at 3L/ha + Avadex® at 2L/ha (tri-allate) applied before crop seeding and Ally® (metsulfuron) at 7 g/ha + BS100 0.25% sprayed at Z13-Z14 caused significant yield loss in Spartacus CL during 2016 at Katanning, but those herbicides were tolerated well by Compass, La Trobe and Flinders.

Limited data suggests that Compass may be sensitive to Howitzer® (diflufenican + bromoxynil + MCPA) at 1L/ha and the new herbicide Talinor® (bicyclopyrone + bromoxynil) at 1.2L/ha applied at Z13-Z15. However, Flinders, La Trobe and Spartacus CL tolerated those herbicides quite well.

Gallery® 750 (isoxaben) at 70-140g/ha is now registered (APVMA approval number: 47333/106011) as a pre-emergent to early post-emergent (up to 1st node stage) herbicide for control of wild radish in barley. It has a very limited post-emergent activity on very small weeds only. Isoxaben is also one of the components in X-Pand® herbicide (100g a.i./ha) that is registered as an early post-emergent on barley (plus triticale and wheat). Gallery® is a soil active herbicide with a long residual activity. Careful attention should be paid to replanting intervals for broadleaf crops grown after barley

on which Gallery® is applied. According to the Gallery® label, use at 70-140g/ha (pre- or post-emergent on barley) requires a plant back period of nine months for lupins and 22 months for canola along with more than 300mm rainfall in total.

Phenoxy herbicides (2,4-D and MCPA) are commonly applied in barley as late post-emergence treatments and to reduce the seed set of wild radish, wild mustard, wild turnip and lupins. Application timing for phenoxy herbicides is more critical than for other herbicides. Barley is most sensitive to phenoxy herbicides at the double ridge stage of ear development (the point at which the ear first starts to form). It is critically important to correctly identify the crop development stage to avoid damaging the crop when spraying with phenoxy herbicides.

Application of phenoxy herbicides during the double ridge stage usually results in distorted or twisted heads later in the season when the heads emerge from the boot. This is normally accompanied by some missing grains in the head and these ear abnormalities could lead to grain yield losses. Double ridge usually occurs when there is between three to four leaves on the mainstem in varieties like La Trobe and Spartacus CL, three to five leaves for Scope CL and between four to five leaves in varieties like Bass, Baudin, Compass, Flinders and Granger.

The best time to apply a phenoxy herbicide (especially at the higher label rate) is to wait until at least one leaf after the double ridge stage and before booting. Application of phenoxy herbicides between flag leaf emergence and the soft dough stage on any barley variety can cause serious yield losses due to effects on pollen development.

It is important to remember that herbicides are only one of the tools in which we can manage weeds. Herbicides are only a useful tool when part of an integrated weed management plan (IWM). An IWM plan should include an element from each of the following five tactics:

- Tactic 1 – deplete weed seed in the target area soil seed bank.
- Tactic 2 – kill weeds (seedlings) in the target area.
- Tactic 3 – stop weed seed set.
- Tactic 4 – prevent viable weed seeds from being added to the soil seed bank.
- Tactic 5 – prevent introduction of viable weed seed from external sources.

When using herbicides to control weeds it is important to rotate between different mode-of-action groups to reduce weed numbers, stop replenishment of the seed bank and minimise the risk of developing herbicide resistant weeds.

Bass(b)

Malt variety

Comments

Bass is a medium spring, semi-dwarf, malt barley acceptable for export as grain and as malt but not for shochu. Best suited to environments with a yield potential above 3t/ha. It has a moderate yield potential combined with good hectolitre weight, high grain plumpness and a high probability of receival as malt barley. Its grain is generally 0.5% higher in grain protein than varieties such as Baudin and La Trobe at the same yield. Can show a moderate head loss risk in the Esperance Port Zone, but not in other Port Zones. Fungicides may be required to manage STNB, powdery mildew and barley leaf rust. As a seedling it is VS to the new Oxford virulent NTNB. Weed competitiveness similar to other semi-dwarf varieties. Market demand exists for the malt quality profile of Bass. Target production zone in 2019 is Kwinana-West with limited segregation opportunities in the Albany Port Zone (subject to production volumes).

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	81	91	84	92	88
Agzone 2	85	94	82	92	94
Agzone 3	98	94	91	91	89
Agzone 4	87	64	85	–	79
Agzone 5	93	92	88	93	92
Agzone 6	91	95	93	91	108

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-6 to -4	+4 to +7
late May	-3 to -2	+4 to +6
early July	0 to +1	+7 to +8

Agronomic traits	
Coleoptile length	Medium
Target plant density	150-180 plants/m^2
Plant height	Short
Straw strength	Very good
Head loss risk	Medium

Herbicide tolerance

Has shown no sensitivity to a range of herbicides / herbicide mixtures at label rates in herbicide tolerance trials conducted in WA.

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

Baudin(b)

Malt variety

Comments

Baudin is a medium spring, semi-dwarf, malt barley that is acceptable for export as grain, as malt and as a shochu barley. Best suited to environments with a yield potential above 3t/ha and where leaf diseases can be promptly sprayed before they reach 5% of leaf area affected. When growing Baudin, an integrated disease management plan needs to be implemented as it is susceptible to all forms of NTNB, STNB, powdery mildew and barley leaf rust. Vigorous Baudin crops have reasonable weed competitiveness despite their short height. Growers in the Esperance Port Zone looking to grow Baudin for malt in 2019 should talk to their preferred acquirer to determine opportunities for contract production into a niche segregation before planting any seed. The 2019/20 harvest is likely to be the last harvest that segregations will be offered for Baudin in Western Australia.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	92	91	79	97	95
Agzone 2	88	89	78	104	93
Agzone 3	92	88	81	91	96
Agzone 4	88	40	80	–	68
Agzone 5	92	89	79	96	92
Agzone 6	77	97	88	91	99

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	+3 to +5	+12 to +17
late May	+2 to +3	+9 to +11
early July	-4 to -2	+3 to +4

Agronomic traits	
Coleoptile length	Medium
Target plant density	110-130 plants/m^2
Plant height	Short
Straw strength	Very good
Head loss risk	Low

Herbicide tolerance

May be sensitive to label rate applications of Paragon® (picolinafen + MCPA) and Tigrex® (diflufenican + MCPA) sprayed at Z13-Z14.

Variety information	
Pedigree	Stirling/Franklin
Breeder / Seed licensee	InterGrain
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.00 - malt/$1.00 - feed

Flinders(Þ)

Malt variety

Comments

Flinders is a medium spring, semi-dwarf, malt barley derived from Baudin with improved powdery mildew (non-*mlo*) and barley leaf rust (due to APR, *Rph20*) resistance. Flinders is being exported as grain and as malt. Best suited to environments with a yield potential above 3t/ha. Grain plumpness of Flinders is an improvement over Baudin, La Trobe and Scope CL with a grain brightness between Bass and Baudin. Fungicides may be required to manage STNB and barley leaf rust, despite having APR to barley leaf rust. As a seedling it is SVS to the new Oxford virulent NTNB. Weed competitiveness is similar to other semi-dwarf varieties. Target production zone in 2019 is Albany-South, with limited segregations in Albany-North (subject to production volumes) and potential niche segregation opportunities in Kwinana-West and the Esperance Port Zone (subject to production and demand).

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	100	94	92	–	94
Agzone 2	99	97	92	100	97
Agzone 3	98	98	96	99	101
Agzone 4	93	65	90	–	80
Agzone 5	99	96	92	–	98
Agzone 6	103	105	102	104	116

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-3 to 0	+7 to +9
late May	0 to +2	+8 to +10
early July	+2 to +3	+8 to +10

Agronomic traits	
Coleoptile length	Short
Target plant density	150-180 plants/m^2
Plant height	Short
Straw strength	Very good
Head loss risk	Low

Herbicide tolerance

May be sensitive to a label rate application of Achieve® (tralkoxydim) sprayed at Z13-Z15.

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

La Trobe(Þ)

Malt variety

Comments

La Trobe is an early spring, semi-dwarf, CCN resistant, malt barley. It is suitable for export as grain, as malt and for use in the manufacture of shochu in Japan. La Trobe and Spartacus CL are the most yield responsive malt varieties to nitrogen. Whilst the National Frost Initiative trials suggest La Trobe is sensitive to flowering frost, it appears to yield similarly to other varieties when frosted where compensation can occur. Every La Trobe seed should be treated with a good quality smuticide before sowing. Fungicides may be required to manage STNB and barley leaf rust. As a seedling it is S to the new Oxford virulent NTNB. Do not ruin the integrity of La Trobe malt stacks by contaminating them with Hindmarsh or Spartacus CL barley. Target production zones in 2019 are Kwinana, Albany and Esperance Port Zones.

Yield (%Scope CL)	2013	2014	2015	2016	2017
Agzone 1	104	114	107	101	98
Agzone 2	107	116	113	95	103
Agzone 3	107	112	116	104	105
Agzone 4	109	144	113	–	121
Agzone 5	111	116	123	106	111
Agzone 6	132	113	118	111	107

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

Flowering (days to Z49)	rel. Scope CL	rel. Hindmarsh
late April	-12 to -7	0 to +1
late May	-8 to -7	0 to +1
early July	-7 to -5	0 to +1

Agronomic traits	
Coleoptile length	Short
Target plant density	150-180 plants/m^2
Plant height	Medium
Straw strength	Moderately good
Head loss risk	Medium

Herbicide tolerance

May be sensitive to a label rate application of Diuron + MCPA (diuron + MCPA) sprayed at Z13-Z14.

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

Scope CL(D)

Malt variety

Comments

Scope CL is a medium spring, tall height, malt variety suitable for export as grain and as malt but not for shochu. Scope CL is best suited to environments where brome and barley grass are a problem or where there is imidazolinone residues. Fungicides will be required to manage STNB and barley leaf rust. As a seedling it is S to the new Oxford virulent NTNB. It should be harvested when ripe due to a high head loss risk. Scope CL is registered for use with the imidazolinone chemistry herbicides Intercept®, Intervix® and Sentry®. Do not use other imidazolinone herbicides on Scope CL. Do not ruin the integrity of Scope CL malt stacks by contaminating them with Buloke or Spartacus CL barley. Target production zones in 2019 are Kwinana and Albany Port Zones with limited segregation opportunities (subject to production volumes).

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	96	88	94	99	102
Agzone 2	94	86	89	106	97
Agzone 3	93	89	86	96	96
Agzone 4	92	70	88	–	82
Agzone 5	90	86	82	94	90
Agzone 6	76	88	85	90	93

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

Flowering (days to Z49)	rel. Baudin	rel. La Trobe
late April	-5 to -3	+8 to +12
late May	-3 to -2	+7 to +8
early July	+2 to +4	+6 to +7

Agronomic traits	
Coleoptile length	Short
Target plant density	110-130 plants/m^2
Plant height	Tall
Straw strength	Fair
Head loss risk	High

Herbicide tolerance

Has shown no sensitivity to a range of herbicides / herbicide mixtures at label rates in herbicide tolerance trials conducted in WA.

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

Spartacus CL(D)

Malt variety

Comments

Spartacus CL is an early spring, semi-dwarf, CCN resistant, malt barley. Agronomically it is similar to La Trobe but lacks red anthocyanin pigmentation. Appears to be an improvement over La Trobe for straw strength and head retention as well as producing slightly plumper grain. Has a similar grain yield to La Trobe and is higher yielding than Scope CL in WA. Spartacus CL is registered for use with the imidazolinone chemistry herbicides Intercept®, Intervix® and Sentry®. Do not ruin the integrity of Spartacus CL malt by contaminating it with La Trobe or Scope CL barley. Every seed should be treated with a good quality smuticide before sowing. Fungicides may be required to manage STNB and barley leaf rust. As a seedling it is S to the new Oxford virulent NTNB. Weed competition trials in eastern Australia suggest that Spartacus CL is like La Trobe and not as good as Fathom in the presence of weeds. Target production zones in 2019 are Geraldton, Kwinana and Albany Port Zones with limited segregation opportunities (subject to production volumes) in the Esperance Port Zone.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	–	104	102	98	98
Agzone 2	–	102	103	96	99
Agzone 3	–	102	102	99	99
Agzone 4	–	117	104	–	107
Agzone 5	–	102	105	99	101
Agzone 6	–	98	102	98	98

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-12 to -7	-1 to +1
late May	-9 to -7	-2 to 0
early July	-7 to -5	0 to +1

Agronomic traits	
Coleoptile length	Short
Target plant density	150-180 plants/m^2
Plant height	Medium
Straw strength	Good
Head loss risk	Low

Herbicide tolerance

May be sensitive to a label rate application of Terbyne® Xtreme® + Triflur® X + Avadex® (terbuthylazine + trifluralin + tri-allate) sprayed before crop seeding, Boxer Gold® sprayed at Z12-Z13 and Ally® sprayed at Z13-Z14.

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

Banks[b]

Stage 2 malt accreditation

Comments

Banks (tested as IGB1305) is a new short height, longer season, semi-dwarf barley competing with RGT Planet for grower and market attention. Banks does not have the top end yield potential of RGT Planet but appears to yield similarly between 3-4t/ha and may be higher yielding below 3t/ha (more data needed). Fungicides may be required to manage scald, STNB and barley leaf rust. Like Granger, Banks has a higher level of resistance than other varieties to the new Oxford virulent NTNB as a seedling. Its weed competitiveness has not been tested. Banks has passed Stage 1 of the Barley Australia malting and brewing accreditation process and is currently on track to complete Stage 2 in March 2019.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	–	–	102	101	102
Agzone 2	–	–	101	104	101
Agzone 3	–	–	102	104	105
Agzone 4	–	–	98	–	92
Agzone 5	–	–	97	109	101
Agzone 6	–	–	104	109	113

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	0 to +1	+8 to +10
late May	-1 to +1	+8 to +10
early July	-1 to +1	+7 to +9

Agronomic traits	
Coleoptile length	Short
Target plant density	–
Plant height	Short
Straw strength	Moderately good
Head loss risk	–

Herbicide tolerance

Has not been tested for its sensitivity to label rate applications of herbicides registered for use in Western Australia.

Variety information	
Pedigree	WABAR2312/WABAR2332
Breeder / Seed licensee	InterGrain
Access to seed	Seedclub members & resellers
EPR ($/t, excl. GST)	$4.00

RGT Planet[b]

Stage 2 malt accreditation

RGT Planet (tested as SFR85-014) is a new medium height, medium spring, semi-dwarf introduction from Europe. Appears to be well suited to environments with a yield potential above 4t/ha. In those enviroments RGT Planet is likely to be the highest yielding variety, out-yielding the current yield benchmark Rosalind barley. RGT Planet however, does not appear to carry the same yield advantage in area below 3t/ha. Carries the *mlo* gene, conferring resistance to powdery mildew and APR to barley leaf rust. Fungicides may be required to manage NTNB (including Beecher virulent and new Oxford virulent NTNB), STNB and barley leaf rust when under high pressure. Research from eastern Australia suggests RGT Planet has a similar level of weed competiitveness (against oats) to Compass and Fathom. RGT Planet has passed Stage 1 of the Barley Australia malting and brewing accreditation process and is currently on track to complete Stage 2 in March 2019.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	–	–	–	103	97
Agzone 2	–	–	–	109	101
Agzone 3	–	–	–	108	115
Agzone 4	–	–	–	–	72
Agzone 5	–	–	–	128	108
Agzone 6	–	–	–	128	138

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-5 to -7	+3 to +5
late May	-3 to -5	+4 to +6
early July	-1 to +1	+6 to +8

Agronomic traits	
Coleoptile length	–
Target plant density	–
Plant height	Medium
Straw strength	Moderately good
Head loss risk	Low

Herbicide tolerance

Has not been tested for its sensitivity to label rate applications of herbicides registered for use in Western Australia.

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

Buff(b)

Feed variety

Comments

Buff (tested as IGB1506) is a medium height, early spring, two row, barley bred by InterGrain and registered in September 2018 with improved tolerance to low soil pH and high soil Al. Unlike Litmus, Buff has a white aleurone. On acidic soils Buff is a direct competitor to Litmus as they have similar aluminium tolerance genetcis, conferring increased tolerance to acidic soil. Unlike Litmus, Buff is also a competitor on non-acidic soils to Fathom, La Trobe, Rosalind and Spartacus CL (where an imidazolinone herbicide is not planned for use or there are no imidazolinone residues) due to its improved grain yield performance. The overall disease resistance profile of Buff is similar to Litmus with improvements in its tolerance to scald and NTNB. Fungicides may be required to manage STNB, powdery mildew and barley leaf rust. Its reaction to weed competition is unknown. In 2018 Buff was accepted into malt accreditation trials with Barley Australia. The earliest possible accreditation date is autumn 2021.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	–	–	–	112	113
Agzone 2	–	–	–	121	109
Agzone 3	–	–	–	–	–
Agzone 4	–	–	–	–	79
Agzone 5	–	–	–	109	98
Agzone 6	–	–	–	–	–

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	–	–
late May	–	–
early July	–	–

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

Herbicide tolerance

Has not been tested for its sensitivity to label rate applications of herbicides registered for use in Western Australia.

Variety information	
Pedigree	Not yet released
Breeder / Seed licensee	InterGrain
Access to seed	Seedclub members & resellers
EPR ($/t, excl. GST)	$3.50

Fathom(b)

Feed variety

Comments

Fathom is a medium spring, tall height, CCN resistant feed barley. Best suited to environments with a yield potential below 3t/ha and where there is a high risk of STNB. Similar to or slightly below the grain yield of Compass, La Trobe and Spartacus CL. Fungicides may be required to manage early infections of NTNB and barley leaf rust. As a seedling, VS to the new Oxford virulent NTNB. Fathom has the highest level of resistance to STNB of current varieties. It is mixed for its head colour, having green and waxy green heads. Fathom is one of the more weed competitive barley varieties being similar to Compass and RGT Planet in eastern state weed competition trials.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	101	94	96	107	109
Agzone 2	96	97	93	111	105
Agzone 3	100	95	96	100	98
Agzone 4	101	79	92	–	98
Agzone 5	99	99	91	92	97
Agzone 6	85	101	89	96	84

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-3 to +1	+7 to +12
late May	-3 to -2	+5 to +6
early July	-6 to -4	0 to +2

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

Herbicide tolerance

May be sensitive to a label rate application of Diuron + MCPA (diuron + MCPA) sprayed at Z13-Z14.

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

LG Maltstar(b)

Feed variety

Comments

LG Maltstar is a medium spring, medium height, semi-dwarf barley from the same breeding company as Granger and Oxford. LG Maltstar grain has a white aleurone even though one of its parents is the blue aleurone variety Henley. LG Maltstar has good straw strength combined with a low head loss risk. Like Granger, LG Maltstar carries the *mlo* gene (conferring resistance to powdery mildew) and the APR barley leaf rust gene *Rph20*. Fungicides may be required to manage scald, STNB and early infections of barley leaf rust. LG Maltstar has shown variable reactions in WA disease nurseries to barley leaf rust despite carrying the APR gene *Rph20*. As a seedling it is MS to the new Oxford virulent NTNB. Its reaction to weed competition is unknown. In 2017 LG Maltstar was accepted into malt accreditation trials with Barley Australia. Stage 1 assessment has been delayed until 2019. The earliest possible accreditation date is autumn 2021.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	–	–	–	–	88
Agzone 2	100	96	86	99	94
Agzone 3	96	97	93	98	104
Agzone 4	89	–	–	–	64
Agzone 5	100	94	88	115	99
Agzone 6	110	112	107	111	132

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-1 to +1	+9 to +11
late May	-3 to -1	+6 to +7
early July	+3 to +5	+11 to +13

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

Herbicide tolerance

Has not been tested for its sensitivity to label rate applications of herbicides registered for use in Western Australia.

Variety information	
Pedigree	Henley/Sebastian
Breeder / Seed licensee	Limagrain / Elders
Access to seed	Free to trade
EPR ($/t, excl. GST)	$3.00

Litmus(b)

Feed variety

Comments

Litmus is an early spring, tall height, feed barley with improved tolerance to low soil pH and high soil Al. Best suited to environments with a yield potential below 2t/ha where the sub-soil (10-30cm) has a pHCaCl^2 below 4.8. Carries *Alt1* gene which allows its roots to excrete citrate reducing the toxicity of Al in the soil, resulting in increased grain yield relative to traditional barley varieties on acidic soils. Litmus provides growers with an option to diversify their wheat phase on acidic soils, but does not ameliorate the soil as lime is required to ameliorate soil with a low pH. Litmus has poor straw strength, is susceptible to all leaf diseases but has the lowest yield loss in the presence of crown rot. As a seedling it is S to the new Oxford virulent NTNB. Its reaction to weed competition is unknown. Litmus has been withdrawn by its breeder InterGrain from Barley Australia's malt accreditation process. Due to the presence of blue aleurone in its grain it can only be delivered to sites where active management of blue aleurone in feed barley stacks is occurring.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	109	80	116	102	113
Agzone 2	108	75	105	111	99
Agzone 3	89	88	88	104	100
Agzone 4	94	101	99	–	93
Agzone 5	85	75	79	99	84
Agzone 6	72	72	81	91	92

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-15 to -10	-4 to -1
late May	-11 to -8	-3 to 0
early July	-8 to -6	-1 to +1

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

Herbicide tolerance

Has shown no sensitivity to a range of herbicides / herbicide mixtures at label rates in herbicide tolerance trials conducted in WA.

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

Lockyer(b)

Feed variety

Comments

Lockyer is a longer seasoned, semi-dwarf, short height, high yielding, feed barley. Best suited to environments with a yield potential above 3t/ha. Lockyer is higher yielding than Compass and La Trobe in Agzone 6 and is well suited to environments with a yield potential above 4t/ha. Rosalind out-yields Lockyer in all Agzones except Agzone 6. Relative to Oxford, Lockyer can maintain its grain yield as seeding is delayed into June and July. With April planting, Lockyer has one of the longest durations to awn peep of commercial varieties. Fungicides may be required to manage STNB and barley leaf rust. As a seedling it is S to the new Oxford virulent NTNB. Its reaction to weed competition is unknown.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	113	103	88	–	108
Agzone 2	101	101	91	–	103
Agzone 3	98	96	92	–	108
Agzone 4	104	60	90	–	88
Agzone 5	104	105	91	102	105
Agzone 6	88	114	96	103	88

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	+3 to +5	+13 to +15
late May	+2 to +4	+10 to +11
early July	-1 to 0	+5 to +6

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

Herbicide tolerance

May be sensitive to label rate applications of Achieve® (tralkoxydim), Eclipse® + MCPA LVE (metosulam + MCPA) and Hoegrass® (diclofop-methyl) sprayed at Z13-Z14; and to 2,4-D Amine 625 sprayed at Z15-Z16.

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

Mundah

Feed variety

Comments

Mundah is a very early spring, medium height, feed barley. Best suited to environments with a yield potential below 2t/ha and later sowing systems where early season weed control is necessary. Lower yielding than all the newer varieties including Compass, Fathom, La Trobe, Lockyer, Rosalind and Spartacus CL. Mundah can suffer from head loss and lodging. Fungicides may be required to manage scald, NTNB (Beecher virulent and Oxford virulent), STNB, powdery mildew and barley leaf rust. Mundah appears to have a similar weed competitiveness to Compass and Fathom, although it has not been tested side by side in trials.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	97	93	100	–	100
Agzone 2	96	79	96	–	89
Agzone 3	85	86	78	–	98
Agzone 4	91	100	97	–	86
Agzone 5	83	80	82	–	88
Agzone 6	64	73	83	–	87

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-19 to -17	-10 to -7
late May	-15 to -13	-8 to -5
early July	-9 to -6	-2 to 0

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

Herbicide tolerance

May be sensitive to a label rate application of Wildcat® (fenoxaprop-P-ethyl) sprayed at Z13-Z14.

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

Oxford

Feed variety

Comments

Oxford is a long seasoned, semi-dwarf, short height, 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. In those situations Oxford is often higher yielding than Compass and La Trobe but appears to be inferior to RGT Planet. Rosalind out-yields Oxford in all Agzones except Agzone 6. Oxford appears to be sensitive to flowering frost. Fungicides may be required to manage STNB and early season barley leaf rust. There is evidence of increasing virulence of NTNB and powdery mildew on Oxford barley, mainly on the south coast. Growers should collect infected NTNB and powdery mildew leaf samples from unsprayed crops and send to DPIRD for pathotyping. As a seedling it is S to the new Oxford virulent NTNB. Weed competitiveness is similar to other semi-dwarf varieties.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	102	93	80	95	87
Agzone 2	98	99	83	–	94
Agzone 3	97	98	94	98	104
Agzone 4	89	25	81	–	61
Agzone 5	103	98	88	–	101
Agzone 6	114	119	109	114	134

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-1 to +3	+9 to +13
late May	+2 to +3	+10 to +11
early July	+2 to +4	+9 to +10

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

Herbicide tolerance

Has shown no sensitivity to a range of herbicides / herbicide mixtures at label rates in herbicide tolerance trials conducted in WA.

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

Rosalind(b)

Feed variety

Comments

Rosalind is an early spring, medium height, CCN resistant, feed barley derived from Dash and Lockyer with a high grain yield potential. Suited to all environments where there is a low probability of delivering malt grade barley. Rosalind, first tested in NVT in 2014, is the yield benchmark for barley in WA, regularly out-yielding La Trobe depending on year and Agzone. Rosalind appears to be inferior to RGT Planet at yields above 4t/ha and better below 3t/ha. Has good straw strength and head retention. Fungicides will be required to manage STNB. There is evidence of increased virulence of NTNB on Rosalind barley growing on the south coast and as a seedling it is rated as S to the new Oxford virulent NTNB. Based on its plant architecture (particularly larger leaf size) Rosalind is expected to have a good level of weed competitiveness, but it has not been tested.

Yield (% La Trobe)	2013	2014	2015	2016	2017
Agzone 1	–	108	110	108	110
Agzone 2	–	105	113	110	104
Agzone 3	–	105	106	109	112
Agzone 4	–	116	109	–	111
Agzone 5	–	108	107	110	109
Agzone 6	–	109	108	111	97

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

Flowering (days to Z49)	rel. Scope CL	rel. La Trobe
late April	-12 to -7	-2 to +2
late May	-9 to -3	-2 to +2
early July	-5 to -3	-1 to +2

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

Herbicide tolerance

Showed no sensitivity to a range of herbicides / herbicide mixtures at label rates in a herbicide tolerance trial conducted in WA during 2015.

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

Notes

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