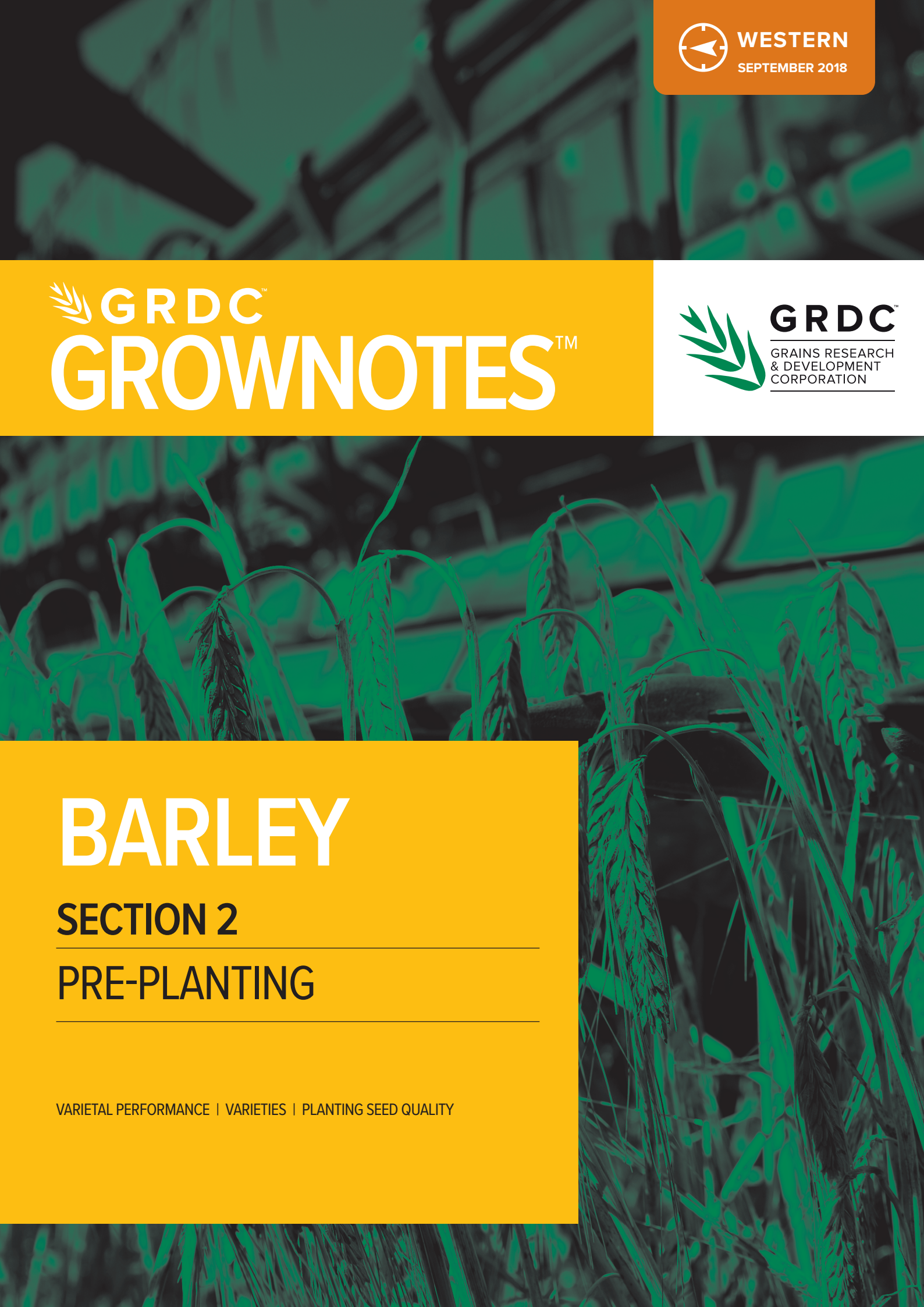


WESTERN
SEPTEMBER 2018

GRDC GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

BARLEY

SECTION 2

PRE-PLANTING

VARIETAL PERFORMANCE | VARIETIES | PLANTING SEED QUALITY

Pre-planting

FAQ

2.1 Varietal performance

2.1.1 Selecting barley varieties

As the number of barley varieties available to growers increases, the decision of which variety to use, come seeding time, has become more difficult. The Barley Variety Guide produced by the Department of Agriculture and Food, Western Australia (DAFWA) and co-funded by Grains Research and Development Corporation (GRDC) provides an independent appraisal of the most relevant barley varieties available to growers in WA. This includes market feedback, grain-yield comparisons, disease-resistance ratings, herbicide tolerance and agronomic attributes. [1]

When selecting a variety, consider crop use, disease prevalence and herbicide tolerance. Select a suitable variety for your planting time and area, taking into consideration yield potential and disease risks. Leaf rust, net blotches and powdery mildew are the more important diseases and selecting a resistant variety can mean improved performance and reliability.

The variety chosen should be:

- appropriate for the environment and farming system
- suitable to the sowing time
- able to be segregated in storage in the case of malting varieties. [2]

Photo 1: *Once at the tillering stage barley is more resilient to pest attack.*

Source: DAFWA

MORE INFORMATION

DAFWA (2016) 2017 Barley variety sowing guide for Western Australia.

GIWA (2016) Western Australian Malting Barley Variety Receival Recommendations 2017/18 Harvest.

GRDC (2015) Using crop competition for weed control in barley and wheat.

GRDC (2015) Barley agronomy results 2014.

GRDC (2014) New and potential malting barley variety update and agronomic developments.

GRDC Crop Variety Guides

1 DAFWA (2016) 2017 Barley variety sowing guide for Western Australia. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/3766

2 P Matthews, D McCaffery, L Jenkins (2014) Winter crop sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

2.1.2 Yielding ability and GRDC-funded National Variety Trials (NVT)

When considering a new variety, growers should compare the yield, grain quality and disease resistance with varieties currently grown.

Grains industry productivity is dependent on the continued adoption and deployment of new technologies, including the adoption of new varieties with superior yield and useful disease-resistance characteristics.

National Variety Trials collect the most relevant varieties for each region and test them alongside the elite lines from the breeding programs. For information on the released varieties in the NVT, visit the NVT website at: www.nvtonline.com.au. [3]

Individual trial results from NVT provide only a snapshot in time and may lead to unsuitable varietal choice. Combining data across trials and years increases the chance of selecting the appropriate varieties; the current long-term analysis is based on geographic region. [4]

National focus

In comparison to wheat, individual barley varieties are generally more widely adopted in Australia, often across a wide range of agro-ecological zones. Consequently, barley breeding programs tend to be nationally focused, with national varieties.

In 2012, a collaborative trial series was initiated, involving the Grain Research Development Corporation (GRDC) funded barley agronomy projects operating in the western, southern, and northern grains regions. The trials compared yield and quality responses of potential malt varieties likely to be grown nationally, under a range of management practices.

Eight varieties, selected with a national rather than a regional focus, were sown across nine locations in WA, SA, Victoria and NSW. The varieties selected were Bass$^{\Phi}$, Flinders$^{\Phi}$, Granger$^{\Phi}$, La Trobe$^{\Phi}$, Skipper$^{\Phi}$ and Wimmera$^{\Phi}$, with Buloke$^{\Phi}$ and Commander$^{\Phi}$ included as controls.

Results from this study show that agronomic management (nitrogen (N) application and seed rate) can influence grain yield and quality. The cultivar IGB1101 showed that it was very adaptable, performing well over the range of sites and treatments imposed.

Environmental factors related to growing season rainfall, and climatic conditions during anthesis and grain fill, in combination with soil N status, also impacted on cultivar performance. Grain protein content (GPC) was observed to be highly influenced by environment, exhibiting large genotype by environment interactions.

The study found that apart from some small variations in physical quality parameters (test weight, retention or screenings), GPC was the major factor influencing the failure of cultivars to meet malt receival standards. [5]

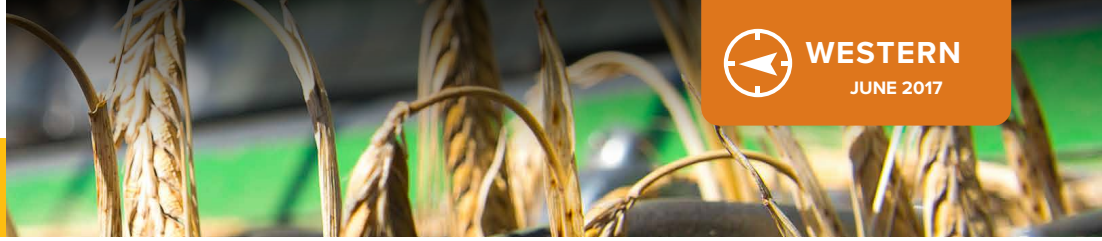
Varieties do respond differently to management. The relative performance of varieties is not constant; it changes as the environment changes. Each variety can be successful if their weaknesses are managed for the environment. Growers need to focus on maximising quality or maximising returns rather than focusing on maximising yield when growing malt barley. [6]

3 NVT (2013) Queensland 2013 wheat varieties. GRDC/Department of Agriculture and Fisheries Queensland, http://www.grdc.com.au/NVT-QLD-WheatVarietyGuide

4 A Kelly, A Smith, B Cullis (2013) Which variety should I grow?, GRDC Update Papers, 12 March 2013, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/03/Kelly-Alison-What-should-I-grow

5 R Graham and B Paynter et al. (2013) Yield and Quality Responses of Potential Malting Barley Varieties of National Significance. 16th Australian Barley Technical Symposium, Melbourne, VIC, 8–11 September 2013, https://www.researchgate.net/publication/274069140_Yield_and_quality_responses_of_potential_malting_barley_varieties_of_national_significance

6 B Paynter (2015) National barley agronomy R&D - focus on V x N x SR interactions. 17th Australian Barley Technical Symposium, Sydney NSW, 13–16 September 2015, https://www.researchgate.net/publication/281853753_National_barley_agronomy_RD_-_focus_on_V_x_N_x_SR_interactions_-_power_point_presentation



2.1.3 Malting and other quality traits

Malting varieties

In WA, to achieve Malt1 specifications, barley growers need to achieve grain protein between 9.5 to 12.5%, in addition to satisfying physical grain quality receival standards, related to grain size, weight and uniformity. [7]

Malting barley varieties in Australia are accredited by Barley Australia. They undergo rigorous testing to ensure they meet malting standards both for domestic and international markets. The Barley Australia website has a list of currently accredited varieties. [8]

Malt barley varieties traditionally account for over 80% of the area sown to barley (Table 1), although in recent years segregated varieties have included the food variety Hindmarsh$^{\Phi}$. Only one feed variety, Mundah, features in the top 10 barley varieties sown in WA. [9]

Malting varieties, in particular, need to be planted, grown and harvested with care. Factors to take into consideration include:

- Phosphorus (P). Too little P will limit yield and increase protein. (WA research shows barley has a similar P requirement to wheat)
- Nitrogen (N). Too little N will reduce yield and quality, whereas excessive N fertiliser can increase screenings and protein levels
- Disease. Appropriate and timely disease management and careful canopy management can improve the chance of achieving malting quality
- Timely weed control. Weeds compete for nutrients and moisture; effective weed control reduces the risk of contamination
- Care with harvest. Avoid skinning the grain; try to minimise weather damage; avoid varietal contamination; use only grain protectants registered for malting barley. [10]

For more information, see: Barley Australia: Preferred varieties list, the DAFWA 2017 barley variety sowing guide for Western Australia and the MyCrop barley app which is also helpful for diagnosis of pest, disease and nutrition.

Table 1: *Grain yield of barley varieties expressed as a percentage of Hindmarsh$^{\Phi}$ (NVT 2005–14). Data presented where there are five or more observations except Rosalind$^{\Phi}$ as only one year of data was available.*

Variety	Agzone 1		Agzone 2		Agzone 3		Agzone 4		Agzone 5		Agzone 6	
	(%)	(no. obs)	(%)	(no. obs)	(%)	(no. obs)	(%)	(no. obs)	(%)	(no. obs)	(%)	(no. obs)
Malt varieties												
Bass$^{\Phi}$	95	8	82	32	94	31	79	11	85	27	96	13
Baudin$^{\Phi}$	85	8	82	32	81	31	76	11	82	27	82	13
Flinders$^{\Phi}$	97	6	94	29	97	27	85	10	93	23	104	11
Granger$^{\Phi}$	100	7	93	32	98	31	82	9	90	27	103	13
La Trobe$^{\Phi}$	103	5	99	25	101	24	97	8	99	20	102	10
Scope CL$^{\Phi}$	94	8	87	32	94	31	85	11	86	27	87	13

7 R Graham and B Paynter et al. (2013) Yield and Quality Responses of Potential Malting Barley Varieties of National Significance. 16th Australian Barley Technical Symposium, Melbourne, VIC, 8–11 September 2013, https://www.researchgate.net/publication/274069140_Yield_and_quality_responses_of_potential_malting_barley_varieties_of_national_significance

8 P Matthews, D McCaffery, L Jenkins (2015) Winter crop sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

9 DAFWA (2016) 2017 Barley variety sowing guide for Western Australia. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/3766

10 P Matthews, D McCaffery, L Jenkins (2015) Winter crop sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

Variety	Agzone 1		Agzone 2		Agzone 3		Agzone 4		Agzone 5		Agzone 6	
Food varieties												
Hindmarsh$^{\Phi}$	100	8	100	32	100	31	100	11	100	25	100	13
Feed varieties												
Compass$^{\Phi}$	101	4	98	20	103	20	97	6	98	16	98	8
Fathom$^{\Phi}$	97	6	90	29	98	27	93	10	96	24	96	11
Fleet$^{\Phi}$	92	8	85	32	95	31	86	11	90	25	90	13
Litmus$^{\Phi}$	66	4	88	20	89	20	88	6	80	16	80	8
Lockyer$^{\Phi}$	100	8	93	32	98	31	87	11	96	26	103	13
Mundah	73	8	84	29	87	31	88	11	80	27	76	13
Oxford$^{\Phi}$	103	7	89	27	96	31	71	9	87	25	108	11
Rosalind$^{\Phi}$	-	2	107	11	103	10	104	4	104	8	105	4
Spartacus CL$^{\Phi}$	-	2	101	11	98	10	99	4	99	8	101	4
Yagan	-	0	-	0	-	0	-	0	-	0	-	0
Hindmarsh$^{\Phi}$ yield (t/ha)	**2.87**	**8**	**2.88**	**32**	**4.42**	**31**	**1.95**	**11**	**3.30**	**25**	**3.17**	**13**

Source: NVT Online nvtonline.com.au

PODCAST

GRDC (2012) New barley test. Driving Agronomy Podcast.

VIDEO

GRDC (2011) Malting Barley Purity GCTV 6. Video.

Malting barley purity test

Australia's barley industry has a global reputation as a producer of high-quality malting barley. From a trade perspective it is an enviable reputation, so the GRDC and Diversity Arrays Technology (DArT), one of the world's leading crop DNA profiling laboratories, devised a purity test for malting barley varieties that will ensure our reputation is maintained.

The commercial test, developed with funding from GRDC, helps growers to ensure they are growing malting barley varieties most sought after by maltsters. Malting barley varieties are increasingly more difficult to differentiate. The test can determine the purity of a variety is and which other varieties may be present in a sample. For more information, visit: GrainGrowers Products and Services—Barley testing.

Food-grade varieties

This is a classification introduced for the 2010 harvest by Barley Australia. Barley varieties need to meet all of the physical quality parameters that apply to accredited malting barleys, such as protein, test weight, screenings and head retention, before they can be accepted into Food Barley segregations. This classification was developed to accommodate Hindmarsh$^{\Phi}$, a variety developed to supply maltsters but which failed to gain malting accreditation.

Feed varieties

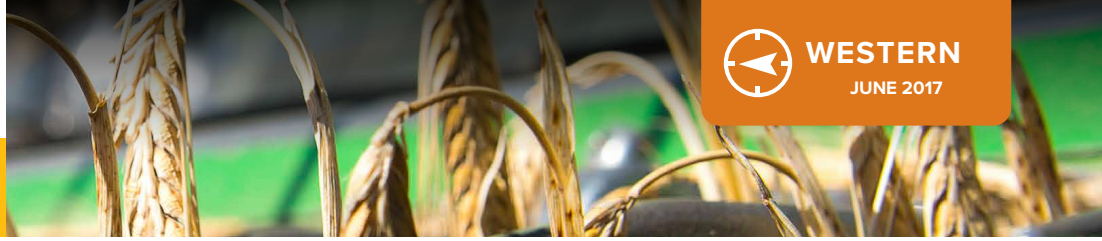
Feed accredited varieties include any two-row varieties with white aleurone layer. [11]

2.1.4 Disease resistance

Seedling and adult resistance

Leaf disease ratings include both seedling- and adult-stage resistance ratings for the foliar leaf diseases net type net blotch (NTNB), spot type net blotch (STNB), powdery mildew and barley leaf rust (Table 2 and Table 3). There is no seedling data for scald so only the adult-stage resistance is tabulated.

11 GTA (2013) Barley standards. 2013/2014 season. Grain Trade Australia, http://www.grainland.com.au/web/Grainland_Manuals/Product%20Manuals/Grain%20Standards/GTA%20Barley%20Standards%20-%20%202013-14.pdf



Seedling ratings are applicable at early growth stages (two to three-leaf stage) and are important for making decisions on seed fungicide treatments and/or knowing 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 like 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 stem elongation. Variation in the seedling and adult rating of a variety is most likely due to the presence or absence of adult plant resistance genes.

The ratings of varieties may vary over time and these are noted where observed. Seasonal changes occur because of differences in disease pressure, spread of the disease in the region, changes in climatic conditions, stubble retention and development of new pathotypes. [12]

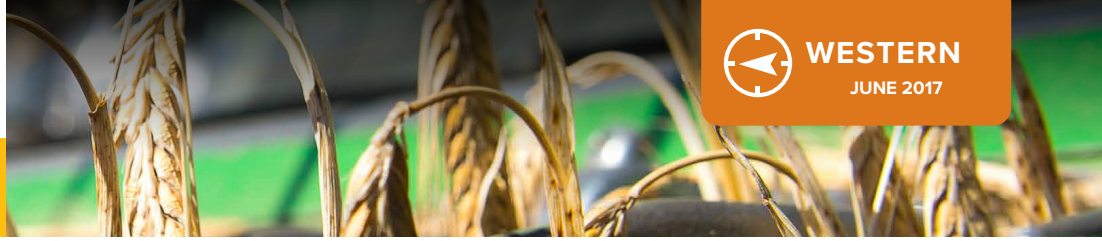
Table 2: *Seedling (two- to three-leaf stage) leaf disease resistance profiles when grown in WA.*

Disease[1]	Scald	Net type net blotch[4]	Net type net blotch[4]	Spot type net blotch	Powdery mildew[5]	Barley leaf rust6
Pathotype[2]	**Medina**	**Beecher virulent (95NB100)**	**Beecher avirulent (97NB1)**	**(South Perth)**	**(South Perth)**	**(5457 P-)**
Growth Stage[3]	**Seedling**	**Seedling**	**Seedling**	**Seedling**	**Seedling**	**Seedling**
Malt varieties						
Bass$^{\Phi}$	-	MR	S	MRMS	MSS	S
Baudin$^{\Phi}$	-	S	S	MRMS	VS	SVS
Flinders$^{\Phi}$	-	MRMS	S	MS	R	MS
Granger$^{\Phi}$	-	MS	MS	S	R	MS
La Trobe$^{\Phi}$	-	MS	MRMS	S	MSS	MS
Scope CL$^{\Phi}$	-	MR	MR	MS	R	S
Food varieties						
Hindmarsh$^{\Phi}$	-	MRMS	MRMS	SVS	MRMS	S
Feed varieties						
Compass$^{\Phi}$	-	MRMS	S	MRMS	MS	S
Fathom$^{\Phi}$	-	S	S	MR	MS	S
Fleet$^{\Phi}$	-	MSS	MRMS	MR	MRMS	MS
Litmus$^{\Phi}$	-	S	S	S	MS	S
Lockyer$^{\Phi}$	-	MR	MR	S	MS	S
Mundah	-	S	MS	S	SVS	S
Oxford$^{\Phi}$	-	RMR	MR	S	R	S
Rosalind$^{\Phi}$	-	MR	MR*p*	MS	MS*p*	MRMS
Spartacus CL$^{\Phi}$	-	MSS	MSS	SVS	MS	MS
Yagan	-	MRMS	MRMS	MRMS	R	S

Source: Sanjiv Gupta

1. Resistance rating: VS = very susceptible, S = susceptible, MS = moderately susceptible, MRMS = intermediate, MR = moderately resistant, R = resistant, / = due to multiple strains of the pathogen the alternate reaction is also presented, p = provisional rating, - = no data available.

12 DAFWA (2016) 2017 Barley variety sowing guide for Western Australia. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/3766



2. Pathotype: source of disease used in evaluating the disease reaction of the different barley varieties. The source used for evaluating varietal resistance represents the most common pathotype present in WA. On farm reactions of varieties may therefore differ if the pathotype/s present differ to the pathotype used in testing.
3. Growth stage: the seedling resistance score reflects resistance at the two to three leaf stage (data not relevant 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: there are two major pathotypes (95NB100 and 97NB1) of NTNB present in WA. The Beecher avirulent (97NB1) pathotype is the dominant isolate, but north of the Great Eastern Highway, Beecher virulent (95NB100) and avirulent (97NB1) pathotypes are present in similar proportions. The reaction of Bass$^{\Phi}$, Compass$^{\Phi}$ and Flinders$^{\Phi}$ as seedlings will differ significantly depending on the pathotype present.
5. Powdery mildew: varieties with a VS or S rating at the seedling stage (Baudin$^{\Phi}$, IGB1334T, Mundah and Rosalind$^{\Phi}$) should be treated with a seed dressing active against powdery mildew to prevent early infection during the tillering stage.
6. Barley leaf rust: a new pathotype (5457 P-) was detected in September 2013 virulent on the Rph3 gene. The resistance score before the / is the seedling resistance in the presence of 5453 P-. The resistance score after the / is the seedling resistance in the presence of 5457 P-. As Bass$^{\Phi}$ and Compass$^{\Phi}$ only carry the Rph3 gene, their seedling and adult resistance in the presence of 5457 P- is reduced. Granger$^{\Phi}$ and Oxford$^{\Phi}$ carry an adult plant resistance gene Rph20.

Disease surveillance

Growers and consultants observing barley varieties carrying significantly greater levels of disease than expected should collect infected material for pathotype identification. These include barley varieties rated as MRMS, MR or R to scald, NTNB, STNB, powdery mildew or barley leaf rust.

Samples of powdery mildew infected leaf material should be forwarded to the Centre for Crop and Disease Management at Curtin University. Unlike other leaf diseases, powdery mildew infected leaves need to be placed into agar to maintain a live culture for pathotyping. To arrange sample collection contact Simon Ellwood via email on simon.elwood@curtin.edu.au and phone +61 (0)8 9266 9915.

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 leaf in half so infected area is on the inside. Do not wrap leaf material in plastic or send in plastic lined envelopes.

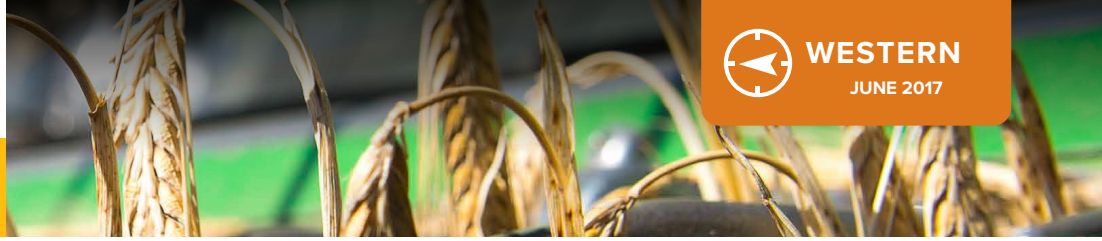
Scald, NTNB and STNB infected leaf material should be sent to the Department of Agriculture and Food Western Australia, Locked Bag 4, Bentley Delivery Centre WA 6983 and marked attention Jason Bradley. For more information contact Jason Bradley (jason.bradley@agric. wa.gov.au) or phone +61 (0)8 9368 3982.

Barley leaf rust samples should be sent directly to the ACRCP Annual Cereal Rust Survey, Plant Breeding Institute, Private Bag 4011, Narellan NSW 2567. For more information, contact Professor Robert Park (robert.park@sydney.edu. au) or phone +61 (0)2 9351 8806. [13]

Disease rankings

Disease ranking for barley lines and cultivars in NVT is now carried out independently through nationally coordinated projects. A disease-assessment process was implemented for barley in 2012, following the model established for wheat.

13 DAFWA (2016) 2017 Barley variety sowing guide for Western Australia. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/3766



Nationally coordinated NVT disease screenings provide a comparative evaluation of a line's performance under different environments and disease epidemics, giving increased confidence to the disease ratings applied to new varieties. This assists growers in their varietal selection and management decisions and encourages breeding entities to develop varieties with adequate multiple-disease resistance. [14]

For more information See Section 9: Diseases.

Table 3: *Agronomic characteristics of a range of barley varieties when grown in WA. The varieties available to WA growers offer a range of characteristics, allowing growers to chose a variety most suited to their situation.*

Agronomic trait	Coleoptile length[1]	Maturity with late May sowing[2]	Frost risk (floret sterility)[3]	Boron leaf symptoms	Straw strength	Head loss risk[4]	Plant height at maturity[5]	Grain plumpness
Malt varieties								
Bass$^{\phi}$	Medium	Medium	Normal	Medium	Very good	Medium	Short	Good
Baudin$^{\phi}$	Medium	Medium	Normal	Medium	Very good	Low	Short	Fair
Flinders$^{\phi}$	Short	Medium	Lower	Medium	Very good	Low	Short	Mod. good
Granger$^{\phi}$	Medium	Medium	Higher	-	Good	Low	Medium	Mod. good
La Trobe$^{\phi}$	Short	Early	Higher	Medium	Mod. good	Medium	Medium	Mod. good
Scope CL$^{\phi}$	Short	Medium	Normal	-	Fair	High	Tall	Fair
Food varieties								
Hindmarsh$^{\phi}$	Short	Early	Normal	Medium	Fair	Medium	Medium	Mod. good
Feed varieties								
Compass$^{\phi}$	Medium	Medium	Normal	-	Fair	Medium	Medium	Good
Fathom$^{\phi}$	Medium	Medium	Normal	Medium	Fair	Low	Tall	Good
Fleet$^{\phi}$	Long	Medium	Normal	Low	Fair	Medium	Medium	Good
Litmus$^{\phi}$	Short	Early	Normal	Medium	Fair	Medium	Tall	Mod. good
Lockyer$^{\phi}$	Medium	Late	-	Medium	Mod. good	Low	Short	Poor
Mundah	Medium	Very early	Normal	Medium	Fair	Medium	Medium	Very good
Oxford$^{\phi}$	Medium	Late	Higher	-	Very good	Low	Short	Very poor
Rosalind$^{\phi}$	Short	Medium	-	Medium	Good	Low	Medium	Mod. good
Spartacus CL$^{\phi}$	Short	Early	-	Medium	Good	Low	Medium	Mod. good
Yagan	Medium	Very early	-	Medium	Fair	Medium	Medium	Very good

Source: DAFWA

1. Coleoptile length: short (40–60 mm), medium (60–80 mm) and long (80–100 mm).
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. 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.
4. Plant height at maturity: very short (<45 cm), short (45–55 cm), medium (55–65 cm) and tall (65–75 cm) relative to Stirling and Buloke$^{\phi}$ at sites where their straw (ground to base of ear) was between 65–75 cm long. [15]

14 G Hollaway, G Platz (2012) Coordinated disease management. National Variety Trials supplement. GRDC Ground Cover Issue 101, https://grdc.com.au/__data/assets/pdf_file/0020/117191/ground-cover-supplement-101-nvt.pdf.pdf

15 DAFWA (2016) 2017 Barley variety sowing guide for Western Australia. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/3766

MORE INFORMATION

GRDC (2016) Managing frost risk– Northern Southern and Western Regions. Fact sheet.

DAFWA (2009) Bulletin 4765. Maintaining variety purity in the WA malting barley industry.

VIDEO

GCTV 15: Frost Ratings

2.1.5 Frost ratings

Grain growers and their advisers will soon be able to reference Frost Susceptibility Ratings for many varieties of wheat and barley. The ratings are an outcome of the Australian National Frost Program, part of GRDC's Frost Initiative. For more information, see Section 14: Environmental issues.

2.1.6 Agronomic attributes

It can be very difficult to distinguish between varieties once they are sown in the paddock (Table 4).

Some questions about the defining characteristics might include:

- What did the crop look like at eight to ten 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 rachis?

If visual cues are not enough, the grain will need to be tested at an accredited laboratory for varietal purity. AGWEST Plant Laboratories offers a mass spectrometry test that compares the protein profile of a combined sample, or 30 individual seeds, or 150 individual seeds.

Grain plumpness

The benchmark malt variety for grain plumpness is Bass$^{\Phi}$. All the newer malt varieties have a grain plumpness better than Baudin$^{\Phi}$ but not as good as Bass$^{\Phi}$. Bass$^{\Phi}$ is plumper than Flinders$^{\Phi}$ and Granger$^{\Phi}$. Plumpness of La Trobe$^{\Phi}$ is similar to Hindmarsh$^{\Phi}$, whereas Commander$^{\Phi}$ is not quite as plump as Hindmarsh$^{\Phi}$. Scope CL$^{\Phi}$ is slightly plumper than Buloke$^{\Phi}$ and similar to Hindmarsh$^{\Phi}$.

Grain colour

At grain colour levels of 53-59 'L*', the benchmark malt variety is Baudin$^{\Phi}$. Within this range the grain colour of Bass$^{\Phi}$ and Flinders$^{\Phi}$ is similar to Baudin$^{\Phi}$, with Hindmarsh$^{\Phi}$ and La Trobe$^{\Phi}$ being about 0.5–0.7 'L*' darker and Granger$^{\Phi}$ about 1.1 'L*' darker. Below 55 'L*' Commander$^{\Phi}$ is similar to Baudin$^{\Phi}$, but brighter above 55 'L*'. Scope CL$^{\Phi}$ is similar in its grain colour to Hindmarsh$^{\Phi}$ and Buloke$^{\Phi}$, but is darker than Bass$^{\Phi}$ and Baudin$^{\Phi}$ below 60 'L*'. [16]

16 DAFWA (2016) 2017 Barley variety sowing guide for Western Australia. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/3766

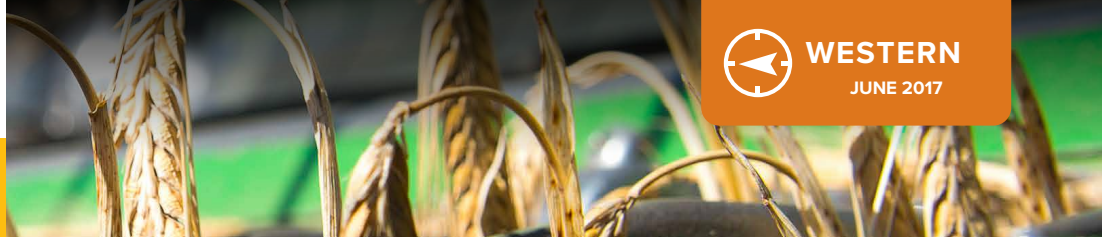


Table 4: *Visual characteristics of a range of barley varieties when grown in WA. While it can be difficult to determine a barley variety once sown, these visual characteristics can be useful to aid identification.*

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$^{\phi}$	Prostrate	Present	Weakly present	Long	Parallel	Short-medium	Long
Baudin$^{\phi}$	Prostrate	Strongly present	Present	Medium	Parallel	Short-medium	Long
Flinders$^{\phi}$	Prostrate	Strongly present	Present	Medium	Parallel	Medium-long	Short
Granger$^{\phi}$	Prostrate	Present	Weakly present	Medium	Parallel	Medium	Short
La Trobe$^{\phi}$	Erect	Present	Present	Medium	Parallel	Medium-long	Short
Scope CL$^{\phi}$	Semi-erect	Weakly present	Absent	Medium	Tapering	Medium	Long
Food varieties							
Hindmarsh$^{\phi}$	Erect	Present	Present	Medium	Parallel	Short-medium	Short
Feed varieties							
Compass$^{\phi}$	Semi-erect	Present	Weakly present	Long	Tapering	Medium-long	Long
Fathom$^{\phi}$	Erect	Weakly present	Weakly present	Very long	Parallel	Medium	Long
Fleet$^{\phi}$	Erect	Absent	Absent	Very long	Parallel	Medium-long	Long
Litmus$^{\phi}$	Erect	Weakly present	Weakly present	Long	Parallel	Medium	Long
Lockyer$^{\phi}$	Prostrate	Weakly present	Present	Long	Parallel	Medium	Long
Mundah	Erect	Weakly present	Weakly present	Long	Parallel	Medium	Short
Oxford$^{\phi}$	Prostrate	Present	Present	Long	Parallel	Medium	Long
Rosalind$^{\phi}$	Erect	Present	Present	Medium	Tapering	-	Long
Spartacus CL$^{\phi}$	Erect	Absent	Absent	Medium	Parallel	-	Short
Yagan	Erect	Present	Present	-	Tapering	-	Short

Source: DAFWA Bulletin 4765, breeding companies and IP Australia Plant Breeders Rights database pericles.ipaustralia.gov.au/pbr_db/search.cfm

2.2 Varieties

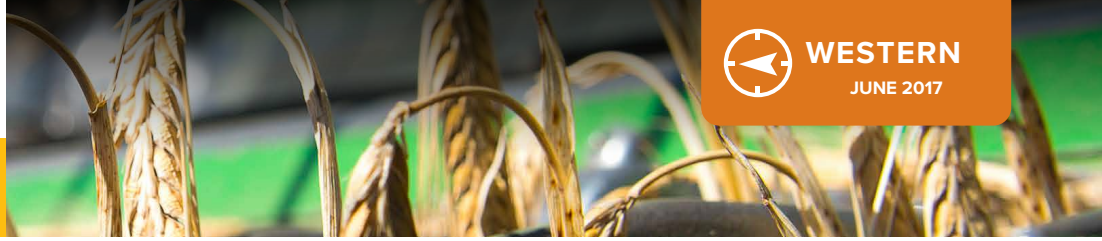
Each of the established, new and future varieties has agronomic (yield, quality, disease, agronomy) strengths and weaknesses. These need to be carefully weighed against demand signals from the market, pricing of malt varieties, pricing of the food variety Hindmarsh$^{\phi}$, and the location of receival sites. [17]

2.2.1 Malt variety

Bass$^{\phi}$

Bass$^{\phi}$ 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 3 t/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

17 DAFWA (2016) 2017 Barley variety sowing guide for Western Australia. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/3766



0.5% higher in grain protein than varieties such as Baudin$^{\Phi}$ and La Trobe$^{\Phi}$ at the same yield and high rates of late nitrogen should be avoided. Can show a moderate head loss risk in the Esperance Port Zone, but not in other Port Zones. Fungicides will be required to manage barley leaf rust, STNB, powdery mildew. Weed competitiveness is similar to other semi-dwarf varieties. Target production zones in 2017 are Kwinana-West, Albany and Esperance Port Zones. (InterGrain/Syngenta)

Baudin$^{\Phi}$

Baudin$^{\Phi}$ is a medium spring, semi-dwarf, malt barley that is acceptable for export as grain, as malt and as a shochu barley. Baudin$^{\Phi}$ is still the 'market leader' for the Chinese, south-east Asian and Japanese brewing markets. Best suited to environments with a yield potential above 3 t/ha and where leaf diseases can be promptly sprayed before they reach 5% of leaf area affected. When growing Baudin$^{\Phi}$, an integrated disease management plan needs to be implemented as it is susceptible to powdery mildew, NTNB, STNB, and barley leaf rust. Vigorous Baudin$^{\Phi}$ crops have reasonable weed competitiveness despite their short height. Target production zone in 2017 is the Esperance Port Zone, whilst niche segregations may be available in Kwinana-West and Albany-North. (Intergrain)

Flinders$^{\Phi}$

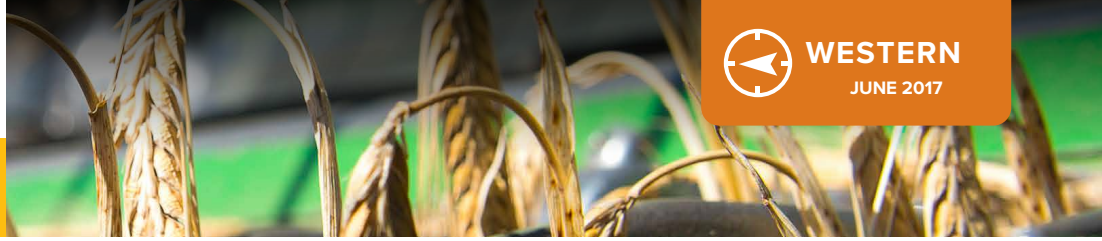
Flinders$^{\Phi}$ is a medium spring, semi-dwarf, malt barley derived from Baudin$^{\Phi}$ but with improved resistance to powdery mildew (non-mlo resistance) and barley leaf rust (due to adult plant resistance, Rph20). Flinders$^{\Phi}$ is being assessed for export as grain and as malt. Best suited to environments with a yield potential above 3 t/ha. Flinders$^{\Phi}$ is a higher yielding option than Hindmarsh$^{\Phi}$ and La Trobe$^{\Phi}$ in environments with a potential above 5 t/ha (i.e. Agzone 6). Grain plumpness of Flinders$^{\Phi}$ is an improvement over Baudin$^{\Phi}$, Hindmarsh$^{\Phi}$, La Trobe$^{\Phi}$ and Scope CL$^{\Phi}$ with a grain brightness between Bass$^{\Phi}$ and Baudin$^{\Phi}$. Fungicides will be required to manage STNB and early infections of barley leaf rust. Weed competitiveness is similar to other semi-dwarf varieties. Target production zones in 2017 are Kwinana West, Albany and Esperance Port Zones. (Intergrain/Syngenta)

Granger$^{\Phi}$

Granger$^{\Phi}$ is a medium spring, semi-dwarf, malt variety being assessed for export as grain but not as malt or for shochu. Best suited to environments with a yield potential above 3 t/ha. Granger$^{\Phi}$ is a higher yielding option than Hindmarsh$^{\Phi}$ and La Trobe$^{\Phi}$ in environments with a potential above 5 t/ha (i.e. Agzone 6). Granger$^{\Phi}$ (like La Trobe$^{\Phi}$ and Oxford$^{\Phi}$) is more sensitive to frost (higher frost sterility) than other barley varieties. Granger$^{\Phi}$'s grain is plumper than that of Baudin$^{\Phi}$, but not as plump as Bass$^{\Phi}$. Grain brightness is expected to be an issue in coastal areas as it has a naturally darker kernel than other malt varieties. Fungicides will be required to manage scald, STNB and early infections of barley leaf rust. Has durable resistance to powdery mildew (mlo resistance). Target production zones in 2017 are Albany and Esperance Port Zones. (Limagrain/Heritage Seeds)

La Trobe$^{\Phi}$

La Trobe$^{\Phi}$ is an early spring, semi-dwarf, CCN resistant, malt barley. It is being assessed for export as grain and as malt and for use in the manufacture of shochu in Japan. La Trobe$^{\Phi}$ is suited to all environments as a replacement for Hindmarsh$^{\Phi}$. Agronomic performance (maturity, weed competitiveness, grain yield, grain plumpness, grain brightness) of La Trobe$^{\Phi}$ is almost identical to Hindmarsh$^{\Phi}$. It is the most yield responsive malt variety to N. La Trobe$^{\Phi}$ (like Granger$^{\Phi}$ and Oxford$^{\Phi}$) is more sensitive to frost (higher frost sterility) than other barley varieties. Every La Trobe$^{\Phi}$ seed should be treated with a good quality smuticide before sowing. Fungicides will be required to manage STNB and barley leaf rust. Target production zones in 2017 are Geraldton, Kwinana, Albany and Esperance Port Zones. (Intergrain/Syngenta)



Scope CL$^{\Phi}$

Scope CL$^{\Phi}$ is a medium spring, tall height, malt variety suitable for export as grain and as malt but not for shochu. Scope CL$^{\Phi}$ is best suited to environments where brome and barley grass are a problem or where there is imidazolinone residues. Scope CL$^{\Phi}$'s agronomic response (phenology, disease resistance, weed competitiveness, head loss risk, grain yield and grain quality) is almost identical to Buloke$^{\Phi}$. Fungicides will be required to manage STNB and barley leaf rust. It should be harvested when ripe due to a high head loss risk. Scope CL$^{\Phi}$ is registered for use with the imidazolinone chemistry herbicide Intervix®. Do not use other imidazolinone herbicides on Scope CL$^{\Phi}$. Target production zones in 2017 are Geraldton, Kwinana and Albany Port Zones.

2.2.2 Food variety

Hindmarsh$^{\Phi}$

Hindmarsh$^{\Phi}$ is an early spring, semi-dwarf, CCN resistant, food barley that is exported to general grade malt markets in China and to Japan for shochu production. Higher yielding than all malt and feed barley varieties (except Compass$^{\Phi}$, La Trobe$^{\Phi}$, Spartacus CL$^{\Phi}$ and Rosalind$^{\Phi}$) in environments with a yield potential below 3 t/ha. Above 4 t/ha its yield is often inferior to Flinders$^{\Phi}$, Granger$^{\Phi}$, Lockyer$^{\Phi}$, Oxford$^{\Phi}$ and Rosalind$^{\Phi}$. Hindmarsh$^{\Phi}$ is not as plump as Bass$^{\Phi}$, Flinders$^{\Phi}$ and Granger$^{\Phi}$, but superior to Baudin$^{\Phi}$ and Scope CL$^{\Phi}$. Grain brightness may be an issue in coastal regions. All seed should be treated with a good quality smuticide before sowing. Fungicides will be required to manage STNB and barley leaf rust. Hindmarsh$^{\Phi}$ is likely to be phased out as a segregated variety after the 2017/18 harvest. Target production zones in 2017 are Kwinana-East and Albany Port Zones. (DPI (Vic)/SeedNet)

2.2.3 Feed variety

Compass$^{\Phi}$

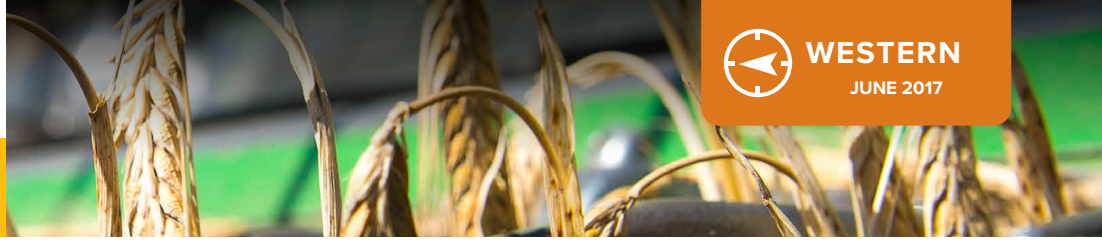
New medium spring, medium height, CCN resistant, feed barley derived from Commander$^{\Phi}$, but with a higher yield potential. Best suited to environments with a yield potential below 4 t/ha. Compass$^{\Phi}$ has a similar grain yield potential to Hindmarsh$^{\Phi}$, La Trobe$^{\Phi}$ and Spartacus CL$^{\Phi}$ in Western Australia. Compass$^{\Phi}$ is susceptible to lodging, particularly in high yielding situations. Fungicides will be required to manage barley leaf rust. Compass$^{\Phi}$ is one of the more weed competitive barley varieties. Undergoing Stage 1 of Barley Australia testing in 2016 with malting accreditation possible in 2018. (University of Adelaide/SeedNet)

Fathom$^{\Phi}$

Medium spring, tall height, CCN resistant feed barley. Best suited to environments with a yield potential below 3 t/ha and where there is a high risk of STNB. Similar to or slightly below the grain yield of Compass$^{\Phi}$, Hindmarsh$^{\Phi}$, La Trobe$^{\Phi}$ and Spartacus CL$^{\Phi}$. Fungicides will be required to manage early infections of NTNB and barley leaf rust. Fathom$^{\Phi}$ 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$^{\Phi}$ is one of the more weed competitive barley varieties. (University of Adelaide/SeedNet)

Fleet$^{\Phi}$

CCN resistant, medium spring, medium height, feed barley with good overall disease resistance. Fleet$^{\Phi}$ is now out-classed as a feed variety and is not recommended for production. Grain yield is generally below Compass$^{\Phi}$, Fathom$^{\Phi}$, Hindmarsh$^{\Phi}$, La Trobe$^{\Phi}$, Rosalind$^{\Phi}$ and Spartacus CL$^{\Phi}$. The hectolitre weight of Fleet$^{\Phi}$ is 2-3 kg/hL lighter than Hindmarsh$^{\Phi}$ and Lockyer$^{\Phi}$ and up to 1 kg/hL lighter than Mundah. It is susceptible to lodging and head loss with early planting. Fleet$^{\Phi}$ has a long coleoptile (so can be planted deep) and is suited to both sandy and clayey soils. Fungicides are not likely to be required in low and medium disease risk environments. Fleet$^{\Phi}$



is not as competitive against weeds as Compass$^{\Phi}$ and Fathom$^{\Phi}$. (University of Adelaide/SeedNet)

Litmus$^{\Phi}$

Early spring, tall height, feed barley with improved tolerance to low soil pH and high soil aluminium (Al) levels. Best suited to environments with a yield potential below 2 t/ha where the sub-soil (10-30 cm) has a pHCa 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$^{\Phi}$ provides growers with an option to diversify their wheat phase on acidic soils, but does not ameliorate the soil. Lime is required to ameliorate soil with a low pH. Litmus$^{\Phi}$ has poor straw strength and is susceptible to all leaf diseases. Litmus$^{\Phi}$ has been submitted to Barley Australia for evaluation as a malt barley but due to the presence of blue aleurone in its grain its future is uncertain. (InterGrain/Syngenta)

Lockyer$^{\Phi}$

Longer seasoned, semi-dwarf, short height, high yielding, feed barley. Best suited to environments with a yield potential above 3 t/ha. Lockyer$^{\Phi}$ is higher yielding than Compass$^{\Phi}$, Hindmarsh$^{\Phi}$ and La Trobe$^{\Phi}$ in Agzone 6 and in environments with a yield potential above 4t/ha. Rosalind$^{\Phi}$ out-yields Lockyer$^{\Phi}$ in all Agzones except Agzone 6. Relative to Oxford$^{\Phi}$, Lockyer$^{\Phi}$ is able to maintain its grain yield as seeding is delayed into June and July. Fungicides will be required to manage STNB and barley leaf rust. Weed competitiveness has not been tested. (InterGrain)

Mundah

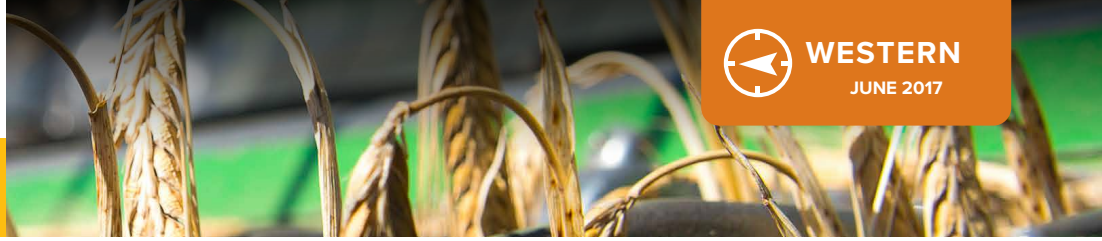
Very early spring, medium height, feed barley. Best suited to environments with a yield potential below 2t/ha and later sowing systems where early season weed control is necessary. Mundah is now outclassed by Fathom$^{\Phi}$, Spartacus CL$^{\Phi}$ and Rosalind$^{\Phi}$. Lower yielding than all the newer feed varieties including Compass$^{\Phi}$, Fathom$^{\Phi}$, Lockyer$^{\Phi}$, Roe and Rosalind$^{\Phi}$. Mundah can suffer from severe head loss and lodging. Fungicides are required to manage scald, NTNB (Beecher virulent), STNB, powdery mildew and barley leaf rust. Mundah is one of the more weed competitive barley varieties. (InterGrain)

Oxford$^{\Phi}$

Long seasoned, semi-dwarf, short height, feed barley. Best suited to environments with a yield potential above 4 t/ha (i.e. Agzone 6). Oxford$^{\Phi}$ performs best with late April or early May planting but its yield potential falls rapidly as seeding is delayed. In those situations, Oxford$^{\Phi}$ is often higher yielding than Compass$^{\Phi}$, Hindmarsh$^{\Phi}$ and La Trobe$^{\Phi}$. Rosalind$^{\Phi}$ outyields Oxford$^{\Phi}$ in all Agzones except Agzone 6. Oxford$^{\Phi}$ (like Granger$^{\Phi}$ and La Trobe$^{\Phi}$) is more sensitive to frost (higher frost sterility) than other barley varieties. Fungicides will be required to manage STNB and early season barley leaf rust. There is evidence of increasing virulence of NTNB and powdery mildew on Oxford$^{\Phi}$ barley, mainly in the Stirlings to Coast region. Growers should collect infected leaf samples before spraying with a fungicide. Weed competitiveness is similar to other semi-dwarf varieties. (Limagrain/Heritage Seeds)

Rosalind$^{\Phi}$

Rosalind$^{\Phi}$ (tested as IGB1302) is a new medium spring, medium height, CCN resistant feed barley derived from Dash and Lockyer$^{\Phi}$ with a high grain yield potential. Suited to all environments where there is a low probability of delivering malt grade barley. Rosalind$^{\Phi}$, first tested in NVT in 2014, is the new yield benchmark for barley in WA, outyielding Hindmarsh$^{\Phi}$ in Agzones 2 to 6 by 3% or more. Has good straw strength and head retention. Fungicides will be required to manage STNB. There is evidence of increased virulence of NTNB on Rosalind$^{\Phi}$ barley growing on the south coast. Based on its plant architecture (particularly larger leaf size) Rosalind$^{\Phi}$ is expected to have a good level of weed competitiveness, but it has not been tested. (InterGrain/Syngenta)



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DAFWA (2016) Barley variety factsheets.

National Variety Trial Results.

Barley Australia: Varieties handbook.

Paynter, Blakely - Compass and La Trobe head to head from 25 to 400 plants/m² at York in 2014

GRDC (2014) Select the best when saving seed for next years crops. GRDC Media Centre.

Spartacus$^{\Phi}$

Spartacus CL$^{\Phi}$ (tested as IGB1334T) is a new early spring, imidazolinone tolerant feed barley that is agronomically similar to La Trobe$^{\Phi}$. Spartacus CL$^{\Phi}$ plants lack the red anthocyanin pigmentation associated with Hindmarsh$^{\Phi}$ and La Trobe$^{\Phi}$ plants. Has a similar grain yield to Compass$^{\Phi}$, Hindmarsh$^{\Phi}$ and La Trobe$^{\Phi}$ and is higher yielding than Scope CL$^{\Phi}$ in WA. Spartacus CL$^{\Phi}$ is registered for use with the imidazolinone chemistry herbicides Intervix® and Sentry®. Every seed should be treated with a good quality smuticide before sowing. Fungicides will be required to manage STNB and barley leaf rust. In Stage 1 of Barley Australia testing in 2016 with malting accreditation possible in 2018. (InterGrain/Syngenta)

Yagan

Very early spring, medium height, feed barley. Best suited to environments with a yield potential below 2 t/ha or in weed management situations for late sowing or short seasons. Reaches awn peep 12–16 days earlier than Mundah and 14-20 days earlier than Hindmarsh$^{\Phi}$ with late May sowing. As Yagan has not been sown in NVT trials since 2003 there is no current NVT MET data available. Results from DAFWA barley agronomy time of sowing trials suggest that Fleet$^{\Phi}$, Hindmarsh$^{\Phi}$ and Lockyer$^{\Phi}$ are all higher yielding than Yagan. Hindmarsh$^{\Phi}$ also has improved hectolitre weight and grain brightness relative to Yagan. Fungicides may be required to manage scald, STNB and barley leaf rust. Weed competitiveness not tested. (InterGrain) [18]

2.3 Planting seed quality

2.3.1 Seed size

Early seedling growth relies on stored energy reserves in the seed. Good seedling establishment is more likely if seed is undamaged by insects or harvesting, is stored at suitable temperatures and moisture conditions, and comes from a plant that had adequate nutrition during its growth and grainfilling period. Seed size is also important. The larger the seed, the greater the endosperm and starch reserves. So, although seed size does not alter germination, bigger seeds have faster seedling growth, higher numbers of fertile tillers per plant and potentially higher grain yields. Research in New South Wales in 2008 showed small seed (25.64 g/1,000 seeds) had emergence equal to 90% of that of large seeds (41.31 g/1,000 seeds) when sown at 44 mm depth; however, emergence dropped to 67% when sown at 87 mm, and 53% when sown deep (at 112 mm).

1,000 grain weight

Seed size is usually measured by weighing 1,000 grains to determine the 1,000-grain weight. The 1,000-grain weight varies among varieties and from season to season. Sowing rate needs to vary according to the 1,000-grain weight for each variety, and each season, in order to achieve desired plant densities. Seed grading is an effective way to separate good-quality seed of uniform size from small or damaged seeds and other impurities. [19]

2.3.2 Seed germination and vigour

Seed germination and vigour are highly influential for establishment and yield potential.

Germination begins when the seed absorbs water and ends with the appearance of the radicle. It has three phases:

- water absorption (imbibition)

18 DAFWA (2016) 2017 Barley variety sowing guide for Western Australia. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/3766

19 N Fettell, P Bowden, T McNee, N Border (2010) Barley growth & development. PROCROP Series. Industry & Investment NSW/ NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/516180/Procrop-barley-growth-and-development.pdf

- activation
- visible germination. [20]

Seed vigour includes the properties of the seed that determine the level of activity and performance of the seed during germination and seedling emergence. Losses of seed vigour are related to the reduced ability of seeds to carry out all of the physiological functions that allow them to perform.

This process, called physiological ageing (or deterioration), starts before harvest and continues during harvest, processing and storage. It progressively reduces performance capabilities through changes in cell-membrane integrity, enzyme activity and protein synthesis. These biochemical changes can occur very quickly or more slowly—from a few days to a few years—depending on genetic, production and environmental factors not fully understood. The end point of this deterioration is death of the seed; that is, complete loss of germination.

However, seeds lose vigour before they lose the ability to germinate. That is why seeds that have similar high germination values can differ in their physiological age (the extent of deterioration) and so differ in seed vigour and the ability to perform. [21]

When purchasing seed, request a copy of the germination and vigour analysis certificate from your supplier. For seed stored on-farm, growers can send it to a laboratory for analysis.

A laboratory seed test for germination should be carried out before seeding to calculate seeding rates; however, a simple, on-farm test can be done:

- Use a flat, shallow seeding tray (about 5 cm deep). Place a sheet of newspaper on the base to cover drainage holes and fill with clean sand, potting mix or freely draining soil. Ideally, the test should be done indoors at a temperature of ~20°C or lower. Alternatively, lay a well-rinsed plastic milk container on its side and cut a window in it, place unbleached paper towels or cotton wool in the container. Moisten and place on a window-sill
- Randomly count out 100 seeds. Do not discard damaged ones and sow 10 rows of 10 seeds at the correct seeding depth. This can be achieved by placing the seed on the smoothed soil surface (or alternative medium) and pushing in with a pencil marked to the required depth. Cover with a little more sand or soil and water gently
- Keep growing medium moist but not wet; overwatering will result in fungal growth and possible rotting.
- After seven to 10 days, the majority of viable seeds will have emerged
- Count only normal, healthy seedlings. If you count 78 normal, vigorous seedlings, the germination percentage is 78%. Germination of 80% is considered acceptable for cereals.

The results from a laboratory seed-germination test should be used in calculating seeding rates. [22]

For more information on factors affecting germination, see Section 4: Plant growth and physiology.

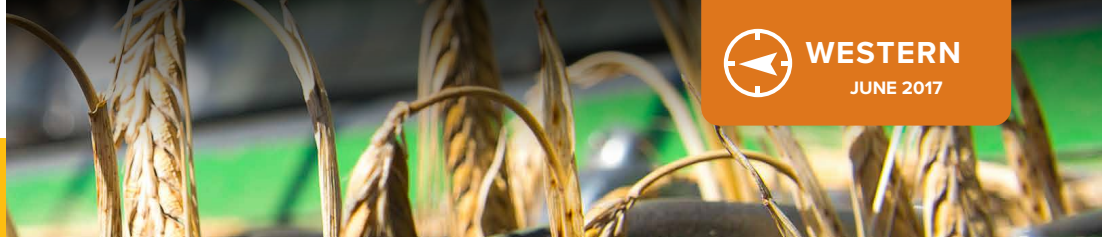
Disease

Grain retained for seed from a wet harvest is more likely to be infected with seed-borne disease. It is also more likely to suffer physical damage during handling, increasing the potential for disease.

20 N Fettell, P Bowden, T McNee, N Border (2010) Barley growth & development. PROCROP Series. Industry & Investment NSW/ NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/516180/Procrop-barley-growth-and-development.pdf

21 ISTA Vigour Test Committee (1995) Understanding seed vigour. International Seed Testing Association, https://www.seedtest.org/upload/pri/product/UnderstandingSeedVigourPamphlet.pdf

22 GRDC (2011) Saving weather damaged grain for seed. Northern and Southern Regions. Retaining Seed Fact Sheet, GRDC Jan. 2011, http://storedgrain.com.au/wp-content/uploads/2013/06/GRDC_FS_RetainingSeed2.pdf



Seed-borne disease generally cannot be identified from visual inspection, so it requires laboratory testing. Once a satisfactory germination percentage is known, seed should be tested for diseases including fusarium head blight.

2.3.3 Seed storage

Barley is more susceptible to insect damage in storage than many grains. Germination can be affected by grain temperature, grain moisture content and insect infestation.

Generally, high grain temperatures and high grain-moisture content can cause low germination (<95%). Insect infestation can have a similar effect. Ideally, malting barley would be kept free of insects, and in aerated storage at grain temperatures of 10–20°C with a moisture content <10.5%. However, this is not generally practical and it is important to be aware of the interaction between moisture and temperature (Table 5).

At 20–30°C, short–medium-term storage presents some risk but once the temperature of the grain exceeds 30°C, germination is likely to be affected. Temperatures significantly above 30°C will cause grain to become non-viable.

This applies for drying grain that is required to maintain its germination for malting purposes or as a seed crop. It should be dried slowly at low temperatures.

The moisture of grain in storage will affect its ability to maintain quality over time. The lower the grain moisture, the more stable its storage ability. In practical terms, it is more economical to store grain at ~12% moisture content. [23]

Table 5: *An indication of the interaction between moisture and temperature. The combination of low moisture percentage barley with a storage temperature of 10-20 °C has the greatest potential storage period of between 12 and 18 months.*

Barley moisture %	Storage temperature	Potential storage period
<10.5	10–20°C	Very long, 12–18 months
	20–30°C	Moderate, 6 months
	>30°C	Short, 3 months
10.5–11.5	10–20°C	Long, 12 months
	20–30°C	Moderate, 6 months
	>30°C	Short, 3 months
11.5–12.5	10–20°C	Moderate, 6 months
	20–30°C	Short, 3 months
	>30°C	Very short, <3 months
>12.5	10–20°C	Short, 3 months
	20–30°C	Very short, <3 months
	>30°C	Perhaps 1 month

Source: NSW DPI

A seed is a living organism that releases moisture as it respires. The aim of seed storage is to preserve the viability of the seed for future sowing. The following issues need to be considered:

- Temperature <15°C. High temperatures can quickly damage seed germination and quality
- Moisture <12%. Temperature changes cause air movements inside the silo that carry moisture to the coolest parts of the silo. Moisture is carried upwards by convection currents in the air created by the temperature difference between the warm seed in the centre of the silo and the cool silo walls, or vice versa.

23 DAF Qld (2012) Barley planting, nutrition and harvesting. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

Moisture carried into the silo headspace may condense and fall back as free water, causing a ring of seed to germinate against the silo wall

- Aeration slows the rate of deterioration of seed if the moisture content is kept at 12.5–14%. Aeration markedly reduces grain temperature and evens out temperature differences that cause moisture movement
- Pest management. Temperature <15°C stops all major grain insect pests from breeding, slowing their activity and resulting in less damage. [24]

2.3.4 Safe rates of fertiliser sown with the seed

Crop species differ in tolerance to N fertiliser when applied with the seed at sowing (Refer to Table 6). Research funded by Incitec Fertilisers has shown that the tolerance of the crop species to ammonium fertilisers placed with the seed at sowing is related to the fertiliser product (ammonia potential and osmotic potential), the application rate and soil characteristics such as moisture content.

Table 6: *Ranking of crop species establishment in their response (1, most tolerant; 6, least tolerant) to ammonia or ammonium applied in close proximity to the seed. Barley is similar to wheat in its tolerance to ammonia or ammonium applied close to the seed but is much more tolerant than canola.*

Winter crop species	Germination	Root length	Shoot length
Barley	2	2	3
Canary seed	4	4	2
Canola	5	5	–
Chickpeas	1	1	–
Wheat	3	3	1

Source: Incitec Pivot

The safest method of applying high rates for fertilisers with high ammonium content is to place them away from the seed by physical separation (combined N–P products) or by pre- or post-plant application (straight N products). [25]

With placement closer to the seed, contact between high concentration solutions and the seedling is more likely.

With no-till practices, seed and fertiliser are often placed close together, which increases the chance of germination being reduced by toxicity. Possibly counteracting this is less disturbance and generally more compact, better moisture-holding soil near the seed, particularly if press wheels are used.

Toxicity levels are highest when seeding into moist, light sands and when seeding in any soil type is followed by a warm dry period.

Experience in WA has shown that fertiliser toxicity in barley is rarely an issue at current fertiliser use rates. [26]

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GCTV18: Storing planting seed. Video.

24 N Fettell, P Bowden, T McNee, N Border (2010) Barley growth & development. PROCROP Series. Industry & Investment NSW/NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/516180/Procrop-barley-growth-and-development.pdf

25 Incitec Pivot Fertilisers (2014) Big N, nitrogen fertiliser placement and crop establishment. Incitec Pivot Ltd, http://bign.com.au/Big%20N%20Benefits/Nitrogen%20Fertiliser%20Placement%20and%20Crop%20Establishment

26 DAFWA (2015) Diagnosing seedling fertiliser damage in cereals. Department of Agriculture and Food, Western Australia, https://agric.wa.gov.au/n/1986