

Recent changes in disease resistance profiles of barley varieties in Western Australia

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Key Messages

- Scald – risk likely to increase if significant areas of Granger barley are sown.
- Net type net blotch – risk not expected to change with the adoption of newer varieties.
- Spot type net blotch – risk expected to continue to increase with greater plantings of Hindmarsh and La Trobe.
- Powdery mildew – overall risk is expected to decline until new pathotypes become dominant.
- Barley leaf rust – growing varieties with APR can reduce the risk, but fungicide spraying may still be required.
- Barley and cereal yellow dwarf– risk expected to increase with increased plantings of Hindmarsh and La Trobe.

Background and Aims

The disease resistance profiles of the new barley varieties change with the release, adoption and emergence of new strains/pathotypes of foliar leaf diseases in Western Australia. The shift in resistance profiles influences the decisions of growers and advisers who need to manage leaf diseases with the deployment of barley varieties in Western Australia (WA).

The aim of this paper is to depict the current status of barley diseases and stimulate discussion on short-term disease prospects in the Western Australian barley industry due to the adoption of new barley varieties.

Method

Disease resistance assessments are made annually on all current and emerging barley varieties by DAFWA's Pathology Group. Based upon the disease scores for the six most prominent foliar leaf diseases, ratings were attributed to the top 20 barley varieties grown in WA (Tables 1, 2 and 3). Varieties are listed in Table 1 if they were sown on at least 0.2% (> 2,000 ha) of the WA barley area in either 2013 or 2014 or are forecast to exceed 0.2% of the barley area in 2015. Adult disease responses (resistance after flag leaf emergence) were recorded using the CIMMYT scale of 0-9 and then converted to the severity nomenclature as per the GRDC guidelines. Varieties were classified as VS (very susceptible), S (susceptible), MS (moderately susceptible), MRMS (intermediate), MR (moderately resistant), R (resistant) and/or a combination of these, if the disease score had a range between two classifications.

Results

Twenty barley varieties account for 99% or more of the current area sown to barley in Western Australia, with five varieties (Bass, Baudin, Buloke, Hindmarsh and Scope CL) accounting for 4 in every 5 barley hectares sown to barley in 2013 and 2014 (Table 1). It is predicted that these 5 varieties will still account for 80% of the barley acreage in 2015 with Hindmarsh (>30%) and Scope CL (>20%) predicted to be more than 50% of the total crop area. The release of Compass, Flinders and La Trobe, however, and the emergence of Granger will see changes in the variety disease resistance profile grown in Western Australia, with Baudin, Buloke, Gairdner and Vlamingh on the decline (Table 1, 2 and 3). Most varieties have been stable in their adult disease rating since 2013, except where there has been a pathotype change resulting in a loss of a major resistance gene (eg. *Rph3* virulence in barley leaf rust).

Scald

Scald is potentially a very damaging disease and can reduce grain yield by up to 45% with reduced grain quality. Scald has only been a sporadic problem for barley producers in the past decade. Varieties with a high current adoption like Bass, Hindmarsh and Scope CL and the new varieties Compass, Flinders and La Trobe have some resistance, so scald levels should remain low in Western Australia. However, the emergence of Granger (S) in southern and central higher rainfall cropping zones will increase the risk of this disease becoming more prominent in these regions particularly. Litmus is rated SVS to scald, however it will be predominantly grown in areas where Yagan (VS) has been previously popular, environments which are generally not conducive to large outbreaks of scald. Growers need to be vigilant and use appropriate management strategies, particularly in susceptible varieties, to keep this stubble borne disease under control. Although highly variable, the scald

pathogen has not changed much over the years in Western Australia, so we don't expect to dramatic changes in the resistance profiles of barley varieties to this disease.

Variety	% barley area 2013	% barley area 2014	% barley area 2015 (f)
Bass	8%	10%	13%
Baudin	9%	7%	6%
Buloke	21%	12%	4%
Commander	<1%	<1%	2%
Compass	0%	<1%	<1%
Fathom	<1%	<1%	<1%
Fleet	<1%	<1%	<1%
Flinders	<1%	<1%	<1%
Gairdner	8%	5%	3%
Granger	<1%	<1%	3%
Hindmarsh	30%	36%	34%
La Trobe	<1%	<1%	3%
Litmus	0%	<1%	<1%
Mundah	4%	3%	2%
Oxford	<1%	1%	2%
Roe	<1%	<1%	<1%
Scope CL	8%	18%	23%
Stirling	<1%	<1%	<1%
Vlamingh	7%	3%	1%
Yagan	1%	<1%	<1%

Table 1. Barley variety popularity (based on area sown) for the 2013 and 2014 cropping season (source: CBH) and forecast (f) for 2015 cropping season (source: Blakely Paynter, DAFWA)

Variety	Scald 2013	Scald 2014	Scald 2015	NTNB 2013	NTNB 2014	NTNB 2015	STNB 2013	STNB 2014	STNB 2015
Bass	MRMS	MRMS	MRMS	MRMS/MS	MRMS/MSS	MRMS/MSS	S	S	S
Baudin	MS	MSS	MSS	S	S	S	S	S	S
Buloke	MS	MS	MS	MS/MRMS	MRMS	MRMS	MS	MS	MSS
Commander	MSS	MSS	MSS	S	S	S	MSS	MSS	MSS
Compass	S	MS	MS	MRMS/S	MRMS/MSS	MRMS/MSS	S	S	MSS
Fathom	MRMS	MR	MR	S	MSS	MSS	MRMS	MRMS	MRMS
Fleet	MS	MS	MS	MRMS/MR	MRMS/MR	MS/MR	MS	MS	MS
Flinders	MRMS	MS	MS	S	MS	MS	S	S	S
Gairdner	MRMS	MS	MS	MS/MRMS	MRMS	MRMS	S	S	S
Granger	S	S	S	MS/MRMS	MS/MRMS	MS/MRMS	S	S	S
Hindmarsh	MRMS	MRMS	MRMS	MS	MS	MS	S	S	SVS
La Trobe	MR	MR	MR	S/MRMS	MS/MRMS	MS/MRMS	S	S	SVS
Litmus	SVS	SVS	SVS	S	S	S	S	S	S
Mundah	S	S	S	S/MS	S/MS	S/MS	S	S	S
Oxford	MS	MS	MS	MRMS/MR	MRMS/MR	MS/MRMS	S	S	S
Roe	MSS	MSS	MSS	MSS	MSS	MSS	S	S	S
Scope CL	MS	MS	MS	S/MRMS	MRMS	MRMS	S	S	S
Stirling	S	S	S	S	S	S	MSS	S	S
Vlamingh	MR	MR	MR	MRMS	MRMS	MRMS	S	S	S
Yagan	VS	VS	VS	S/MRMS	MSS/MRMS	MSS/MRMS	S	S	S

Table 2. Change in the Western Australian adult disease resistance ratings of twenty barley varieties against scald, net type net blotch (NTNB:Beecher virulent and Beecher avirulent pathotypes) and spot type net blotch (STNB) from 2013 to 2015.

¹If a differential response to net type net blotch exists, virulent reaction is before slash and avirulent reaction after slash.

Net type net blotch

Two net type net blotch pathotypes, Beecher virulent and Beecher avirulent, are present in Western Australia. Many varieties (Bass, Compass, Fleet, Granger, La Trobe, Mundah, Oxford and Yagan) display a differential response depending on which pathotype is present, whilst the rest show the same response to both pathotypes. Those with a differential adult response are shown in Table 2 with a slash (virulent / avirulent) and their disease reaction may vary, even on the same farm, depending on what pathotype is dominant. The Beecher avirulent pathotype is the dominant pathotype, but north of the Great Eastern Highway the Beecher virulent and avirulent pathotypes are present in similar proportions. The more popular varieties Bass, Hindmarsh and Scope CL and the new varieties Compass, Flinders, Granger and La Trobe have some resistance to both pathotypes, whereas Baudin, Commander and Litmus are susceptible to both pathotypes. Commander, Litmus and Baudin (although in decline) should be avoided to limit the disease in the State. Crop rotation (ie. avoiding barley stubble) and in-crop management (ie. foliar fungicides) are still important tools in reducing the disease risk of net type net blotch.

Spot type net blotch

Spot type net blotch remains a challenge as a large majority of the varieties are susceptible, except Fathom which is intermediate in its response (Table 2). Newer pathotypes / isolates of this disease have been detected from Western Australia (Gupta *et al.* 2012). Irrespective of the varietal choice the disease can be best managed with crop rotation and in-crop management practices at this stage. Several products with a range of fungicide active ingredients are registered as foliar sprays to control this disease. Advice on how to best manage spot type net blotch, with particular relevance to Scope CL barley, can be found at agric.wa.gov.au/n/3695.

Variety	PM 2013	PM 2014	PM 2015	BLR 2013	BLR 2014	BLR 2015	BCYD 2013	BCYD 2014	BCYD 2015
Bass	MS	MS	MS	MR	MR/S	MR/S ¹	-	MR	MR
Baudin	VS	VS	VS	SVS	SVS	SVS	-	MR	MR
Buloke	MR	MR	RMR	S	S	S	-	MRMS	MRMS
Commander	MRMS	MR	MR	SVS	S	S	-	MRMS	MRMS
Compass	MRMS	MR	MR	R	MR/S	MR/S ¹	-	MRMS	MS
Fathom	MRMS	MRMS	MRMS	S	S	R ²	-	MR	MRMS
Fleet	MRMS	MRMS	MRMS	MRMS	MS	MS	-	MRMS	MRMS
Flinders	R	R	R	S	MR	MR	-	MR	MR
Gairdner	S	S	S	S	S	S	-	MR	MR
Granger	R	R	R	RMR	RMR	RMR	-	MRMS	MRMS
Hindmarsh	MS	MRMS	MRMS	S	S	S	-	S	S
La Trobe	MRMS	MRMS	MRMS	S	S	S	-	S	S
Litmus	MSS	MS	S	S	S	S	-	S	S
Mundah	S	MSS	MSS	S	S	S	-	S	S
Oxford	R	R	R	R	R	R	-	MRMS	MRMS
Roe	MS	MS	MS	S	S	S	-	MS	MS
Scope CL	MR	R	R	S	S	S	-	MR	MRMS
Stirling	S	S	S	S	S	S	-	MRMS	MRMS
Vlamingh	S	S	S	S	S	S	-	MS	MS
Yagan	MRMS	MRMS	MRMS	S	S	S	-	S	S

Table 3. Change in the Western Australian adult disease resistance ratings of twenty barley varieties against powdery mildew (PM), barley leaf rust (BLR) and barley & cereal yellow dwarf (BCYD) from 2013 to 2015.

¹Bass and Compass are S to barley leaf rust if pathotype 5457 P-is present.

²Fathom has late APR to barley leaf rust.

Powdery mildew

In Western Australia, Powdery Mildew has been the most devastating disease over the past decade and has been estimated to cost \$33m/yr in lost barley production with management practices in place (Murray and Brennan 2010). This has been mainly due to the wide cultivation of highly susceptible varieties like Baudin, Gairdner and Vlamingh (Tables 1 and 3). Fortunately those varieties are in decline. The now popular varieties Hindmarsh and Scope CL have resistance genes which are partially effective at the adult stage providing significant protection from this disease. The newer varieties Compass, Flinders, Granger, La Trobe and Oxford, have different resistance genes to each other and they currently provide adequate protection against this disease, reducing need for in-crop protection. However, growers need to be vigilant due to the detection of pathotypes which can overcome several resistance genes (Tucker *et al.* 2013) in many varieties except Granger which carries the *mlo* gene which imparts robust resistance. Overall, powdery mildew management is less likely to be required in many newer varieties but remains a challenge for the ongoing cultivation of varieties that are susceptible. The detection of pathotypes capable of breaking currently deployed resistance genes and resistance to some triazole fungicides could increase its importance in the future.

Barley leaf rust

Leaf rust is a considerable threat to the barley industry, primarily in southern production regions. The majority of older varieties, such as Baudin, Gairdner and Vlamingh are susceptible, as are many newer varieties such as Bass, Compass, Hindmarsh, La Trobe and Scope CL. A new pathotype (5457 P-) was detected in 2013 and became established across the South Coast in 2014. This pathotype is virulent to the resistance gene *Rph3*, rendering the previously resistant varieties Bass and Compass as susceptible, cultivation of these varieties is unlikely to provide any benefit for rust control. Varieties such as Granger and Oxford carry the adult plant resistance (APR) gene *Rph20* as well as *Rph3* and remain MR. Fathom and Flinders have other APR resistance genes to barley leaf rust, but Fathom's resistance is late to kick in. Varieties with effective APR are less affected by leaf rust but may still benefit from fungicide protection under high disease pressure.

Barley and cereal yellow dwarf

Although the disease is not as threatening as other foliar diseases, it can damage susceptible varieties under high virus disease pressure. The importance of barley and cereal yellow dwarf is likely to increase with greater area sown of Hindmarsh and subsequently La Trobe, both are susceptible to this disease. This disease is mostly confined to the medium to high rainfall areas of Western Australia and is promoted by presence of green bridge.

Conclusion

Overall, barley disease resistance profiles in WA have improved as compared to previous years. This is mainly due to the improvement in the genetic resistance of the newer or likely to be adopted varieties. However, the overall disease risk will always depend on which varieties become popular and how these varieties are utilised in the farming system. Changing variety preferences across the wheatbelt can change the primary disease risks facing an industry. The prime examples of this are the potentially lesser importance of powdery mildew due to reduced area of S and VS varieties (eg. Baudin) but increased importance of spot type net blotch due in part to dominance of SVS variety Hindmarsh. This does not diminish the requirement for management in individual crops but can alter the widespread dominance of a particular disease due to reduced susceptibility of the crop as a whole and subsequent reduction in disease carryover and pressure. Overall, growers need to remain alert of the changes in disease ratings which may impact on the management recommended for each specific disease for different barley varieties.

The Western Australian barley industry is a key supplier to international brewing companies (through maltsters). It takes brewing companies up to 5 years to gain confidence in new malting varieties. As a consequence the international market is not able to react quickly to varietal changes. Pathotype changes in foliar diseases can quickly downgrade a resistant rated variety to a susceptible rated variety, as demonstrated with the changed ranking for Bass with the occurrence of *Rph3* virulence in leaf rust in 2013. It may become costly therefore to continue to grow this newly susceptible variety to meet market demand. So whilst genetic disease resistance is a key factor in reducing the cost of growing barley, crop rotation and in-crop management will always play a critical role in reducing the in-season losses associated with disease infection.

In planning which variety to grow over coming seasons it is important to review the current disease resistance ratings found in the annual barley variety sowing guide (ie. Paynter *et al.* 2014) and to understand the biology of the primary disease risks to help determine the appropriate management approaches for each variety. Look at stubble loadings for the two previous seasons, understand the green bridge risk, consider the resistance of the variety as a seedling (as separate to its resistance as an adult) when planning which seed dressing to use and determine the best available foliar fungicide options available and application timing to achieve optimal disease control. Further information on barley foliar disease management is available at agric.wa.gov.au/n/343.

References

- Gupta S, Loughman R, D'Antuono M and Bradley J (2012). Characterization and diversity of *Pyrenophora teres* f. *maculata* isolates in Western Australia. *Australasian Plant Pathology* **41**:31-40.
- Murray GM and Brennan JP (2010). Estimating disease losses to the Australian barley industry. *Australasian Plant Pathology* **39**:85-96.
- Paynter, BH, Hills AL, Gupta S, Collins S, Dhammu H, Malik R and Trainor G (2014). Barley variety sowing guide for Western Australia 2015. Department of Agriculture and Food, Western Australia, Bulletin 4860.
- Tucker MA, Jayasena K, Ellwood SR and Oliver RP (2013). Pathotype variation of barley powdery mildew in Western Australia. *Australasian Plant Pathology* **42**:617–623.

Key words

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