

Monitoring powdery mildew resistance in barley varieties

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Key messages

- Laboratory seedling tests indicate that some of the genes postulated to provide resistance to powdery mildew in some commercial barley varieties may be compromised.
- Field screening of these varieties has shown that local differences in variety responses can occur but no widespread regional variation, or 'breakdown' in the field resistance of varieties to powdery mildew was observed in 2013.
- The field response of varieties tested reflected the resistance rankings published in variety guides.

Background

Powdery mildew (*Blumeria graminis* f. sp. *hordei*) samples collected throughout the south-west of Western Australia (WA) have been found by the Australian Centre for Nectrophic Fungal Pathogens (ACNFP) at Curtin University to have a wide range of virulences against the resistance genes deployed in our commercial barley varieties (Tucker *et al.* 2013). Given this new information, there is a need to examine the regional variability in the field response of barley varieties grown in WA. Examining the field response of a range of varieties across several environments, whilst sampling mildew isolates for laboratory testing, will provide feedback on field implications on the variability of isolate virulence and on potential instability of variety responses dependent on isolate dominance or regional variability.

Aims

- Assess the impact of region and pathotype on field response of commercial varieties to powdery mildew across WA.
- Compare the field response of lines with known genes (Pallas isolines) with those postulated in commercial varieties.

Method

Small nurseries were established at seven sites across the WA wheatbelt - Dandaragan (DN), Northam (NO), Cunderdin (CN), Katanning (KA), South Perth (SP), South Stirling (SS) and Gibson (ES).

At each site, 30 commercial varieties and 9 Pallas isolines were sown in 0.5 – 1 m rows in a randomised block design with 2-3 replicates. Normal trial management (herbicide, insecticide, and fertiliser) was applied, however no fungicide was applied. Natural disease development was allowed at all sites.

Disease assessments were carried out at three growth stages following the onset of disease; approximately tillering (Z24-30), stem extension (Z31-33) and heading (Z55-65). Disease was assessed on 3 to 5 plants in each row, assigning a per cent leaf area affected (%LAA) by sporulating mildew on the top 3 open leaves. Data was averaged across plants

and replicates to provide a site mean response for each variety. To compare across sites, data was expressed as disease severity relative to the susceptible control Baudin at each site.

Isolates of powdery mildew sampled from either Baudin or Stirling at each site were subjected to laboratory screening to determine virulence present at a site. Powdery mildew susceptible varieties, Baudin and Stirling, were chosen to limit the impact of host plant resistance on the virulence profile of the isolates collected.

Using a detached seedling leaf laboratory assay, each isolate was screened against a full set of Pallas isolines and selected varieties and assessed using a five point (0 to 4) infection type (IT) scale. The scale was adapted from Torp et al (1978) and used to assign a single infection type to each isolate/cultivar interaction. Isolates with an infection type of 3 or 4 were considered virulent.

Results

Powdery mildew was detected in all seven nurseries. A selection of the disease data is presented in Table 1 at three different developmental stages – tillering (Z22 - Z30), stem extension (Z31 - Z33) and heading (Z55 - Z65). Leaf infection (%LAA) in Baudin was at least 20% of the top 3 leaves at each stage and for each site in Table 1. In general, as the resistance rating increased, the level of powdery mildew detected decreased (when considered within a growth stage).

In the varieties with an adult resistance score of MS or above, there were regional differences in the disease expression of some varieties (ie. Bass, Commander, Compass, Flagship, Fleet, Skiff, Skipper and Yagan). In many cases differences were small and further experiments over coming seasons will help elucidate these differences and track any changes in regional disease expression. The largest regional difference was for Yagan which is classified as R in the seedling stage and MRMS at the adult stage. It did not show disease at any stage in South Perth (SP), however it expressed obvious disease as a seedling (tillering growth stage) at Gibson (ES). Commander, Compass and Lockyer also showed significant differences as seedlings between Gibson and South Perth, but were moderately resistant to resistant as adult plants.

Laboratory testing of isolates (collected from six of the nurseries) against the Pallas isolines and a small sub-set of the commercial varieties is presented in Table 2. These tests were conducted on seedlings and the data should be compared to the seedling reactions in Table 1. Virulence (an IT score of 3 or 4) at the seedling stage was expressed by at least one isolate on all the Pallas isolines except P6, and all varieties except Dash and Flinders. All isolates were virulent against postulated resistance genes Mla8 (Baudin and Pallas) and Mlk1 (P17).

Table 1. Postulated resistance genes, resistance score and leaf area affected (top 3 leaves) by powdery mildew as a percentage of Baudin for selected commercial varieties and Pallas isolines at different developmental stages.

Variety / Line	Postulated genes	Resistance rating ¹		Relative disease severity (% of Baudin)							
				Tillering		Stem extension		Heading			
		Seedling	Adult	SP	ES	KA	DN	SP	ES	KA	NO
Baudin	Mla8	VS	VS	100	100	100	100	100	100	100	100
Gairdner	Mlg	VS	S	86	122	27	<1	52	23	43	24
Stirling	none	VS	S	98	100	13	57	63	53	32	3
Vlamingh	Mla8	S	S	95	103	52	100	28	27	21	2
Bass	Mla8	MS	MS	40	9	7	<1	13	6	12	1
Flagship	Mlg, MIGa	-	-	80	61	11	0	29	20	9	2
Skiff	MI(Ch)	MS	MRMS	45	16	27	2	11	5	34	16
Capstan	MIGa	MRMS	MRMS	15	7	2	0	<1	1	2	2
Fathom	MIGa	MRMS	MRMS	20	5	5	0	3	7	3	0
Fleet	MIGa	MRMS	MRMS	0	19	0	0	<1	0	<1	0
Hindmarsh	Mla8, MILa	MRMS	MRMS	26	11	<1	0	2	3	3	0
La Trobe	Mla8, MILa	MRMS	MRMS	20	3	0	0	1	1	1	0
Lockyer	Mla8, MILa	MRMS	MRMS	30	1	3	<1	5	5	4	1
Navigator	Mla12, Mlg	R-MR	MRMS	0	0	0	0	0	0	0	0
Yagan	MI(Ch), Mlra	R	MRMS	0	68	0	<1	0	5	2	0
Buloke	Mla7, MILa, MIU	MR	MR	0	0	<1	0	0	0	0	0
Commander	Mlg, MIGa, MILa	MRMS	MR	41	4	<1	<1	<1	<1	<1	0
Compass	?	MS	MRp	41	0	0	0	<1	2	2	0
Barque	MIGa	MRMS	RMR	20	22	1	0	0	2	2	0
Shepherd	Mla3	R	R	0	0	0	0	<1	0	0	0
Dash	Mla7, Mlk1, MILa	R	R	0	0	0	0	0	0	0	0
Flinders	?	R	R	0	0	0	0	0	0	0	0
Granger	mlo	R	R	0	0	0	0	0	0	0	0
Oxford	MI(St)	R	R	0	0	0	0	0	0	0	0
Scope	Mla7, MILa, MIU	R	R	0	0	0	0	0	0	0	0
Skipper	?	MS-S	R	26	7	4	0	0	<1	<1	0
Pallas	Mla8	S	MS	35	21	3	0	2	4	5	0
Pallas P2	Mla3	R	R	0	0	0	0	0	0	0	0
Pallas P4A	Mla7, Mlk1, MIU	MR	RMR	0	0	0	0	0	0	0	0
Pallas P4B	Mla7, MlaNO3	MR	RMR	0	0	0	0	0	0	0	0
Pallas P6	Mla7, MI(G2)	MR	RMR	0	0	0	0	<1	0	0	0
Pallas P10	Mla12	R	R	0	0	0	0	<1	0	0	0
Pallas P14	Mlra	MR	R	0	0	0	<1	0	0	<1	0
Pallas P17	Mlk1	MS	MS	50	32	2	0	2	7	7	0
Pallas P23	MILa	MRMS	MR	15	2	0	0	0	<1	<1	0
Baudin (%LAA)	Mla8	VS	VS	67	20	24	22	60	26	34	22

¹Resistance rating: VS = very susceptible, S = susceptible, MS = moderately susceptible, MRMS = intermediate, MR = moderately resistant, R = resistant, p = provisional rating only, - = no data available. Data from DAFWA Bulletins 4855.

²Location: SP = South Perth, KA = Katanning, NO = Northam, DN = Dandaragan, SS = South Stirling and ES = Gibson.

Table 2 Laboratory seedling infection type response of selected barley varieties and Pallas isolines in response to powdery mildew collected from six locations. Isolates that produce an infection type of 3 or 4 are considered virulent.

Variety / Line	Postulated genes	Location ¹					
		SP	KA	NO	DN	SS	ES
Barque	MIGa	-	3	4	-	0	0
Baudin	Mla8	-	4	4	-	4	4
Buloke	Mla7, MILa, MIU ³	-	4	0	-	4	4
Dash	Mla7, Mik1, MILa	-	0	0	-	0	0
Flinders	?	-	0	0	-	0	0
Yagan	MI(Ch), Mlra	-	0	4	-	4	0
Pallas	Mla8	-	4	4	-	4	4
Pallas P2	Mla3	4	3	1	3	0	3
Pallas P4A	Mla7, Mik1, MIU ³	4	3	3	3	0	0
Pallas P4B	Mla7, MlaNO3	4	3	1	3	2	0
Pallas P6	Mla7, MI(G2)	2	0	0	0	0	0
Pallas P10	Mla12	4	0	1	0	0	4
Pallas P14	Mlra	4	0	0	0	3	0
Pallas P17	Mik1	4	4	4	4	4	4
Pallas P23	MILa	4	4	4	0	4	4

¹Location: SP = South Perth, KA = Katanning, NO = Northam, DN = Dandaragan, SS = South Stirling and ES = Gibson.

Conclusions

The first year of data from these trials indicate that regional differences in variety resistance responses to powdery mildew can occur. Also that for many barley varieties, there are significant differences in their level of disease expression at a seedling stage compared with the adult stage.

Varieties in WA can be categorised based on the postulated or known genes that control their resistance. The presence of powdery mildew pathotypes with virulence against these resistance genes will impact on the variety resistance response. From the laboratory, and field observations, virulence for the resistance genes Mla8, MILa, Mik1 and Mlg is widespread across WA production zones. Varieties reliant on these genes alone are generally VS to MS and responses at all sites reflected this. Varieties with intermediate resistance or above (MRMS, MR and R) to powdery mildew carry postulated or known genes that effectively confer their resistance to powdery mildew.

As previously described, seedling laboratory tests indicate that pathotypes virulent for resistance genes present in some MR varieties are present in WA but that these pathotypes are not uniformly distributed across the wheatbelt (Tucker et al. 2013, Table 2).

Seedling infection in Yagan was greater at Gibson than at South Perth, while conversely, under very high disease pressure, Commander and Compass expressed greater disease at South Perth than at Gibson. This suggests that the powdery mildew population at these two sites contained a different range of virulences and that different preventative management approaches may be appropriate for these varieties in these regions. Regional variability was most evident in seedling responses (field and laboratory tests). Adult plants of most MRMS or better varieties had very little mildew on them.

Major resistance genes are effective at all growth stages but where they are compromised other genes conferring varying levels of adult plant resistance (APR) could be present. In the absence of additional APR genes, both seedling and adult response will be compromised. Where pathotypes with seedling virulence occur, greater attention to early season disease management may be indicated.

Varieties containing similar postulated genes (eg. MIGa in Barque, Capstan, Fleet, Fathom and Flagship or Mla8 in Baudin, Vlamingh and Bass) can respond differently within and between sites, indicating that other factors apart from just the known or postulated genes, such as unidentified APR genes or differences in genetic background of the variety, contribute to the observed disease response.

While the differences identified are currently of minor impact, or have occurred in non-commercially relevant varieties, they give a good indication that regional differences in response are possible due to variability within the pathogen population and continued monitoring of variety response is important to facilitate appropriate disease risk assessment and in-crop disease management.

Key words

Blumeria graminis f. sp. *hordei*, Powdery mildew, barley variety

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