



Bundesforschungsinstitut für Kulturpflanzen Federal Research Centre for Cultivated Plants

# Multiple loci provide resistance against diverse *Puccinia hordei* isolates in seedling and in adult plant growth stages in barley landrace *MBR1012*

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www.jki.bund.de



### Hordeum genepools

Barley germplasm provides rich genetic diversity for genetic improvement



Photo by Yu Cai

https://portal.cybertaxonomy.org/f lora-greece/cdm\_dataportal/taxon Photo by Yu Cai

# Barley leaf rust



> Caused by fungi: *Puccinia hordei* 

- Symptom: range from small chlorotic flecks to large pustules containing spores
- Yield losses: 20~60%.
- Malt/feed quality also reduced.



https://www.cropscience.bayer.co.nz/pests/diseases/leaf-rust---barley

# Mapped leaf rust resistance genes



26 seedling stage resistance and 3 adult plant resistance genes have been so far identified.



## MBR1012 is resistant to leaf rust.





Mol Breeding (2012) 30:1253-1264 DOI 10.1007/s11032-012-9712-0

#### Genetic mapping of a leaf rust resistance gene in the former Yugoslavian barley landrace MBR1012

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#### Low-resolution mapping with 91 DH lines



# *Rph<sub>MBR1012</sub>* was mapped as a single dominant gene on chr. 1HS

# High resolution mapping of *Rph*<sub>MBR1012</sub>





Fazlikhani L, et al. Front. Plant Sci. 2019

Institute for Resistance Research and Stress Tolerance

# Objective



 In addition to positional isolation of *Rph<sub>MBR1012</sub>* gene that confers resistance to leaf rust I-80, we are interested to find out whether the gene is responsible for the adult-plant resistance (APR) that was occurred in field conditions.

 Explore if MBR1012 posses multiple resistance loci against diverse pathotypes, i.e. in Australia, which could be used as donors for pyramidisation in elite breeding.

# Plant material and leaf rust isolates



97 Double-haploid lines derived from MBR1012 and Scarlett DH3 and Scarlet MBR1012 DH4 populations was used for assessment to five isolates at seedling stage and APR

DH lines	Number of lines			
	Seedling Res.	Genotyping		
DH-3	50	50K chip		
DH-4	46	15K chip		
Total	97	-		

Table.1 Number of DH lines used for mapping

4663 common SNP markers among the 50K and the 15K Illumina iSelect Chip Platforms were used for mapping.

#### Result

### Parental lines screening in Australia



Parent MBR1012 showed a intermediate IT reaction at seedling stage in response to five isolates, while at adult plant stage was resistant to 5457P+.

Parent Scarlett was resistant to four isolates and susceptible to isolate 5457P+ (3=C) and at adult plant stage.

Line	P. hordei pathotypes						
	5457P+	253P-	5652P+	200P-	220P+	FIELD_2019 (5457P+)	(5457P+)
MBR1012	2=CN	2=C	;12C	2=C	22+C	20MR	-
Scarlett	3=C	;1C	;+N	;1=N	0;	70S	40MRMS

Table. 2 Summary of phenotypic response of parental genotypes to different pathotypes

#### Result

# Phenotyping of DH lines

Chi-square analysis does not fit to 1:1 segregation for monogenic inheritance, revealing a complex genetic background.

Table. 3 Distribution and Chi-squared analysis of DH lines when tested with 5 pathotypes

Isolates	Number of	Number of	X2	P-value	
	R plants	S plants	(1:1)		
5457P+	20	75	30.7	<0.0001	
253P-	65	30	12.9	0.0003	
5652P+	65	29	12.7	0.0002	
200P-	75	21	29.3	<0.0001	
220P+	74	20	29.9	<0.0001	



Phenotypic data of APR from two consecutive years showed high correlation.



#### Results

## Map construction





Genetic linkage map constructed based on 4663 SNPs with Kosambi function and a LOD threshold of 3-10 using MSTmap pipeline.

Results

# QTL mapping



2 QTLs on chr.5H and 1 QTL on chr.7H were identified with 96 DH lines. For APR mapping, single QTL on chr.2H was identified.



#### Results

# Overview of mapping



QTLs on 5H and 7H overlap with Rph2 and Rph3. While APR locus on 2H may be a new locus.

#### Table 3. QTL mapping for each pathotype and APR

Isolates	chr.	Marker	Genetic pos (cM)	Physic pos (Mb)	LOD	PVE (%)	Known QTLs/Gene	Donor
200P-,220P	5H	Hv50K_APR_2552	268.0	44.6	5.4-6.5	17.3-18.6	Rph2 (?)	Scarlett
200P-,220P	5H	Hv50K_APR_2438	312.4	56.4	3.9-4.3	11.2	Rph2 (?)	MBR1012
<mark>253P-,5652P+,</mark> 200P-,220P+	7H	Hv50K_APR_4526	36.7	608.1	<mark>13.5,16.6</mark> 5.0,5.1	<mark>47.5,49.2</mark> 13.6-15	Rph3	Scarlett
5457P+ for APR	2H	Hv50K_APR_0657	123.4	518.5	3.8	21.1	?	MBR1012

# Outline and next steps



- Our study detected 3 genetic loci conferring complete or partial resistance to diverse leaf rust isolates from Australia at the MBR1012 x Scarlett mapping population.
- A single locus on 2H confers adult-plant stage resistance. It might be a novel APR gene in barley.

What we are going to do next....

- > APR assessment in Germany using isolate from Leutewitz.
- > Validate these resistance loci with known linked markers.
- Pyramid the loci from different plants into a single elite cultivar with crosspollination and marker-assisted selection.

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