

## Tracking alleles linked with *Fusarium* head blight resistance QTLs in wheat (*Triticum aestivum*) released in Kyushu region

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*Fusarium* head blight (FHB) is a plant disease occurring in small grains such as wheat, barley and maize. In Japan, the FHB of wheat is one of the most destructive diseases because of its coincidence with the flowering to grain-filling period of wheat which provides a fungus-favorable condition. In addition, FHB decreases the yield and the quality of wheat.

The Kyushu region is one of the main wheat production areas in Japan. After the FHB epidemics in 1963, an intensive breeding program for FHB resistance has been conducted in Kyushu as a national breeding program. Similar to the general breeding program, FHB resistance breeding has been performed by crossing a cultivar of interest with another resistant cultivar. Then, progenies having appropriate traits are selected. Through this process, feasible alleles (feasible one of a number of alternative forms of the same gene) would be selected, which implies that the alleles linked to loci related to an unfavorable agronomic trait may also be excluded. Because of the annual variation in rainfall, FHB disease pressure fluctuates, causing rendering the evaluation of FHB resistance lines laborious and uncertain. By investigating the alleles related to the FHB resistance through the breeding lineage, information on alleles contributing to the FHB resistance in the breeding program can be obtained.

As a first step, thirteen representative cultivars bred from 1920s to 2010s were selected. The seeds of the cultivars were sown on petri dishes and refrigerated at 4°C for four days; subsequently, they were germinated in a 25°C chamber. The germinated plantlets were transplanted to pots and grown in a glasshouse at 25°C. Leaves were harvested 18 days after sowing and used for DNA extraction.

Of the 21 wheat chromosomes, DNA markers linked to the alleles related to FHB resistance were reported in the short arm of chromosomes 2D (2DS), long arm of 2D (2DL), 3BS, 5AS, and 6BS.1-4) By conducting PCR using these markers, types of alleles related to FHB resistance (resistant, susceptible, or other) in individual cultivars were determined. The fragment, after amplification with a DNA marker *UMN10* at 3BS was analyzed by sequencing. The PCR products of the other markers were electrophoresed using MultiNA (Shimadzu, Kyoto, Japan).

The results are listed in Table 1. Resistant alleles on 3BS and 5AS were retained after ‘Shinchunaga’ was bred. The resistant allele on 2DL was fixed in the lineage after ‘Asakazekomugi’ was bred. In contrast, resistant alleles on 2DS and 6BS were excluded from the lineage for cultivars released after the 1940s released cultivars, when ‘Shinchunaga’ had contributed as their frequent crossing parent. Interestingly, the susceptible alleles from ‘Shinchunaga’ had been selected for 2DS, and the resistance alleles on 6BS were selected alternatively from the counter parents of ‘Shinchunaga.’ It can be expected that some alleles responsible for unfavorable agronomic trait(s) on 6BS from ‘Shinchunaga’ may be linked to these regions. ‘Shinchunaga’ has favorable allele (s) such as *rht8* that determines plant height and was selected even linked with the susceptible allele for FHB. In the same manner, other alleles detected in modern cultivars might contribute to FHB resistance rather than the ones detected in old cultivars as new linkage disequilibrium. Further investigation of the alleles related to FHB resistance in every generation of lineages is in progress.

Table 1 Types of FHB resistance-related alleles in Kyushu lineages

Release year	Cultivar	2DS		2DL	3BS	5AS		6BS	
		TaMRP-D1	Xgwm539	UMN10	Xgwm293	Xgwm304	Xwmc398	Xgwm644	
1923	Eshimashinriki	R	o	o	R	R	nd	nd	
1931	Norin 5	R	R	o	R	R	o	R	
1933	Shinchunaga	S	o	R	R	R	R	R	
1936	Norin 20	R	o	R	R	R	R	R	
1943	Norin 52	S	o	R	R	R	o	o	
1956	Shirasagikomugi	S	o	R	o	S	o	o	
1957	Junreikomugi	S	o	R	R	R	o	o	
1978	Asakazekomugi	S	R	R	R	R	o	o	
1986	Wheat Norin PL-4	S	R	R	R	R	R	nd	
1986	Saikai 165	S	R	R	R	R	o	o	
1994	Chikugoizumi	S	R	R	R	S	o	o	
2006	Towaizumi	S	R	R	nd	R	o	o	
2011	Wheat Norin PL-9	S	R	R	o	S	o	o	

R: resistant allele, S: susceptible allele, o: other allele (resistant type unknown), nd: not determined

### References

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