

CORNET Efficient Wheat: The influence of *Rht-D1* on agronomic performance and quality traits in common winter wheat

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Abstract

The gibberellic acid-insensitive dwarfing genes *Rht-B1b* (*Rht1*) and *Rht-D1b* (*Rht2*) are widely distributed in wheat breeding programmes due to grain yield benefits associated with the useful reduction in plant height for these mutant alleles.

The donor of both dwarfing genes in most wheat cultivars is 'Norin 10' that inherited dwarfism from the Japanese landrace 'Daruma'. Pleiotropic effects of 'Norin 10' derived dwarfing genes on grain yield and its components have been reported.

The objectives of the present study were to: (1) analyze the influence of the dwarfing gene *Rht-D1* on agronomic performance and quality traits using a bi-parental winter wheat population, and (2) to compare its effects to that of the gibberellic acid-responsive dwarfing gene *Rht8*. The population Pamier (*Rht-D1b*, *Rht8a*)/Format (*Rht-D1a*, *Rht8b*) consisting of 114 doubled haploid lines along with the parents were grown at three locations (Roggenstein, Feldkirchen and Hadmersleben) in Germany during the 2011/2012 and 2012/2013 cropping seasons, for a total of six environments.

The field trials included the genotypes with two replications, plot sizes of locations ranged between 5.7 m² and 10 m². The population was genotyped using 928 single nucleotide polymorphism (Illumina® Wheat 90k SNP array) and 80 simple sequence repeat markers including markers functional for *Rht-D1* and linked to *Rht8* (*Xgwm261*).

Quantitative trait locus (QTL) analysis revealed significant ($P < 0.001$) QTL for plant height (2012 and 2013),

ear emergence time (2012), 1000-kernel weight (2012 and 2013), grain yield (2012 and 2013), harvest index, grain protein content, grain protein yield, sedimentation volume and falling number that were strongly linked to *Rht-D1*. At this stage of analysis, data for both growing seasons were only available for plant height, ear emergence time, 1000-kernel weight and grain yield. Whereas the *Rht-D1b* mutant allele was found to increase grain yield at location Hadmersleben in 2012 and 2013 by 4.0 dt·ha⁻¹ and 8.4 dt·ha⁻¹, no positive effect of the dwarfing allele on grain yield was observed at south German field sites Roggenstein and Feldkirchen in both years. When compared to the mean of tall sister lines (those carrying the *Rht-D1a* wild-type allele), *Rht-D1b* lines reduced plant height by 21.6% (2012) and 19.4% (2013). In comparison, height reduction associated with *Rht8b* (vs. lines carrying *Rht8a*) averaged 5.4% in 2012 and 5.1% in 2013. An influence of the *Rht-D1b* allele on reduction in 1000-kernel weight was observed and estimated at 4.5% (2012) and 7.3% (2013) of the *Rht-D1a* wild-type allele, whereas the influence of *Rht8* on this character was negligible in both years. In 2012, *Rht-D1b* reduced grain protein content, grain protein yield and sedimentation value by 4.1%, 5.0% and 13.2%, respectively, and improved harvest index and falling number by 4.9% and 11.6%, respectively. In contrast, *Rht8b* showed a slight increase in harvest index (3.0%) without compromising quality traits in bread wheat.

Keywords

Dwarfing genes, QTL, quality traits, SNP, *Triticum aestivum*

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