Reduced height genes affect root growth of wheat

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Introduction

The aim of this project is to characterise the effects of reduced height genes (Rht) on root development and growth of wheat. Cereal cultivars containing semi-dwarfing genes have a reduced stem height phenotype compared to control plants which is caused generally by an interruption of gibberellic acid biosynthesis or gibberellic acid signal transduction. Semi-dwarfing lines have a reduced coleoptile length, which can affect the early vigour and establishment of temperate cereals, but there are conflicting reports about whether and how semi-dwarfing genes affect the root systems of temperate cereals.

Material and Method

Near isogenic lines (*rht* control, *Rht*-B1b (= *Rht*1), *Rht*-D1b (= *Rht*2), *Rht*-B1c (= *Rht*3), *Rht*8, *Rht*-D1c (= *Rht*10), and *Rht*12) of wheat (cv Mercia, Fig. 1) were grown in gel chambers, in soil-filled columns, and the field. Because the height of Mercia is already reduced, presumably due to the accumulation of several minor genes, near-isogenic lines (*Rht* control, *Rht*-B1b, *Rht*B1c) in a tall cultivar background (cv Maris Widgeon) were also included in the field experiment.

Weighed seeds were individually surface sterilised, pre-germinated on filter paper and two seedlings planted in a gel chamber. The plants were grown for 10 d at 15°C.

For the soil-filled columns, seeds with a defined seed mass (40mg ± 1mg) were pre-germinated. Seedlings of each genotype were grown in columns containing soil packed to 1.1 g cm^{-3}. After 26 d, the root systems were washed and scanned.

In the field experiment, individually weighed seeds were sown into columns which had been pushed into a power-harrowed and rolled sandy loam soil (Sonning farm, Reading University, UK). The plants were grown for 46 d.

All root systems were scanned and analyzed using 'Winrhizo' or 'Winrhizotron'.

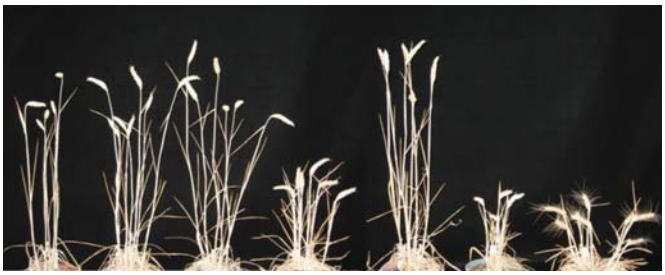


Figure 1: Mercia lines: Mercia rht, *Rht*-B1b, *Rht*-D1b, *Rht*-B1c, *Rht*8, *Rht*-D1c, and *Rht*12

Conclusion

We conclude that root growth is affected by *Rht* genes causing a dwarf phenotype. In soil, the length of the root system was decreased in the dwarfing lines, but in gel chambers the length was increased.

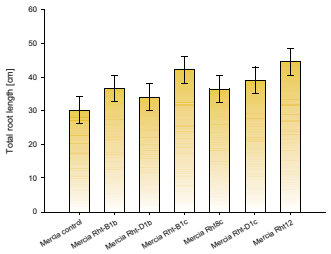
Future expression and localisation studies in barley will test, whether and how gibberellic acid biosynthesis and signal transduction genes influence root growth and development of temperate cereals.

Results

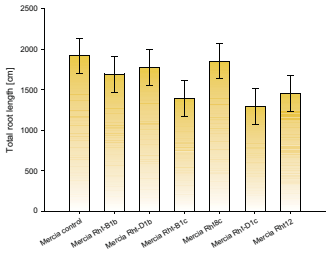
The correlation between seed mass and total root length was determined in an initial experiment, as the average seed mass varies between the near-isogenic lines. Greater seed mass was found to increase significantly total root length, and therefore seed mass was used as a covariant for the analysis of variance in the gel chamber and field experiment.

No significant differences between semi-dwarfing lines (*Rht*-B1b, *Rht*-D1b, *Rht*8, and the control line were found in any experiment nor was there a significant difference between the root length of the two cultivars grown in the field. However, total root length of the dwarf lines (*Rht*-B1c, *Rht*-D1c, and *Rht*12) was greater than that of the control line in the gel chamber experiment, but less in both the soil-filled column and field experiments (Figs 2).

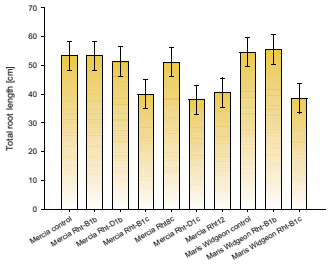
Figure 2: Effects of *Rht* genes on total root length
A) Total root length of NILs grown in gel-chambers after 10 d (the bar is ± 1 standard error of difference: lsd 5% = 7.90 cm $plant^{-1}$)



B) Total root length of plants grown in soil-filled columns after 26 d (the bar is ± 1 standard error of difference: lsd 5% = 441.4 cm $plant^{-1}$)



C) Effects of *Rht* genes on total root length of field grown plants.
NILs of two wheat cultivars (tall cultivar cv Maris Widgeon and cv Mercia) were measured after 30 d (the bar is ± 1 standard error of difference: lsd 5% = 9.02 cm $plant^{-1}$)



Average root diameter and ratio between seminal and lateral (Fig 3) showed no significant differences in the experiments.

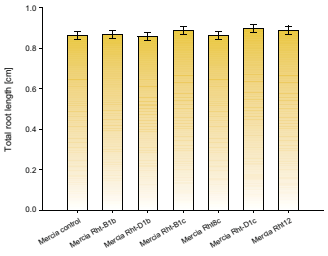


Figure 3: Lateral root: total root length ratio plants grown in soil-filled column (cv Mercia) measured after 26 d (the bar is ± 1 standard error of difference: lsd 5% = 0.04)