Comp 1.1: Phenotyping wheat root system architecture for deep rooting traits and greater deep water acquisition as a strategy to escape drought

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Impact

Deep rooting is the most promising root phenotype for drought avoidance in dryland agriculture (See also poster by Watt et al). This research will have direct impact on breeding and agronomy for improvement of deep water acquisition, what genetic material may have a deep rooting phenotype, and what traits cause deeper rooting.

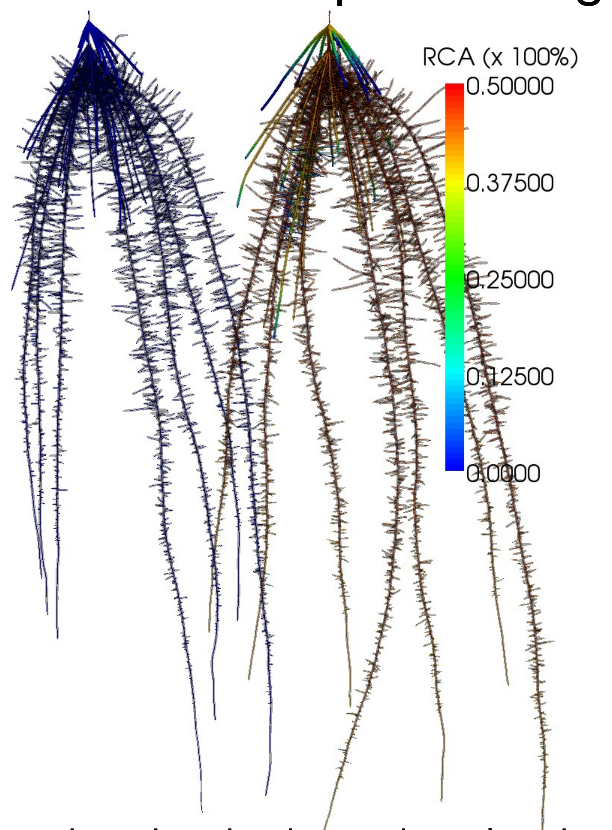

Fig 1: Increased rooting depth may be related to anatomical traits. Here simulation of root cortical aerenchyma formation in maize, which allows deeper rooting under nutrient poor conditions. A genotypic contrast study suggests that high RCA lines also root deeper and have greater yield under drought (1,2).

Fig 2: Nodal roots of field grown barley. During later stages of growth the nodal roots form a large part of barley and wheat root systems, determing the depth of the rootsystem. Data suggests there might be a tradeoff between number and length of nodal roots.

Improved plant processes

Greater and prolonged root elongation is related to hormonal fluxes, soil strength and resource allocation. For example see fig 1,2 and 3. Whole plant phenotyping of contrasting genetic materials under simulated drought scenarios will give greater understanding into how these traits combine in a deep rooting, drought tolerant phenotype.

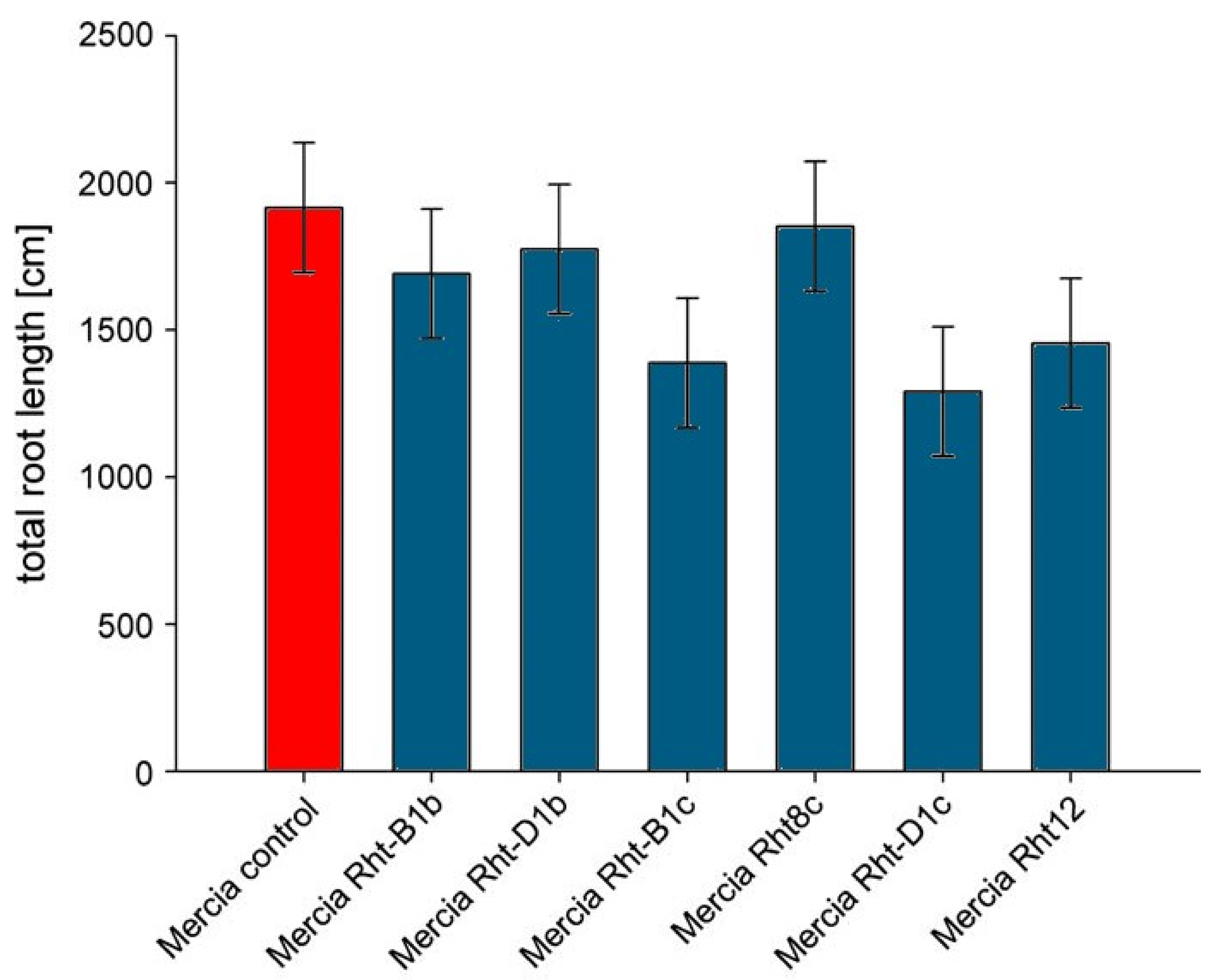

Fig 3: Dwarfing genes, involved in gibberellin pathway, not only reduce stem elongation, but also result in comparatively smaller root systems (3). However, the mechanisms are not well understood.

Main research methods

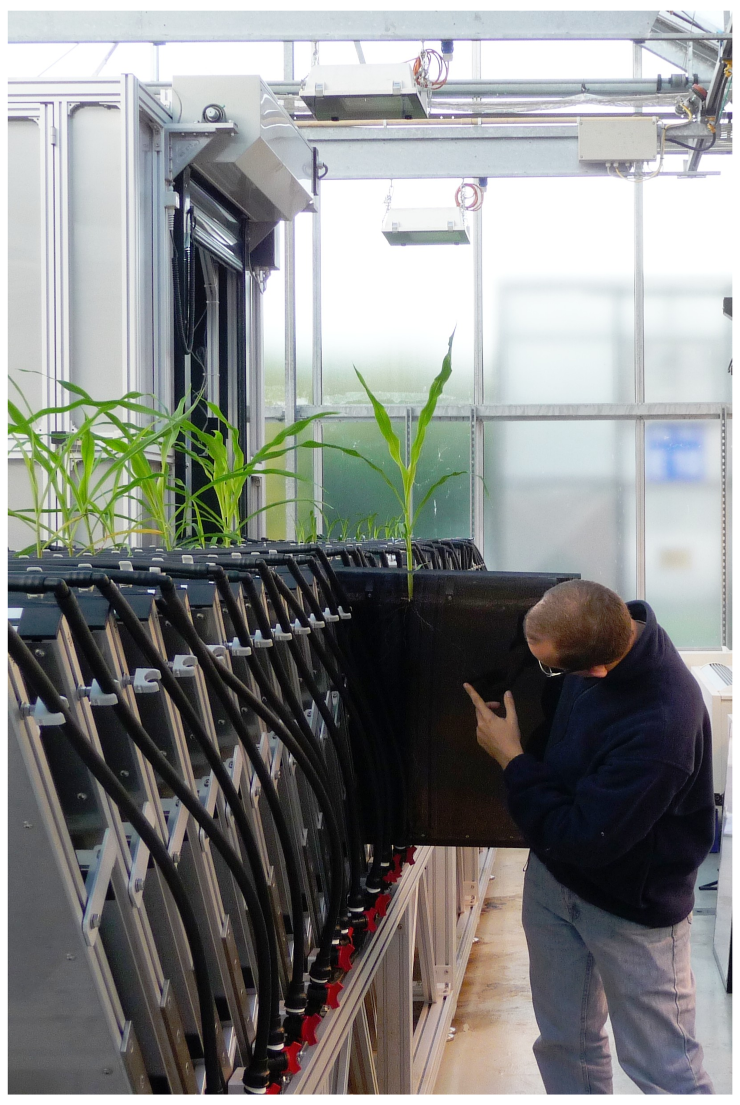

Fig 4: Non-invasive root phenotyping with automated rhizoboxes (4)

Fig 5: Non-invasive measurements of starch deposition, water content or transport using portable NMR (5)

Combining different noninvasive techniques (fig 4,5 and 6), we can observe on a single plant the growth of the root system, the water extraction profile and water fluxes through the plant. Using functional structural modeling (fig 6), we can put all the data together in order to have a mechanistic understanding of hydrodynamics in conjunction with growth.

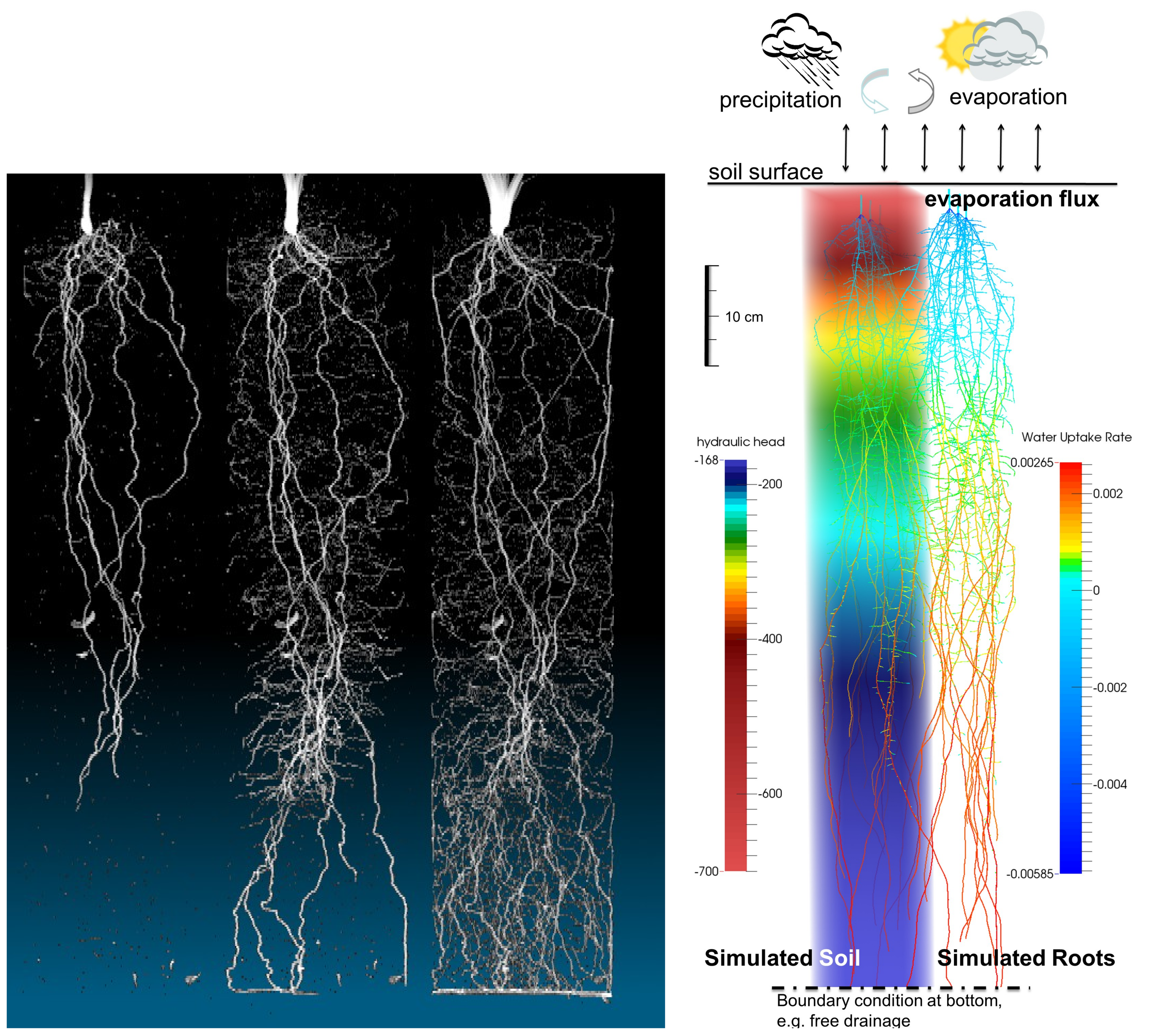

Fig 6: Development of barley root system and the water extraction by that root system can be observed by MRI and be modeled with *SimRoot*. Left: MRI image of barley root system at 4,6 and 7 weeks after germination (for MRI see 6). Right: Simulation of barley root system growing in a drying soil profile (for *SimRoot* model see 1).

Novelty of approaches

Current technological advances with MRI, portable NMR and high throughput root phenotyping methods, allow for a radically new approach and novel insights into how and when deep rooting results in deep water extraction and what traits may influence rooting depth, including tradeoffs such as the aforementioned connection between dwarfing and rooting depth.

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