An Instrumented Rhizotron to Investigate the Root Growth In Wheat

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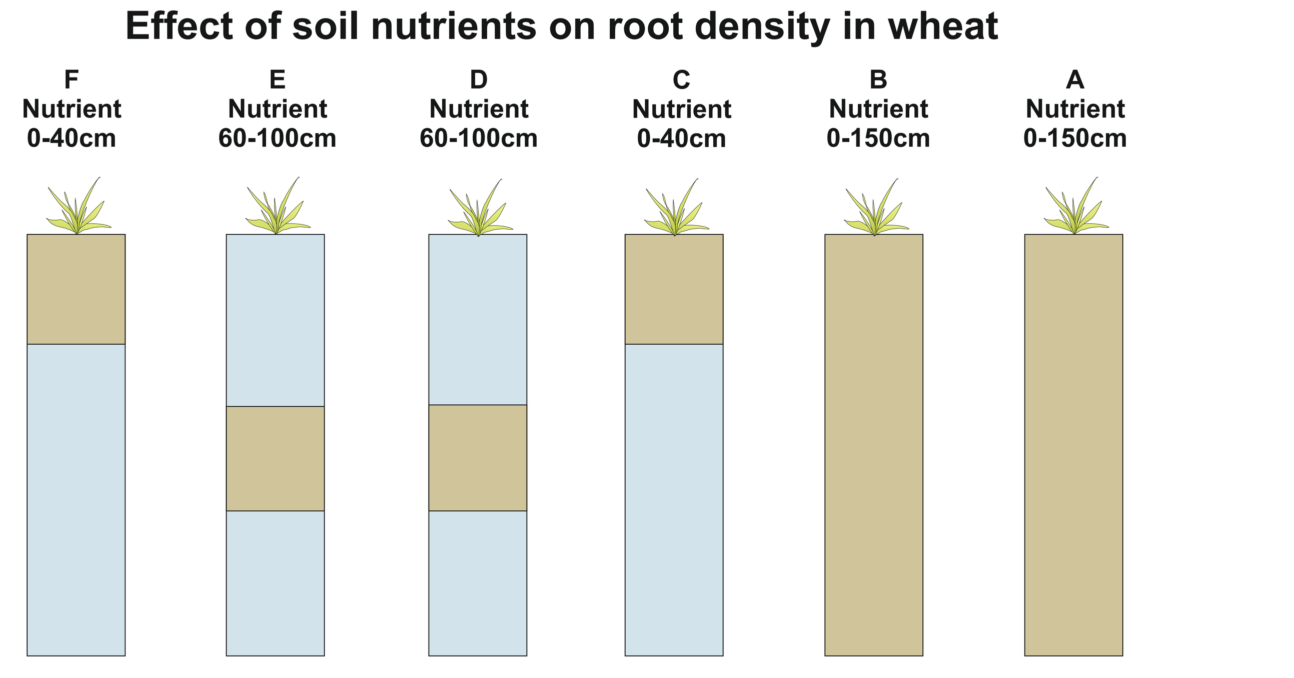
There has been much recent interest in modifying root system properties to overcome the effects of soil abiotic stress on crop growth and yield (Lynch 2007; Ghanem et al. 2011). Plant root systems are usually exposed to heterogeneous environmental conditions due to vertical differences in soil moisture and strength. Strong subsurface layers of soil can confine root systems to shallower soil layers, thus limiting water uptake from deeper layers. Even in dry periods when the soil surface has been dried by roots, substantial soil moisture can remain at depth (Whalley et al. 2006; 2008; White and Kirkegaard 2010). Increased depth of root penetration in wheat may therefore confer drought tolerance by allowing roots to access soil water at depth (Li et al. 2010; Lopes and Reynolds, 2010). Genetically altering root distribution between upper and lower soil layers may represent a viable strategy to improve access to water, and a recent study indicated that experimentally manipulating the root distribution within a single cultivar altered shoot growth and physiology (Martin-Vertedor and Dodd, 2011).

A significant barrier to progress is the availability of suitable laboratory approaches to study root growth. In this poster we describe a rhizotron system 1.4 m high, 0.5 m wide and 0.08 m deep. This is sufficient size to allow the wheat to be grown to maturity and to allow the use of buriable soil moisture and related sensors. We present preliminary experiments and report data from Rht NILs (near isogenic lines) in a mercia background that are affected by nutrient distribution. We also describe an irrigation system that allows spatial variation in soil moisture in both vertical and horizontal directions.

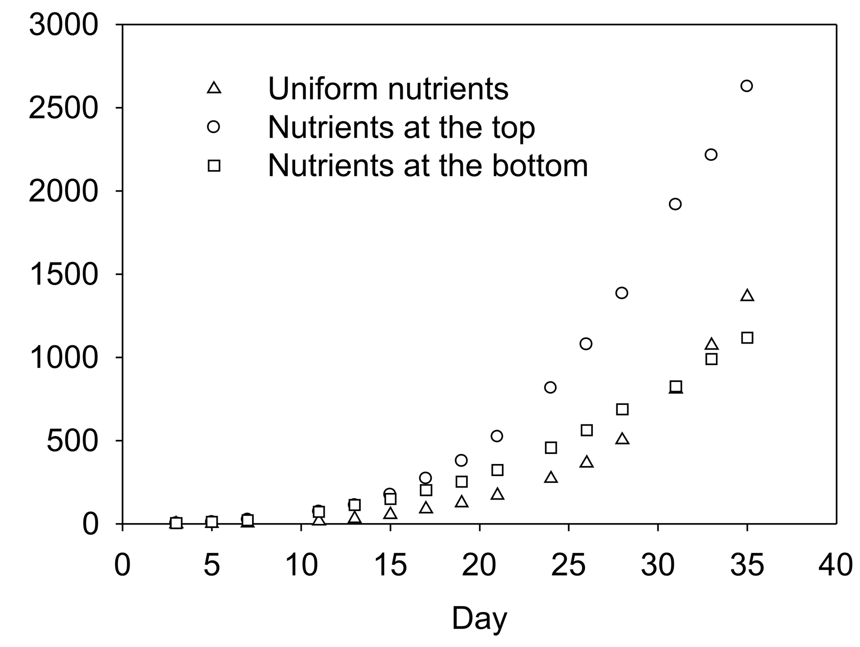
The experimental treatments

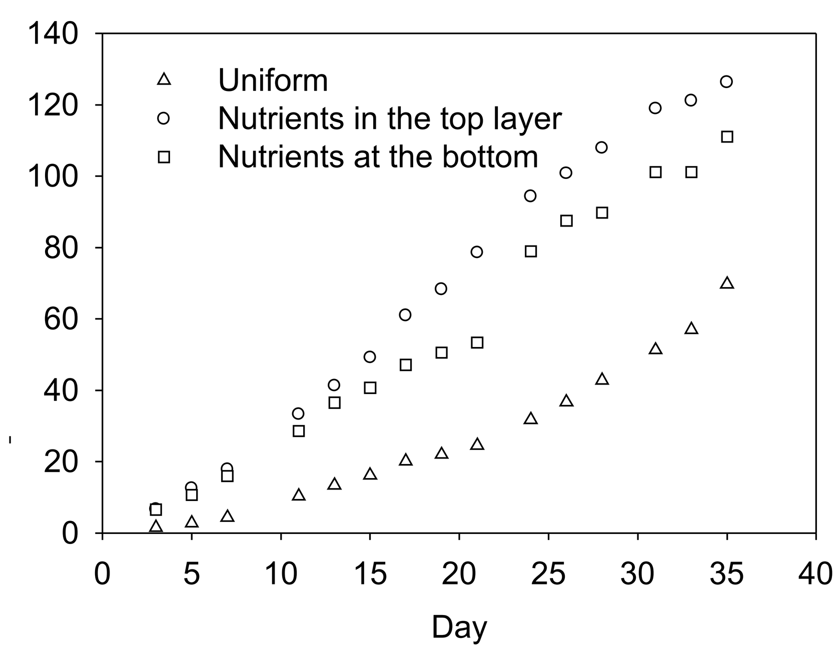


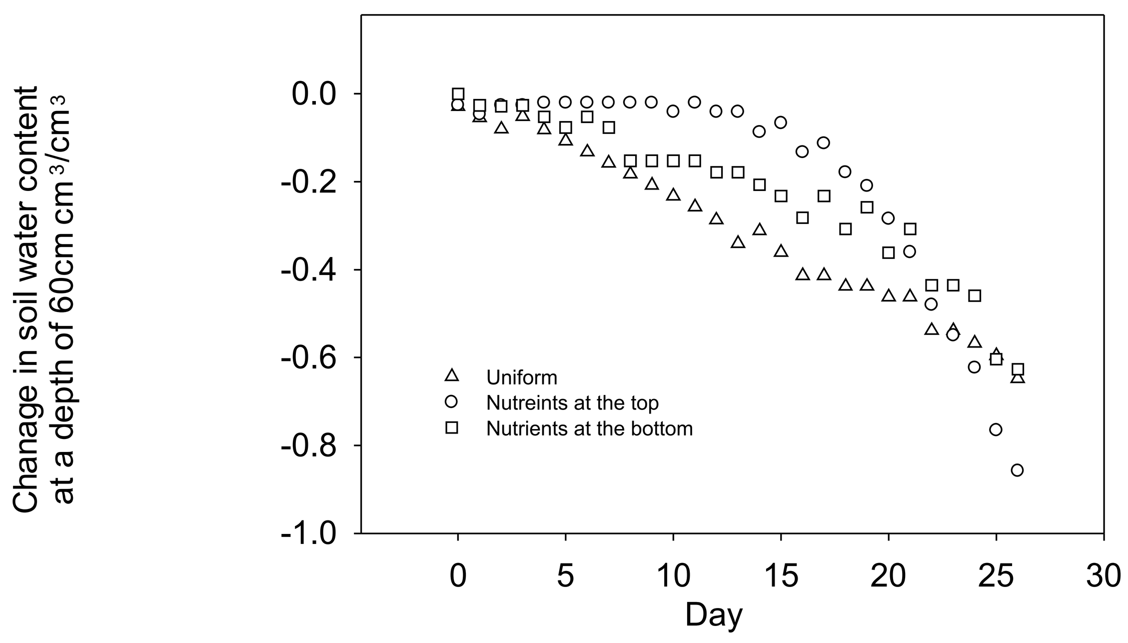
Rhizotrons packed in 5cm layers with sandy soil from Butt Furlong Woburn to a natural field density of 1.5kg 1000cm^{-3} with a moisture content of 17% w/w. Soil moisture adjusted to 17% w/w with either nutrient solution (Hoagland's standard solution) or water.
A single pre germinated seed (Mercia Rht1) is placed centrally against the glass face at a depth of 1cm.
A Pr1 soil moisture profile probe incorporated in each rhizotron.

The experimental system

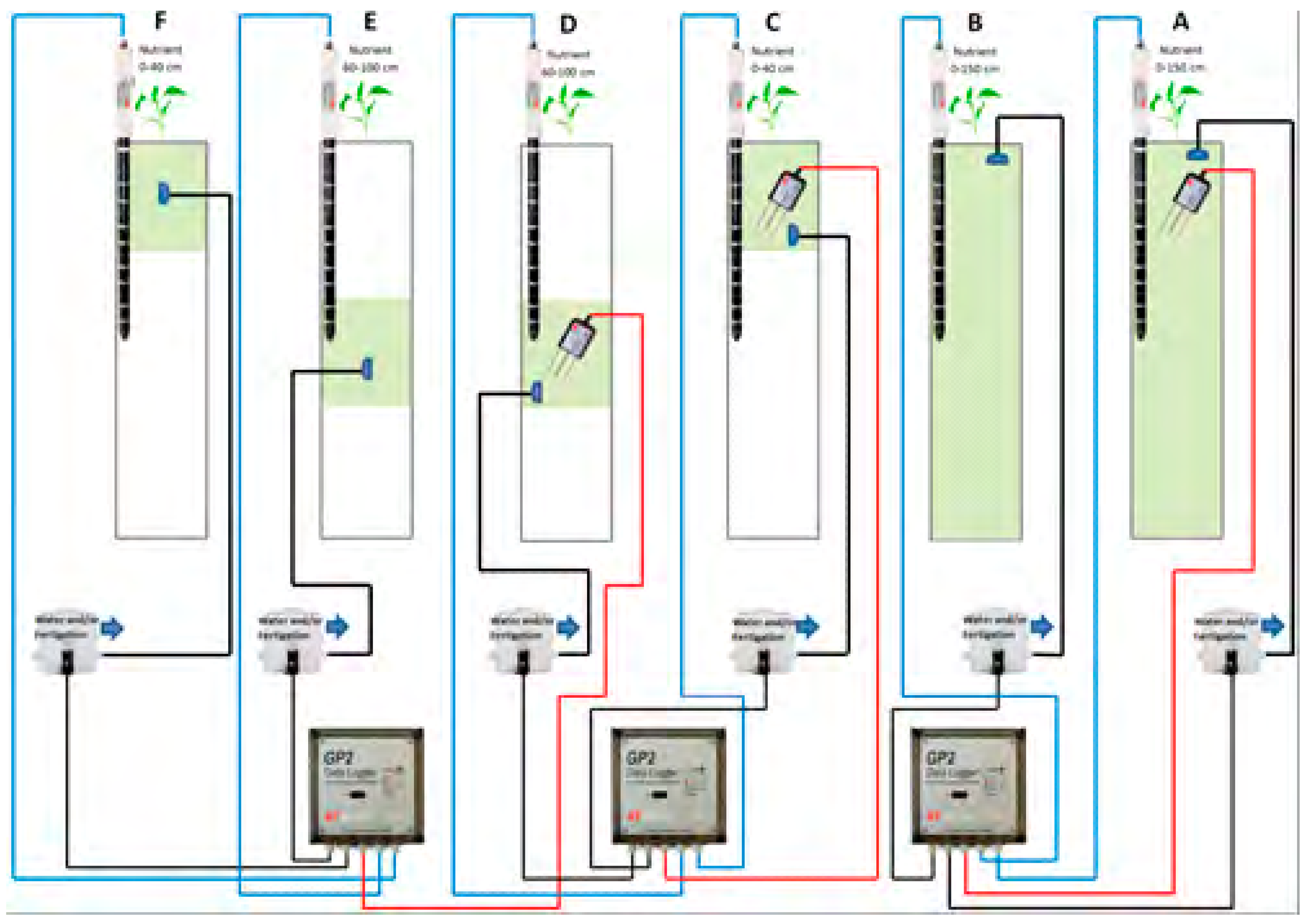
Preliminary results







Future work



The next step in this experimental investigation will be to employ Delta-T's GP2 Advanced Logger and Controller with the WET Sensor and the PR2 Profile Probe to measure and log soil conductivity (nutrient level), soil moisture and temperature. Each GP2 is capable of providing precise closed-loop irrigation control at different soil depths when combined with the PR2, as well as fertigation control when combined with the WET Sensor.

Conclusions

Preliminary data suggest that there is greater root growth and activity when nutrients are heterogeneously distributed in soil. Water uptake at depth is delayed when the nutrients are concentrated in the surface layer. When the nutrients were uniformly distributed the root depth was reduced.

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