Root growth responses to soil physical conditions.

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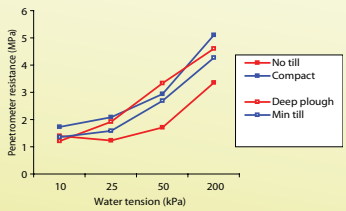
Background

- **Roots experience a range of physical constraints including mechanical impedance, water stress and oxygen deficiency.**
- **We are linking studies of soil physical properties to root responses *invitro* and in the field.**

Soil physical environment

Soil strength depends on soil type, water potential, and structure.



Soil strength (penetrometer resistance) increases as soil dries, and is greatest in compacted soil. Roots can experience large mechanical impedance even at field capacity

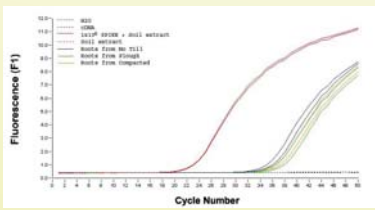
Root gene expression in field soil

We are developing methods for studying expression of root genes in relation to soil physical conditions.

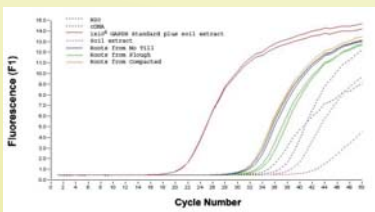
Genes: Arabidopsis At3g54890 (to monitor extraction efficiency); Barley GAPDH (root internal standard); Barley BPW (target gene associated with water transport).

Barley root RNA from 3 tillage treatments: Graphs show PCR using Light cycler for AtSPIKE (A), GAPDH (B) and BPW (C) sequences.

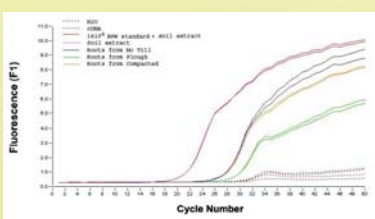
A



B



C



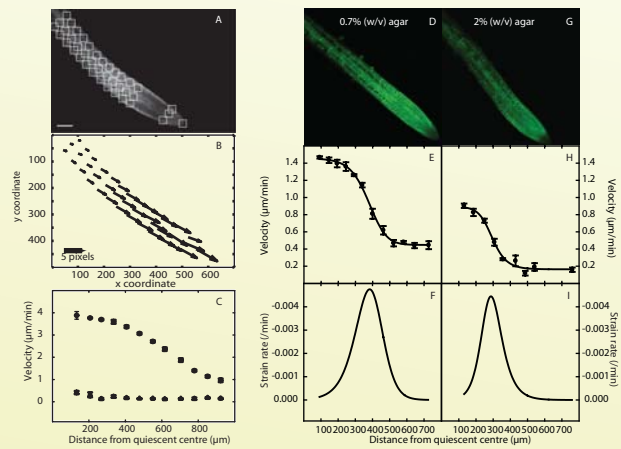
Root responses to soil conditions

Computer visualisation of root growth

Mechanically impeded roots are shorter and fatter with more border cells.

Aims: Quantify cell expansion and root growth over short time intervals to study control of root responses under stress.

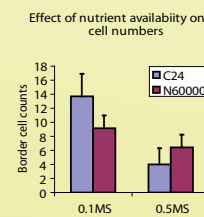
Particle Image Velocimetry (P.I.V.) tracks pixel patches between images to measure growth, with a 2 min resolution.



P.I.V. process (A-C). A: Patch placement on confocal image. B: Displacement vector field showing direction and relative movement of patches. C: Calculated velocity of patches verses distance from quiescent centre.

D-I: *Arabidopsis* growth on 0.7% agar (D-F) and 2% agar (G-I) using P.I.V. Confocal images of roots (D,G). Root tissue velocity as related to position along the root length (E,H) Strain rate calculated from velocity curves (F, I).

More border cells are associated with nutrient stress and mechanical impedance.



Nutrient stress induces border cell production in Arabidopsis.

We are screening for mutants that have altered border cell responses under nutrient and physical stress.

Future work

1. Quantify soil physical stresses experienced in field throughout season
2. Measure variation in root gene expression (including border cell genes), for *in vitro*, and soil grown roots.
3. Computer visualisation - development of a model to track cell features and extract cell expansion data, so that gene function can be related to growth in soil environment.

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