Quantitative analysis of root responses to multiple physical constraints: effects of soil pore structure

SCRI living technology

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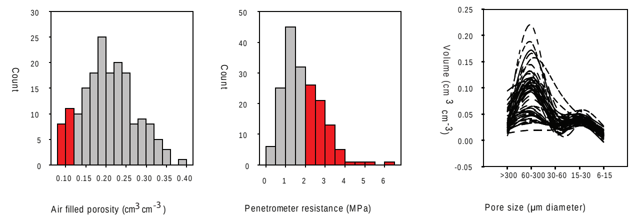
Introduction

Climate change may result in significant changes in rainfall patterns. The physical structure of soil affects both drainage and water retention. This reduces root elongation rates and can potentially affect crop yield.

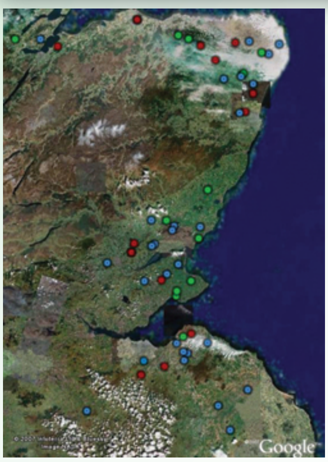
Objectives

- Assess the physical status of agricultural soils
- Investigate the effects of soil physical properties on root growth

Soil physical status



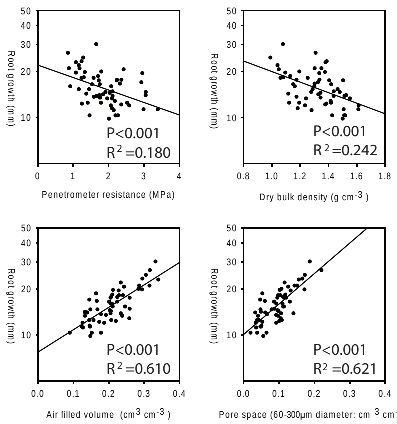
- 3% of soils had air volume <10%
- 39% had soil strength >2MPa penetrometer resistance
- significant variation in the pore space distribution.



Methods

- Sampling area: North East Scotland (left)
- 3 intact soil cores collected from 59 fields
- Matric potential adjusted to -20kPa
- Barley seedling root elongation assay

Physical effects on root growth: the importance of pore structure.



- 50% of field soils slowed root elongation by more than 50%.

Conclusions

- Soil physical properties in field are likely to be slowing root elongation.
- Root elongation rates are closely related to the volume of air filled pores in field cores (particularly the 60-300µm diameter range), in contrast to sieved repacked cores suggesting soil structure is important.

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References:
Wuyts, N. et al. (2010) Automated motion estimation of root responses to sucrose in two Arabidopsis ecotypes using confocal microscopy. Submitted.
Roberts T.J. et al. (2010). Estimating the motion of plant root cells from in vivo confocal laser scanning microscopy sequences. Machine Vision & Applications. 10.1007/s00138-009-0207-x

Future analysis of physical contraints to root growth

RNA expression analysis

- RNA expression analysis in roots extracted from soil cores: e.g. response of aquaporins in barley roots to changes in water availability in two different cultivation systems (right)

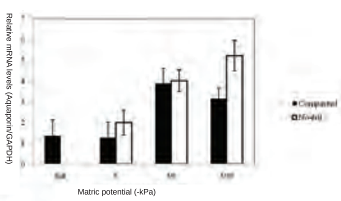
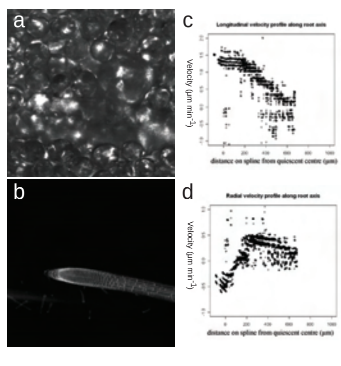


Image analysis

- PlantVis is an image analysis tool being used to analyse root elongation and growth strategies in artificial systems with different pore structures (Roberts et al. 2010, Wuyts et al. 2010)



Confocal image of A.thaliana root expressing 35S:LTIb:eGFP, growing in glass bead system (transmission image (a), GFP expression (b)). PlantVis analysis of growth (longitudinal expansion of root (c), radial movement (d))