Plant growth responses to soil physical constraints.

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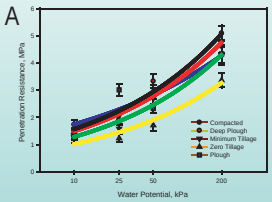
Background

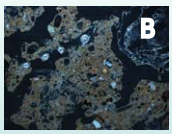
Root growth can be constrained by soil physical properties such as soil strength. This can lead to smaller variable yield and decreased water and nutrient uptake. Plants respond to these constraints by changes in overall root structure and responses at the individual meristem level such as increasing border cell production. We are studying a range of traits within a selection of barley cultivars, to investigate how different rooting types overcome these constraints.

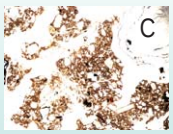
Soil physical properties

Soil strength depends on soil type, water content and soil structure (A). Soil structure can be influenced by different tillage treatments (B-D)

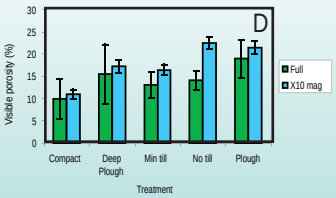
(A) Soil strength (penetrometer resistance) increases as soil dries, and is greatest in compacted soil.



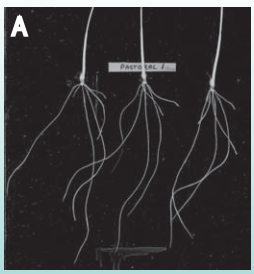


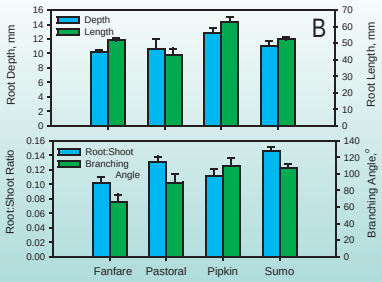


Thin sections of ploughed soil: Pore space appears black (B; using polariser & analyser) or white (C; light field). Thus visible porosity and its distribution can be quantified (D). This is however only a fraction of overall porosity



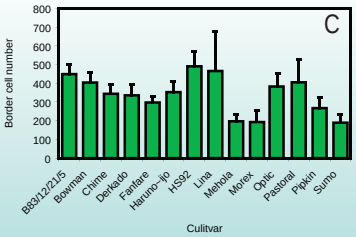
Early seedling properties





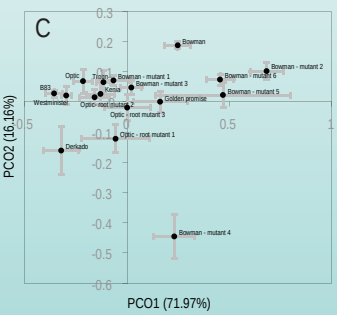
Dual thin gel layer plates (A) are being used to assess seedling root depth and inital root angle (B).

Border cell numbers have also been assessed in a range of cultivars (C)

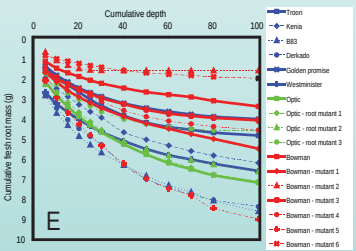


Mature plant above and below ground traits

Cultivar and mutant barley lines have been assessed for developmental traits, e.g time to tillering, number of tillers and distribution of fresh weight across above and below ground portions of the plants.

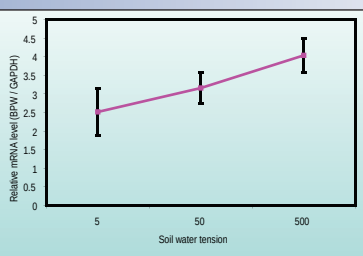


A - Greenhouse set up for barley
B - Example above ground barley portion and seed head at harvest.
C - Principle components analysis of fresh weight distribution between barley cultivars and mutants (Main tiller, remaining tillers, leaves, seed heads, total root)
D - Root harvesting from specific depths
E - Variation in rooting depth between cultivars. Cumulative fresh weight of root material (from top through to 100cm depth).



Future work

Plants with specific root traits and combinations of traits will be used to assess their relative importance on the plants' ability to overcome physical constraints.
Plants will be assessed under differerent soil types, compaction levels and water availability.
Expression of genes linked to responses of plants to soil conditions will be explored.



mRNA levels of BPW obtained by quantitative RT-PCR in plant roots grown under different water availability, in soil cores. BPW is involved in water uptake

Acknowledgements

This work is supported by Scottish Executive Environment and Rural Affairs Department. Barley cultivars and mutants were obtained from collections of Barley maintained by Genomics Programme SCRI. - See also reference Caldwell, D., McCallum, N., Shaw, P., Muehlbauer, G.J. & Waugh, R. (2004) A structured mutant population for forward and reverse genetics in barley (Hordeium vulgare L.). Plant Journal 40, 143-150.