

Root biomechanics: Effects of soil density, waterlogging and root type

K. W. Loades^{1,2}, A. G. Bengough¹, M. F. Bransby² and P. D. Hallett¹

¹SCRI, Invergowrie, Dundee DD2 5DA. ²University of Dundee, Dundee, DD1 4HN

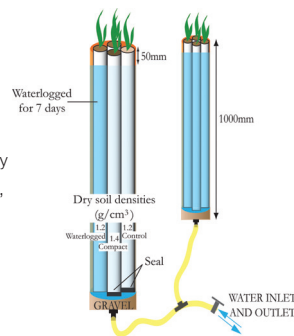
Introduction

Plant roots stabilise soils and provide anchorage but these vital functions are poorly understood. Root elasticity and strength are key properties in predicting soil strength and the contribution of roots to soil reinforcement. Biomechanical properties are likely to vary in the root system depending on age and environment. No information is available to date on the effects of soil density and waterlogging on root biomechanics.

Plant growth and treatments

Barley (*Hordeum vulgare*, cv Bowman) are grown in an environmental chamber for 3 weeks with roots subjected to 3 different soil treatments.

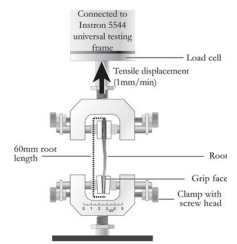
- Day and night light cycling, 18 and 6 hours respectively
- Temperature changes with day and night cycles, 12°C and 18°C
- Fixed volume watering for non waterlogged plants



Biomechanical testing

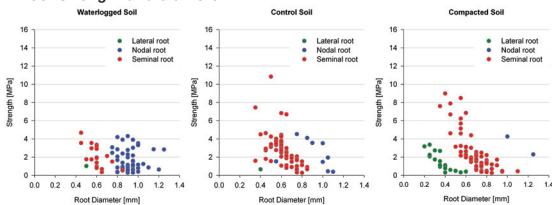
The strengths of each seminal, nodal and lateral root was measured and distance from stem base, at the soil surface, recorded. Distance from stem base is indicative of root age

- Roots washed from soil and stored at 4°C
- Different root types separated, seminal, nodal and lateral
- Root diameter measured under 40x magnification



Results – Root strength

Root strength and diameter

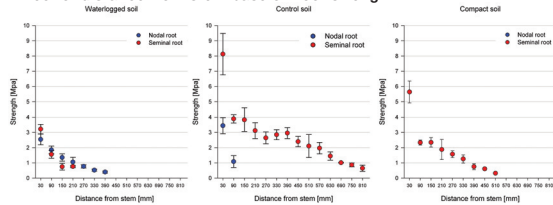


- Seminal root strength decreased with increasing diameter in all soils
- Nodal root strength not affected by diameter on control and waterlogged soils
- Lateral root strength affected by diameter in compacted soils

Treatment	Root	Diameter
Compacted	Seminal	<0.001***
Compacted	Nodal	-
Compacted	Lateral	<0.001***
Control	Seminal	<0.001***
Control	Nodal	NS
Control	Lateral	-
Waterlogged	Seminal	0.004**
Waterlogged	Nodal	NS
Waterlogged	Lateral	-

Results – Age effect on root strength

Effect of distance from stem base on root strength



- In all treatments seminal root strength was affected by distance from stem base (P<0.001 for compacted soil, P<0.001 for control soil and P<0.05 for waterlogged soil)
- Nodal root strength affected by distance from stem base in control and waterlogged soil, P<0.01 and P<0.001 respectively
- Root sections 30mm below the plant were stronger than other root sections in all soils (P<0.001)

Treatment	Root	Distance from stem base
Compacted	Seminal	<0.001***
Compacted	Nodal	-
Compacted	Lateral	-
Control	Seminal	<0.001***
Control	Nodal	0.002**
Control	Lateral	-
Waterlogged	Seminal	0.026*
Waterlogged	Nodal	<0.001***
Waterlogged	Lateral	-

Future work

- Analyse root tissue for lignin content enabling links between root composition, biomechanical properties and growth conditions
- Examine effects of treatments on root elasticity
- Incorporate study results into soil reinforcement models to predict soil stability under differing soil conditions
- Investigate soil stability profile with increasing distance from the surface using root strength data presented