EGU26-7232, updated on 17 Apr 2026
https://doi.org/10.5194/egusphere-egu26-7232
EGU General Assembly 2026

Understanding root biomechanics in high-strength environments- assessing the feasibility of penetration and fracture FE models with SRXCT.

Conor Wright[1], Emily Ramsdale[1], Daniel McKay Fletcher[2], Katherine Williams[3], James Le Houx[4], and Siul Ruiz[1]

[1]Mechanical Engineering, University of Southampton, SO17 1BJ
[2]Scotland's Rural College, EH9 3JG
[3]School of Biology, University of Portsmouth, PO1 2UP
[4]ISIS Neutron and Muon Source, Science and Technologies Facilities Council, OX11 0QX

Trends in mechanised agriculture and drought events are leading to soil compaction, a form of degradation that increases soil's mechanical strength, resulting in deleterious effects on a soil's ability to provide critical ecosystem services. Despite this, plant roots have been shown to grow in mediums with high mechanical constraints. Hence, understanding roots' underpinning biomechanical growth processes and limitations could inform on how best to harness roots for regenerating degraded soils and restoring desirable soil structure. We initially assessed this with two modelling frameworks and use limited X-Ray CT data to infer root pressures via Digital Volume Correlation. Our first model simulated direct root tip penetration into surrogate (solid gypsum) and natural soils, modelled as elastoplastic von Mises materials. We included geometric non-linearity through finite strain theory. Simulations used hydromechanical properties of unsaturated soils from literature to better estimate field conditions and compare these trends with surrogate soil material properties. We quantified ease of penetration via average pressure on the root tip face, thus estimating the soil moisture content that acts as a limit for root penetration. Subsequently, we explored the utility of roots using crack propagation to overcome pressure limits under dry and brittle conditions. We varied exerted root pressure and by altering boundary conditions, we modelled root growth in both experimental and field scales. Results showed that roots can overcome their direct penetration limits via crack propagation. However, coupling experimental and model results suggest roots invoke a combination of local softening through exudation and successive crack propagation to extend in mechanically harsh mediums.