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Assessing the influence of the rhizosphere on the water release characteristic using X-ray Computed Tomography

Saoirse Tracy (1), Keith Daly (2), Neil Crout (1), Malcolm Bennett (1), Tony Pridmore (1), John Foulkes (1), Ian Sinclair (2), Tiina Roose (2), and Sacha Mooney (1)

(1) The School of Biosciences, University of Nottingham, U.K , (2) The School of Engineering and the Environment, University of Southampton, U.K.

Understanding how water is distributed in soil and how it changes during the redistribution process or from root uptake is crucial for enhancing our understanding for managing soil and water resources. The application of X-ray Computed Tomography (CT) to soil science research is now well established; however few studies have utilised the technique for visualising water in pore spaces due to several inherent difficulties. Here we present a new method to visualise the water in soil in situ and in three-dimensions at successive drying matric potentials. A water release curve was obtained for different soil types using measurements from their real pore geometries. The water, soil, air and root phases from the images were segmented using image analysis techniques and quantified. From these measurements we characterised pore size, shape and connectivity for both air and water filled pores. The non-destructive technique enabled water to be visualised in situ and repeated scanning allowed wetting patterns to be analysed. The technique was carried out on field structured soil cores and cores that were sampled adjacent to established roots (rhizosphere soil) and soil that had not been influenced by roots (bulk soil). The pore geometries of bulk and rhizosphere soil were compared to understand the influence of root systems on the hydraulic dynamics of soil. The experimental results were validated against conventional laboratory derived water release curves and specifically developed mechanistic models of soil-water-root interactions. Micro-scale revelations of the water-soil-root interfaces enabled us to make macro-scale predictions on water movement in soil. It is envisaged that this research will inform interdisciplinary scientists and farmers to improve current mathematical models on root water uptake and soil management techniques.