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The impact of biopores on root growth and root water uptake under different soil physical conditions – a simulation study

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Roots are known to use biopores as preferential growth pathways to overcome hard soil layers and access water and nutrient resources in the subsoil. This study investigates root - biopore interactions at the plot scale under different soil physical conditions using a mechanistic simulation model combined with extensive experimental field data. In the field experiment, spring wheat (Triticum Aestivum L.) was grown on a Haplic Luvisol, which was characterized by a large biopore density. X-ray CT scans of soil columns from the field site were used to create a biopore network that could be integrated into the model soil domain. Water flow in the root – biopore -soil continuum as well as wheat root architecture were simulated with the 3D numerical R-SWMS model (Root Soil Water Movement and Solute transport) for root growth in structured soil over a whole growing season. The model was calibrated against observed root length densities in both bulk soil and biopores by optimizing root growth model input parameters. Scenario simulations with the calibrated model showed the importance of biopores for root growth and root water uptake under high soil compaction and water scarcity in the topsoil layers, respectively.