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# Make the rhizosphere great again: microbes build walls in soil that roots pay for

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Plant roots physically manipulate surrounding soil to ease penetration, provide anchorage, improve water and nutrient capture and enhance gaseous exchange, with knock-on impacts to habitats for microorganisms, soil stabilisation and sequestering of carbon. Root traits that alter soil physical properties include exudates, root hairs, the extent of soil drying and root architecture. We are exploring the extent that different root traits physically manipulate soils, drawing on near isogenic crop lines that differ in root hairs, architecture and exudation, and new physical approaches that quantify rhizosphere impacts.

These approaches include hydromechanical testing that bridge soil physics, soil biology and materials science, small-scale measurements and non-invasive imaging to measure the rhizosphere directly. We use these data in image based models that describe retention and transport of water and nutrients in the rhizosphere. Micromechanics tests have found that barley root exudates initially disperse soil, followed by gelling after secondary decomposition of these exudates by microbes. Maize root exudates, on the other hand, caused a large amount of gelling of the soil, whereas this impact decreased with microbial decomposition. From our data on exudate viscosity, contact angle and surface tension, we have modelled the direct impact on water retention and transport in the rhizosphere, using 3D CT imaging with Synchrotron XRay CT with sufficient resolution to detect root hairs. From these images, pore structure changes were found to be affected by the presence of root hairs in barley. This could have implications to resource capture by plants, showing a secondary impact of root hairs beyond expanding the volume of soil that roots access.