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Can roots influence soil structure via reorganisation of the rhizosphere?

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Soil compaction is a form of degradation that affects agricultural land on a global scale. Primarily caused by the passage of heavy farm machinery, soil compaction can result in the reduction and loss of the soil macropore network, leading to poor aeration, nutrient depletion and reduced permeability of water and penetration of roots into the soil. The compressive effects on soils can be persistent and difficult to alleviate. Currently deep-tillage practices are used as a short-term solution to lessen soil compaction however this intensifies the risk of permanent subsoil compaction. We hypothesise that plant species that are able to grow in heavily compacted soil may increase the number and size of pores helping to positively alter the structure of degraded soils. Hence plants may offer a simple means to improve a compacted soil via localised structural remediation, particularly in and around the rhizosphere. We analysed the root growth patterns of three non-cultivated plant species often found occurring naturally on compacted soils, suggesting they have an intrinsic ability to grow effectively under such circumstances. Ribwort plantain (Plantago lanceolata), dandelion (Taraxacum officinale) and spear thistle (Cirsium vulgare) plants were grown for 28 days in a sandy-loam soil compacted to 1.8 g cm-3 with a penetration resistance of 1.55 MPa. X-ray Computed Tomography was used to observe root architecture in situ and visualise changes in rhizosphere porosity (resolution of 35 μm) at 14 and 28 days after sowing. Porosity of the soil was analysed within four incremental zones up to 420 μm from the root surface. In all species the porosity of the rhizosphere was greatest closest to the root and decreased with distance from the root surface. There were significant differences in the rhizosphere porosity between the three species, with spear thistle plants exhibiting the greatest structural genesis across all rhizosphere zones. This novel approach indicates that roots can have a localised effect in increasing the formation of pore space in the rhizosphere, counteracting any initial compression due to root penetration. The resulting structural alteration of the soil indicates the potential for roots to create and improve soil structure in heavily degraded soils. Further research will be pertinent in advancing our understanding of soil remediation potential by roots, especially at the root-soil interface. Further research will investigate how specific roots traits that induce remedial structural changes could be applicable to the field scale restoration of sites damaged by modern day tillage practises.