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Physical engineering of rhizosphere by plant exudates varies with species, origin and microbial decomposition

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Rhizosphere physical conditions are continually modified by the release of plant root exudates and microbial metabolites. Separate studies have shown that model root exudates influence surface tension, contact angle, water retention and soil stability, but an integrated assessment of these properties for different real root exudates is absent. We hypothesise that influence of root exudates on soil physical properties depends on the physico-chemical characteristics of the exudates itself. The first part of this study examines the physico-chemical characteristics of barley root exudate, maize root exudate, and chia seed exudate. The second part of the study has shown the influence of these root exudates on micromechanics (dispersion and aggregation), water retention, hysteresis and shrinkage-swelling of soils. Highest amount of amino acids and organic acids were observed for barley root exudate followed by maize root and chia seed, respectively. Conversely, the reverse is true for sugars i.e. chia seed exudate > maize root exudate > barley root exudate. We found that barley root exudates have the capacity to weaken soil followed by strengthening after biological decomposition. The initial weakening of soil by barley root exudation may ease root penetration through soil and help in releasing nutrients from soil that were initially not accessible. Maize root exudates and chia seed exudates, on the other hand, strengthen soil from the onset, with biological decomposition decreasing strength that was still significantly higher compared to that of control soil. This strengthening of soil by maize root and chia seed exudation could drive more stable soil structure near roots. Under drying conditions both maize root and chia seed exudates were acted as a gel that retained more water but also enhanced hysteresis during rewetting. On the other hand barely root exudate more acted as a surfactant that decreased soil water retention as well as hysteresis compared to the control soil. The measurements of shrinkage-swelling of soil as a result of root exudation is currently in progress and will be the part of our talk at the meeting. This reflects that exudates not only attenuate plant water stress but also impart mechanical stability to the rhizosphere. These data are highly relevant to the understanding and modelling of rhizosphere development, which is an ongoing phase of our research.