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Rhizosphere water dynamics: role of exudates in mediating water retention and flow characteristics

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In recent years, significant amount of literature showed that rhizosphere's physical and chemical properties markedly differ from those of the bulk soil. Plants invest large portion of their photosynthetic carbon in developing root architecture that optimally exploits water and nutrient distributions in the soil. There is indirect evidence suggesting that these exudates play a major role in altering the of the soil water retention properties. In this study, we investigated the role of root exudates on rhizosphere water dynamics using analog system. Glass beads were used to represent loose soil and dilute solutions of polygalacutronic acid (PGA) to mimic exudates (0, 1, 5, 15 and 29 g/L). The samples were subjected to periods of drying and subsequent equilibration. At each stage, the water potential was measured using WP4C Dewpoint PotentiaMeter. On the other hand, sand samples were saturated with PGA at the same concentration used to study the effect of exudates on water evaporation rate. The effect of root exudates on soil water retention can be attributed to at least two factors. The most widely speculated effect is through enhanced of soil aggregation. This effect is primarily due to capillary adhesion in fine pores within aggregates and is consistent with visual observation of pronounced aggregation in many rhizosphere soils. The second factor is related to osmotic effect of the exudate solution. Our observations show that the capillary effect is mostly limited to higher water potential regime (> -1 bar suction). Whereas the osmotic effect dominates in <- 1 bar suction. At the same time, the osmotic potential results from these organic exudates play an important role in reducing the evaporation rate. These results will provide direct quantitative evidence of how rhizosphere organic matter helps plant-soil relations.