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The effect of biological activity on soil water retention and diffusivity

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Root exudates of both living and artificial origins are known to affect various rhizosphere microbial and micro-faunal activities. However, information on effects on root exudates on soil hydraulic properties responsible for water transmission and distribution in the vadose zone is inadequate, especially in dry soils. To study the effect of artificial root exudates (carbohydrate, amino acids and organic acids mixture) on soil water retention and diffusion process, a laboratory experiment was carried out using soil cores filled with air dried 2-mm sieved loamy sand soils of Cambric Arenosol subclass. Root exudates at three concentrations (1.25, 2.5 & 5.0 g C kg^{-1} dry soil) were added and the soil cores were saturated in distilled water for 48 hours at 20 ^{o}C together with a control. To determine whether microbes have any influence on diffusivity, two additional treatments with sterilization of microbes using mercuric chloride solution (0.10%) in root exudates (2.5 g C kg^{-1} dry soil) and distilled water saturated soil cores were studied. The water in the soil cores was allowed to evaporate at constant temperature (20 $\pm$ 1^{o}C) and at a relative humidity of 0.3. The evaporation loss in terms of volumetric water content in the core was measured regularly until the water content was constant with time. Soil water diffusivity was determined numerically. To determine the water retention properties, soils were saturated and incubated for 14 days at 20 ^{o}C with the same six treatments and retention curves were generated for 8 different suctions, ranging from 0.01 bars to 15 bars.

Results revealed that evaporation from soil cores, initially at a uniform moisture content of saturation, initially decreased linearly with the square root of time. The rate of decrease was gradual in the root exudate treated soils but more rapid in soils treated to stop microbial activity. Addition of root exudates considerably decreased the diffusivity compared to a control treatment. By stopping soil microbial activity, with the addition of mercuric chloride, soil water diffusivity increased in comparison with biologically active soils.