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Surfactant application via drippers for water repellent soil remediation enhances agrochemicals leaching through preferential flow pathways

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Soil water repellency has a substantial effect on soil-water retention and flow. Typically, soils are denoted water repellent when they resist spontaneous wetting by water for more than five seconds. Soil water repellency reduces infiltration capacity, increases surface runoff, soil erosion, and induces uneven distribution of water content, including preferential flow pathways. We describe an in-situ study aiming to remediate these soils by surfactant application using a commercial drip system.

The study was carried out on a commercial citrus orchard irrigated with secondary treated wastewater, which usage has been shown to induce soil water repellency over time. To relieve the adverse effects of soil water repellency, different concentrations of a nonionic surfactant were applied to the soil using a drip system for three years. The spatial variation of the soil's wettability was characterized by the sessile drop method (contact angle) and water drop penetration time (WDPT) test. The spatial soil-water content distributions and flow were monitored undisturbedly by electrical resistivity tomography (ERT) surveys. Spatial soil-agrochemical distributions along transects where the ERT surveys took place were determined by intensive soil sampling at two depths: 0-20 and 20-40 cm.

The ERT results indicated that while the surfactant application via drippers improved the water repellent soil's wettability, it enhanced the development of preferential flow pathways. Although preferential flow pathways associated with treated wastewater irrigation existed in all soil profiles, they were exacerbated by the surfactant application. Additionally, increased leaching of mobile elements, like Cl, N, and EC, was measured for the surfactant-treated plots. Contrarily, P adsorption to the soil particles was increased in the surfactant plots compared to the untreated plots. While the contact angle along the soil surface showed no difference between the untreated and surfactant treated plots, the WDPT decreased in the latter. These findings indicate that aside from the foreknown causes of preferential flow in soils like earthworms, wet and dry cycles, aliphatic hydrocarbons, etc., localized surfactant application by drippers (point sources) for water repellent soils remediation enhances preferential flow and chemicals leaching. Therefore, a different method for surfactant application that remediates soil water repellency without enhancing agrochemicals leaching should be considered and examined.