EGU2020-5565
https://doi.org/10.5194/egusphere-egu2020-5565
EGU General Assembly 2020

Sorptivity and water imbibition into air-dry surfactant-containing soil

Thuc Nguyen and Gilboa Arye
Ben Gurion University of the Negev, Jacob Blaustein Institutes for Desert Research, French Associates Institute for Agriculture and Biotechnology of Drylands, Israel

Surfactants have been widely used in agriculture mainly as adjuvants to aid foliar pesticides to stay on target areas and as wetting agents to counteract the deleterious impacts of soil hydrophobicity. The latter has gained increasing attention among scientists over decades. Many natural and urban hydrophobic soil surfaces (i.e post-fire forest land and golf greens with dry patches respectively) after surfactant application has observed to have improved hydrological behaviors such as enhanced infiltration rate, more evenly-distributed water content, thus resulting in higher water use efficiency, better performances of amenity surfaces and higher crop yield. In general, a surfactant can be classified as cationic, anionic or nonionic according to the charge of its polar group. Commonly, with anionic and nonionic surfactants are employed by either directly mixing with the soil or incorporated into the irrigating. Regardless of the application mode, the occurrence of surfactant adsorption onto soil particles after wetting/drying cycles is highly expected, which, in fact, has already shown in some studies to change the hydraulic properties of the soil, oppositely to initial expectation. Capillary rise, for example, was found to decrease in sand treated with laundry derived detergent. In addition, sub-critical hydrophobicity was observed in sands pre-saturated with greywater derived surfactants after some cycles of wetting and drying. Insights from these studies implied that surfactant application to hydrophilic soils may eventually induce temporal hydrophobic nature. In this regard, the main objective of this study was to quantify the sorptivity and imbibition rate of air-dry soil subjected to wetting and drying with surfactants. Specifically, we employed three types of surfactants: (i) anionic (SDS), (ii) cationic (CTAB) and (iii) nonionic (TX-100). Quartz sand was sieved through 0.5mm sieve and wet-packed into columns (I.D.=3.5cm and L=6cm) with surfactant concentrations above and below the CMC (Critical Micelle Concentration) and then oven-dried at 65^{o}C for 24h. We have repeated this procedure to obtain soil samples undergoing 1 to 5 wetting/drying cycles. The soil samples were subjected to imbibition using the capillary rise method with water and ethanol, from which the initial sorptivity, imbibition rate and contact angle (CA) were calculated. The Wilhelmy plate method (WPM) and sessile drop method (SDM) was also used to measure the CA. The results showed that following one application of the three surfactants, the sorptivity was reduced relative to the control. Further reduction observed only for TX-100 and CTAB soil samples. The CA values obtained from the WPM and SDM implied that sub-critical hydrophobicity was induced only for the CTAB-treated, implying that water imbibition in the SDS and TX-100 treated soil in manly governed by the reduced surface tension rather than in the induced hydrophobicity (i.e. CA). Further

discussion on the governing mechanism of wetting in surfactant-containing soils will be presented next to the results.