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Instability of infiltration fronts due to long term irrigation of treated waste water

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Irrigation of treated waste water (TWW) is a common practice in arid and semiarid areas as it combines a sustainable, all-season available water recourse and the recycling of nutrients. Previous studies have shown that organic compounds can affect wettability of mineral surfaces and may change soil structure. Since TWW provides high loads of organic material, long-term irrigation can lead to persistent structure alteration, hydrophobicity, preferential flow, and leaching of chemicals and nutrients. In this study we (i) developed a new approach to quantify water movement in undisturbed soil cores via X-ray radiography and (ii) detected instabilities of water infiltration in soils irrigated with TWW since more than 20 years.

We investigated soil samples from two orchards in Israel with long-term irrigation of TWW, one of them additionally irrigated with fresh water. The samples provide two different soil textures, and two different treatments of irrigation: fresh water and TWW. Furthermore, we included seasonal dependencies (dry season and rainy season) to determine persistency of effects. Undisturbed, cylindrical soil samples were taken from the upper soil layer (0-20cm) and irrigation experiments were performed inside an X-ray system. Via image analysis we quantified the infiltration front propagation and spatial moisture distribution as a function of time and repeated the experiments with different initial moisture contents.

In this study we show that the stability of infiltration front in these soils is dependent on the irrigated water quality and on the initial water content. Furthermore, we demonstrate that long-term irrigation of TWW can lead to a persistent change in wettability, independent of the season. This study provides experimental evidence about importance of optimizing irrigation management to prevent preferential flow.