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The effect of soil water repellency on water and chemicals distribution in the soil profile for effluent and fresh water irrigation

Rony Wallach (1), Matan Rahav (1), Naaran Brindt (1), and Alex Furman (2)

(1) The Hebrew University of Jerusalem, The R.H. Smith Facultyof Agriculture, Food and Environment, Rehovot, Israel (wallach@agri.huji.ac.il), (2) Faculty of Civil and Environmental Eng., Technion, Haifa, Israel

Water repellency (WR) has been reported for many vegetation types and soils and for effluent irrigation. Citrus trees have been found in a previous and in the current study to render sandy soils hydrophobic. The presented study focuses on the synergistic effect of the uneven wetting patterns and preferential flow pathways, known to occur in WR soils, and irrigation water quality on the spatial distribution of salinity and nutrients in the citrus trees' root zone. The study was performed in a commercial grapefruit orchard that is located at the coastal plain of Israel. The soil is sandy (80 % sand, 9 % silt and 11% clay). An experimental orchard area of 1500 m2 was divided into ten plots - five are irrigated with fresh water and five with secondary treated sewage water (effluent) using a drip irrigation system. Each plot contains 12 trees with spacing of 2x6 m. Soil texture, water repellency persistence (WDPT), and OM were measured for all 10 plots. The spatial and temporal water content distribution in the trees' root zone during and between subsequent irrigation events was measured undisturbedly by the electrical resistivity tomography (ERT) method. Soil water content within the root zone was indeed found highly heterogeneous in space and in time. Using ERT scans, two sites with relatively wet soil underneath and two with relatively dry soil underneath were chosen in each plot for further investigation. Disturbed soil samples from two depths, 0-20 and 20-40 cm, were taken from each site and tested in the laboratory for weight-based saturation, current water content, pH, EC, Cl, Na, Mg, NO_3, P, K, and OM. The overall finding was that the uneven distribution of water content in the water repellent soil has a substantial effect on the salinity and nutrients distribution in the soil profile. Higher salinity and nutrients concentrations were found in the effluent irrigated plots compared to the fresh water plots. In particular, salinity was higher in the dry spots and the shallow layer compared to the wet spots and the deeper layer, respectively, for both effluent and fresh water plots. The SAR was substantially higher in the effluent irrigated plots. Compared to the effluent plots where there were no differences between the wet and dry sites, the SAR in the fresh water plots was significantly higher in the dry sites. Na and Cl were higher in the effluent irrigated plots, and higher in the drier sites in all plots. The nitrate was substantially higher in the effluent plots at all depths and water contents. In addition, nitrate concentration was higher in drier sites and in the shallow layer for both effluent- and freshwater-irrigated plots. Phosphorus concentration was substantially higher in the effluent than in fresh water irrigated plots. However, as opposed to the commonly known P distribution in soil profiles, its concentration in the current study was similar at both depths. Mg and K had not distinct differences among all plots. The OM concentration was higher in shallower than in the deeper layer for all plots.