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Influence of synthetic wastewater on the transport and transformation in irrigated soils

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ABSTRACT

Irrigation with wastewater can increase the available water supply and present a feasible alternative for increasing resources in water-scarce areas. Despite these benefits, some potential negative environmental effects among which degradation of the hydraulic soil properties and groundwater contamination may arise in association with the use of wastewater. Because of these concerns, a randomized complete block design under unsaturated, steady-state flux was performed with aerobic sand columns treated with synthetic wastewater. Water treatments included four irrigation, and different levels of chemical oxygen demand (COD). A time domain reflectometry (TDR) probe was used to measure water content and electrical conductivity at two depths of 20 and 60 cm from the top of columns. Water samples were taken using Rhizon extractors placed at 25 cm and 65 cm from the top. At each column two tensiometers for measuring hydraulic potentials were placed, at two different depths 20 and 60 cm. Four steady-state flux conditions (1 cm h^{-1}) tracer tests were used to obtain transport parameters such as the dispersion coefficient and pore-water velocity by analyzed a transfer-function method. Estimating water and solute transport parameters was simulated by inverse modelling techniques. Statistical analysis shows that transport parameters under the unsaturated conditions were remained fairly constant in all treatments during the experiment time. In contrast, after exploring different possible shapes for a curve the experimental data were fitted in a simple model for evaluating the zero order and first order form of rate equations to evaluate the kinetics. It was found that first order rate expression is the best fit for the synthetic wastewater under different concentrations that gives a best fit shape constant (R^2 = 0.9714). Overall, the HYDRUS-1D model successfully simulated the water flow and Pulse-response experiments in the columns. If during primary stages of municipal wastewater treatment, some elements like solids, the toxics or pathogens be removed, which is essential for trickle irrigation, then the municipal wastewater can be similar to our artificial wastewater. The results show that the effluent of our synthetic wastewater without toxic or pathogen elements, was very clear and its quality exceeded the direct discharge standard, poses little risks for groundwater pollution. In addition, the experimental results also show that the removal efficiencies of COD was high, being more than 65% and 95%.

Keywords: Irrigation; Synthetic wastewater; Chemical oxygen demand; Solute transport; HYDRUS-1D

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