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Isoproturon Transport through variably saturated structured Soil Columns: Experiments and Model Analysis

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Model predictions of pesticide transport in structured soils are complicated by multiple processes acting concurrently. In this study, the hydraulic, physical, and chemical nonequilibrium (HNE, PNE, and CNE) processes governing herbicide transport under variably-saturated flow conditions were studied. Bromide (Br^-) and isoproturon (3-(4-isoprpylphenyl)-1,1-dimethylurea) were applied to two soil columns. An aggregated Ap soil column and a macroporous, aggregated Ah soil column were irrigated at a rate of 1 cm h^{-1} for 3 h. Two more irrigations at the same rate and duration followed in weekly intervals. Nonlinear (Freundlich) equilibrium and two-site kinetic sorption parameters were determined for isoproturon using batch experiments. The observed water flow and Br^- transport were inversely simulated using mobile-immobile (MIM), dual-permeability (DPM), and combined triple-porosity (DP-MIM) numerical models implemented in HYDRUS-1D, with improving correspondence between empirical data and model results. Using the estimated HNE and PNE parameters together with batch-test derived equilibrium sorption parameters, the preferential breakthrough of the adsorbed isoproturon in the Ah soil could be reasonably well predicted with the DPM approach. The transport of isoproturon through the aggregated Ap soil could be described consistently only when HNE, PNE, and CNE were accounted for using the DPM. More sorption sites were found to be kinetic in the preferential flow paths as compared to the matrix. Overall, results were helpful to identify processes involved in preferential herbicide transport through structured soil during variably-saturated water flow.