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Application of single-porosity, dual-porosity and dual-permeability models for estimation of soil hydraulic properties and simulation of contaminant transport in the soil profile

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Single-porosity, dual-porosity and dual-permeability models in HYDRUS-1D (Simunek et al., 3003, 2005) were applied in this study to simulate non-equilibrium water flow and contaminant transport in soil porous media. The field and laboratory experiments and numerical study were performed for five soil types (two Haplic Luvisols, Haplic Cambisol, Dystric Cambisol and Greyic Phaeozem). The transport of chlorotoluron in the soil profile was studied under field conditions in 2004. The herbicide Syncuran was applied on a four square meter plot using an application rate of 2.5 kg/ha of active ingredient. Soil samples were collected after 5, 13, 21, 35, 62, 105 and 151 days to study the residual chlorotoluron distribution in the soil profile. The chlorotoluron mobility for different soil types varies depending on the soil porous structure, presence of coarse gravel and existence of preferential pathways. The soil hydraulic properties were defined using the multi-step outflow experiments performed on 100-cm3 undisturbed soil samples. The HYDRUS-1D code and the numerical inversion were used to analyze the cumulative outflow and the soil-water retention data points to obtain hydraulic parameters characterizing different soil-water flow models: the single-porosity model, the dual-porosity model and the dual-permeability model. The ratios of different pore domains were estimated based on micromorphological studies. Soil water retention curves were also determined using the sand tank and pressure plate apparatus. The saturated hydraulic conductivities were measured us-

ing the constant head test. The chlorotoluron transport under field conditions was simulated using the single-porosity, dual-porosity and dual-permeability models in HYDRUS-1D. Despite having similar total soil hydraulic properties for different flow models, the simulated chlorotoluron transport was different. The chlorotoluron transport in both Luvisols was less and more successfully approximated with the single- and dual-porosity models, respectively. Chlorotoluron concentrations in the soil profile simulated using the dual-permeability model were closer to observed values when chlorotoluron transport was affected by preferential flow then those calculated with the other two models.

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