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Evaluation of ponded infiltration experiments in structured soils by numerical modeling

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One of the most important properties of porous medium, affecting the flow regime in the soil profile, is the topsoil saturated hydraulic conductivity (Ks). Laboratory-determined Ks often fails to characterize properly the respective field value; the Ks lab estimation requires labor intensive sampling and fixing procedures, difficult to follow in highly structured and stony soils. Thus simple double- or single-ring ponded infiltration experiments are frequently performed in situ to obtain the required field scale information. In the present study, several important aspects, affecting the infiltration rate during the infiltration experiments, are analyzed using three-dimensional axisymmetric finite-element dual-continuum model S2D. The analyzed aspects involve: (1) the size of the infiltration ring, (2) the depth of water in the ring, (3) the depth of the ring insertion under the soil surface, (4) the size and the shape of the finite element mesh near the ring wall, and (5) the presence of preferential pathways below the infiltration ring. The analysis suggests that the ring insertion depth influences the infiltration rate significantly. The simulated infiltration rates also exhibit high sensitivity to the shape of the finite-element mesh near the ring wall. Comparison with the observed infiltration curves confirmed the presence of preferential flow effects in the soil under study. Simulation of ponded infiltration experiments by means of inverse dual-continuum modeling delivered closer match than the classical single-continuum approach.