Application of a water infiltration model for simulating water repellency of humus soil

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Abstract

Taking hydrophilic and water-repellent soils from the Guishui River Basin as the research object, one-dimensional infiltration experiments were conducted to study the effects of soil water repellency on cumulative infiltration (CI) and the infiltration rate (IR). The test results show that, for the hydrophilic soil (HS) sample, the CI increases monotonously with time and the IR decreases monotonously. For the water-repellent soil (W-RS), however, the following characteristics were observed: (1) There is an inflection point in the CI and a sudden increase in IR. Larger values of the initial soil water content produce an earlier and more significant inflection point in CI, and a larger peak value of IR. (2) The post-peak stable IR is greater than that the pre-peak value, ignoring the beginning of rapid infiltration, and the overall IR presents a single peak. The applicability of various water infiltration models was analyzed for the two soil types. Numerical analysis suggests the following conclusions: (1) For both HS and W-RS, the Kostiakov function, Gamma function, and Beta function (BF) models exhibit good applicability. (2) For W-RS, the Gauss function model not only reflects the monotonous decrease in IR, but also produces a steady IR in the initial stage, a gradual increase before the peak value, and a gradual decrease after the peak value. Similarly, the BF model reflects the monotonous decrease in IR. A piecewise BF can also reflect the U-shaped change in rapid infiltration before the inflection point, as well as the gradual increase and right-skewed distribution curve of W-RS infiltration before and after the inflection point. The BF model achieves the best simulation accuracy and has the widest applicability.

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