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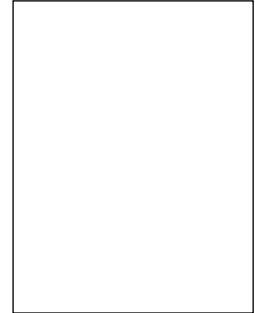
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Characteristics of Water Infiltration in Layered Water-repellent Soils

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ABSTRACT

Water-repellent soil greatly influences infiltration behavior. This research determined the water-repellent (WR) impacts of a silt loam soil layer during infiltration. Three column scenarios were utilized, including homogeneous wettable silt loam (SL) or sand (S), silt loam over sand (SL/S) and sand over silt loam (S/SL). A 5-cm thick SL layer was placed either at the soil surface or 5-cm below the soil surface. The SL soil used for the layer had been treated to produce WR levels of slightly, strongly, and severely WR conditions. As the WR level of the SL soil layer increased from wettable to severely WR, the cumulative infiltration decreased. The traditional wetting front-related equations did not adequately describe the infiltration rate~time relationships for the layered WR soils. The Kostiakov equation provided a good fit in the 1st infiltration stage. Average infiltration rates for the four WR levels during the 2nd infiltration stage were 0.126, 0.021, 0.002, 0.001 mm min⁻¹ for the SL/S scenario, respectively; and 0.112, 0.003, 0.002, 0.0005 mm min⁻¹ for the S/SL scenario, respectively. Pseudo-saturation phenomena were observed when visually examining the wetting fronts and from the apparent estimated change in water content ($\Delta\theta_{AP}$) for the three WR levels in the SL/S scenario. Much larger $\Delta\theta_{AP}$ values indicated the possible existence of finger flow. The delay of water penetration into the surface soil of the strongly WR level in the SL/S scenario suggested negative water heads as infiltration times were longer than 10 min. The SL and sand soil layers produced sharp transition zones of the water content. The WR level of the SL layer had greater effects on infiltration than the layer position in the column profile.

Key Words: water repellent, layered soils, infiltration model, pseudo-saturation

Abbreviations: water repellent-WR; water-repellent soils-WRS; cumulative infiltration-CI; infiltration rate-IR; average infiltration rate- IR_{ave} ; change in soil water content- $\Delta\theta$; wetting front depth -WF; water drop penetration time-WDPT; quantity of octadecylamine-Q_{OC}; time range for water passing the infiltration transformations- t_{RT} .

INTRODUCTION

An understanding of soil water movement is required in the design of pumping wells, flood control procedures, water conservation strategies, and a host of other water-use procedures. Many soil profiles are heterogeneous and have horizontal layers with soil depth (Corradini et al., 2011) that

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