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Author: LI Yi, RENXin, HILL Robert, MALONEW. Robert，Zhao Ying

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# Characteristics of Water Infiltration in Layered Water-repellent Soils

LI Yi [1*], RENXin[1], HILL Robert [2], MALONEW. Robert [3]， Zhao Ying[4]

*1 College of Water Resources and Architecture Engineering, Northwest A&F University, Yangling712100 (China);*
*2Department of Environmental Science and Technology, University of Maryland, College Park, MD 20742 (USA);*
*3 USDA-ARS,National Laboratory for Agriculture and the Environment,Ames, Iowa* 50011 *(USA)*；
*4 Key Laboratory of Plant Nutrition and the Agri-environment in Northwest China, Ministry of Agriculture, Northwest A&F University, Yangling, Shaanxi,*712100 (*China*).

## ABSTRACT

Water-repellent soil greatly influences infiltration behavior. This research determinedthe 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 WRlevelof 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 infiltrationrate~time relationships for thelayeredWR soils. The Kostiakov equation provided a good fit in the 1st infiltrationstage. Average infiltration rates for the four WR levels during the 2nd infiltrationstagewere0.126, 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 WRlevels 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 WRlevel 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 levelof the SL layer had greater effects on infiltration than the layer position in the column profile.

*Key Words*: waterrepellent, 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 heterogeneousand have horizontal layers with soil depth (Corradini et al., 2011) that