Effects of shrub on one-dimensional suction distribution and water infiltration in a three-layer landfill cover system

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Key Words:

Shrub, Suction, Drying and wetting, Landfill cover, Soil column

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Background

- One essential function of a landfill cover is to prevent water infiltration into the waste so as to reduce the generation of leachate. Plants are commonly found on landfill covers to protect soil from erosion and provide an attractive natural environment.
- Moreover, plants extract moisture from landfill cover soils by transpiration and hence influence soil suction and water infiltration.
- However, past studies on the effects of plants on suction distribution and water infiltration were conducted in uniform soil. The studies on layered soils, such as those in a landfill soil cover system, during drying and wetting have not been investigated thoroughly.

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Testing Program and Procedures

- Two soil columns of a three-layer landfill cover system with a topsoil layer were tested. The landfill cover system consisted of a topsoil layer for plants, a two-layer cover with a capillary barrier effect (CCBE) (i.e. a silt layer overlying a gravelly sand (GS) layer), and an underlying clay layer. One soil column was planted with a shrub, *Schefflera arboricola*, while the other was left bare. .
- After soil compaction, instrumentation, trans-plantation, and the adaptation period of three months, both soil columns were subjected to one drying-wetting cycle. To achieve the same initial testing condition, the two columns were saturated before the drying-wetting cycle.

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Test Results (1/3)

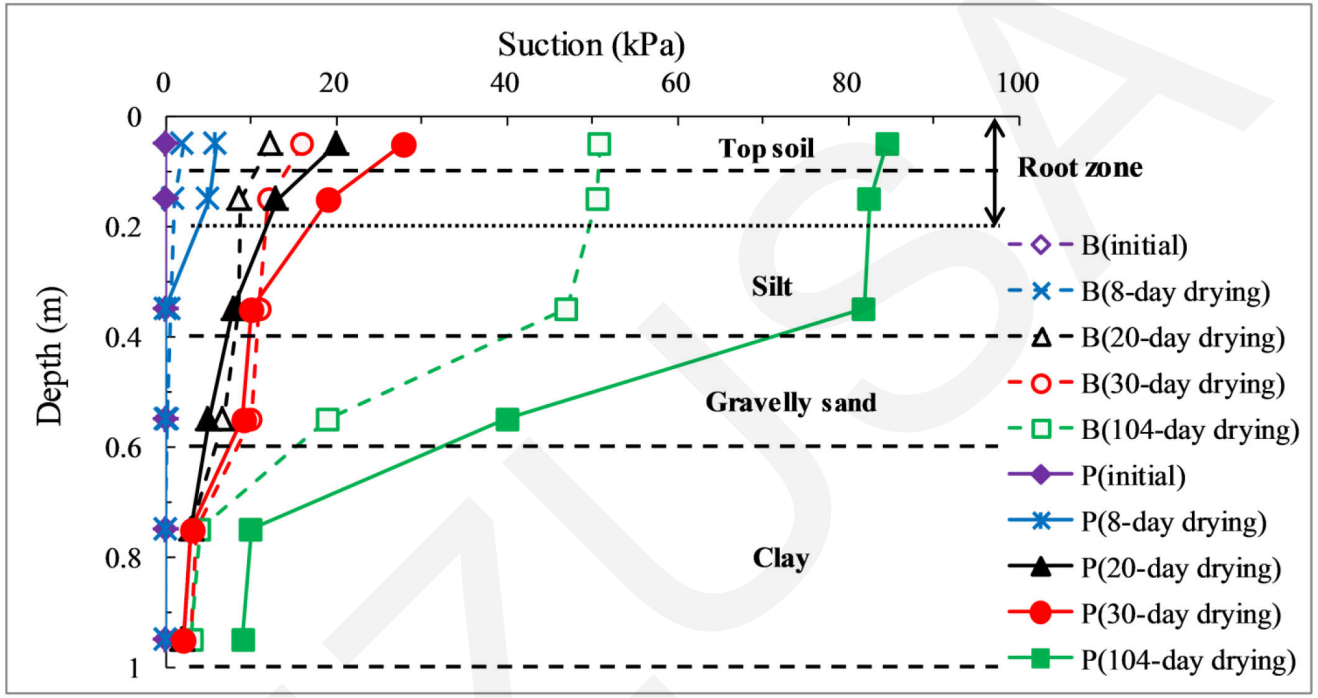


Fig.1

- Fig.1 presents the measured suction distribution profiles of the bare (B) and planted (P) soil columns during drying

Test Results (2/3)

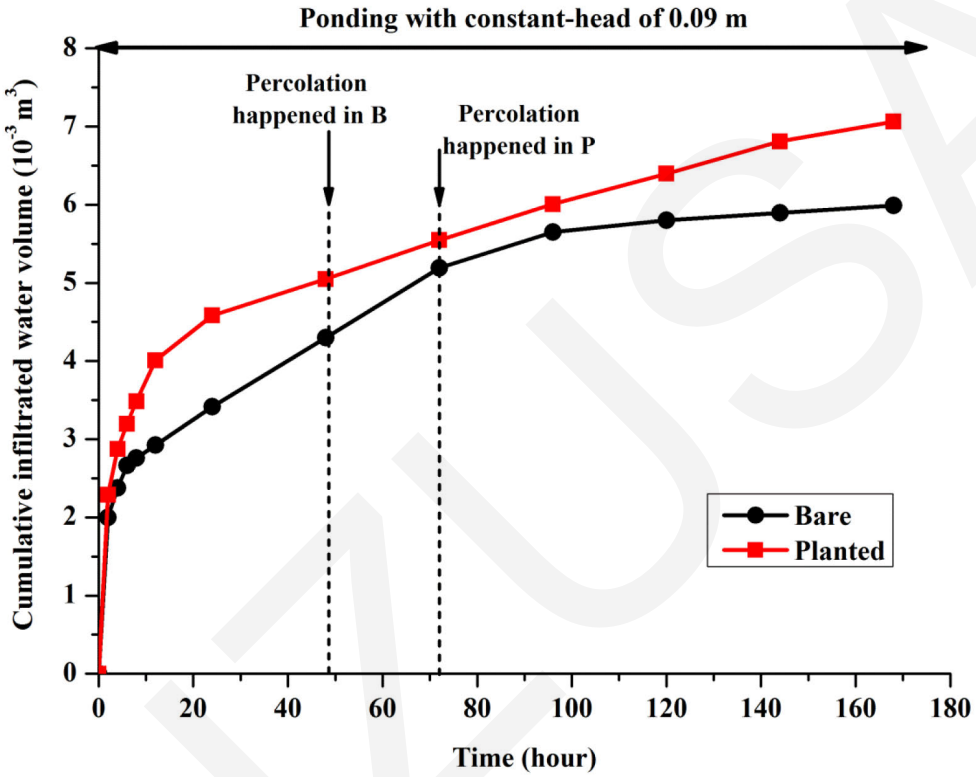
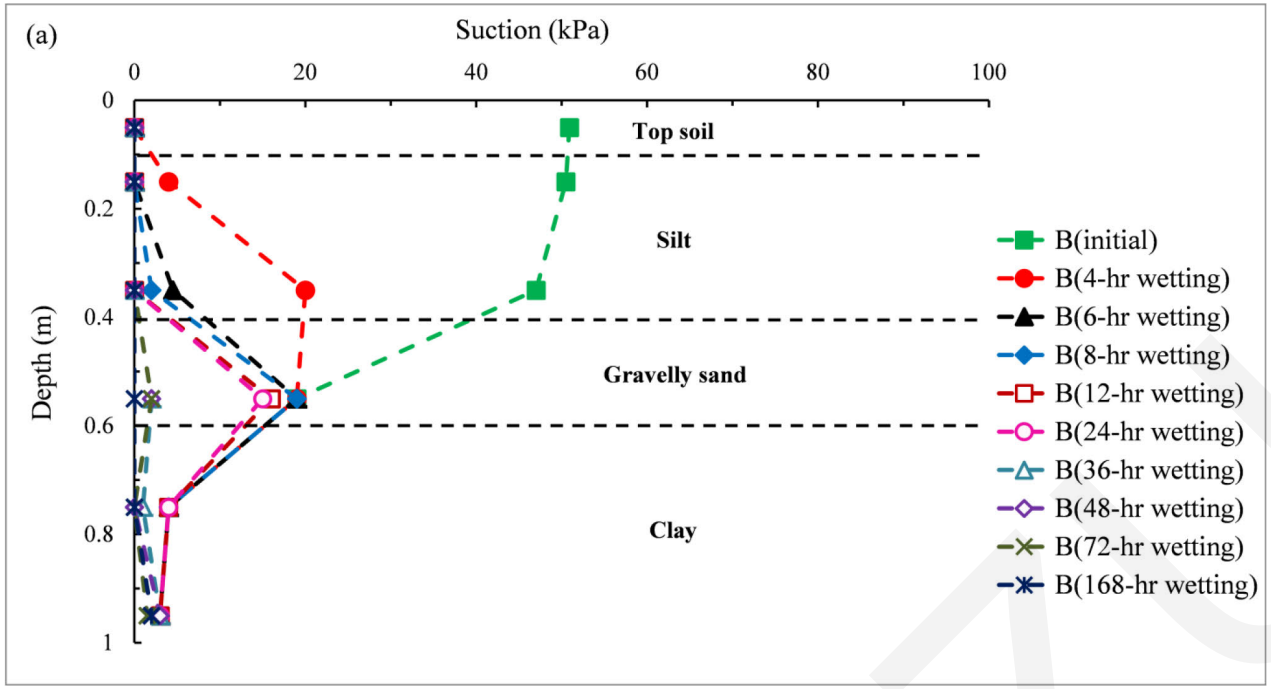


Fig.2

- Fig.2 depicts the cumulative infiltrated water volume in the bare (B) and the planted (P) soil columns during wetting

Test Results (3/3)



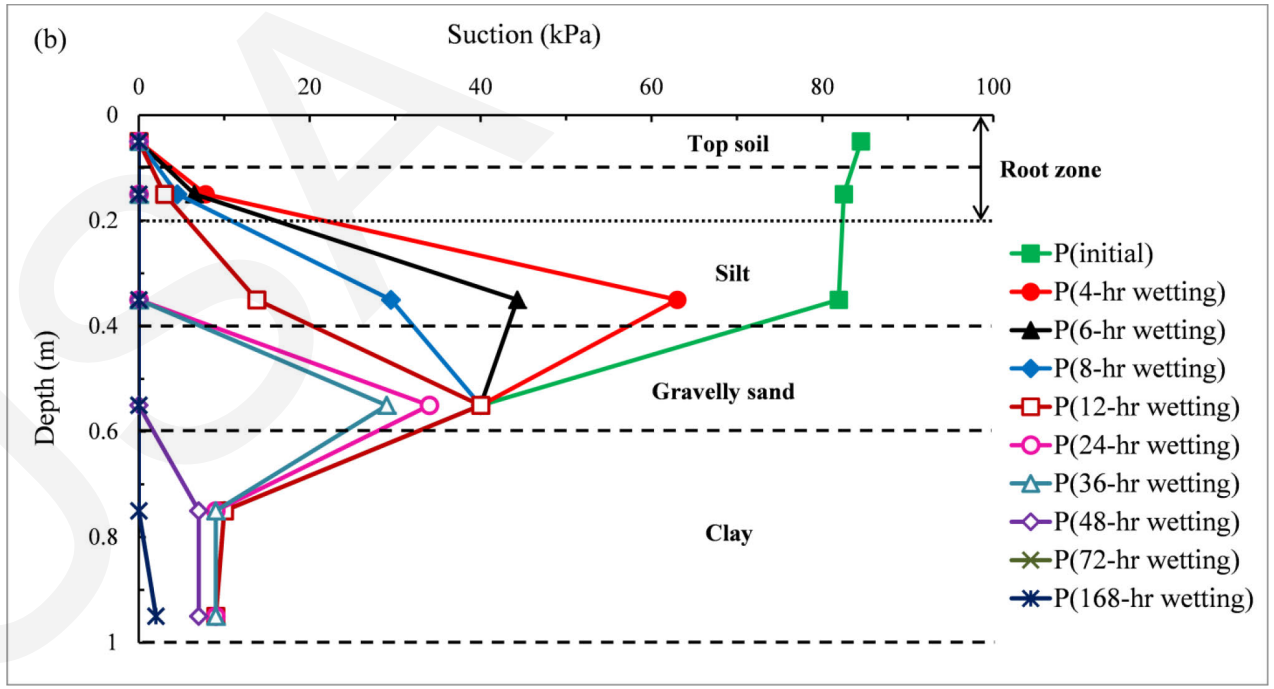


Fig.3

- Fig.3 presents the measured suction distribution profiles of (a) the bare (B) and (b) planted (P) soil columns during wetting

Conclusions (1/2)

- After 104 days of drying from a nearly saturated condition, measured suction in the planted soil column due to plant transpiration was from 60 to 200% higher than in the bare soil column to a depth of 1 m. The vertical suction influence zone of the planted soil column was nearly five times the root depth (0.2 m) after 20 days of drying.
- The cumulative volume of infiltrated water in the planted soil column was higher than that of the bare soil column during the wetting test. A preferential channel flow caused by the root system may be the reason resulting in a higher water infiltration observed in the planted column.
- The suction retention capacity during wetting in the planted soil column was significantly higher than that in the bare soil column, especially in the lower part of the root zone and deep below the root zone.

Conclusions (2/2)

- The upper two-layer CCBE was effective during 8 h of wetting in the bare soil column and 12 h in the planted soil column, despite higher water infiltration in the planted soil column (26% higher after 8 h and 37% higher after 12 h). This may have been due to the higher initial suction induced by plant transpiration, resulting in a higher water retention capacity in the upper silt layer of the planted column.
- Despite the planted column having a higher infiltration rate, it exhibited a lower percolation rate because of the higher initial water storage capacity of the upper silt layer. However, the planted column should percolate more water if the infiltration is applied long enough to cancel the effects of initial high suction on the water storage capacity.

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