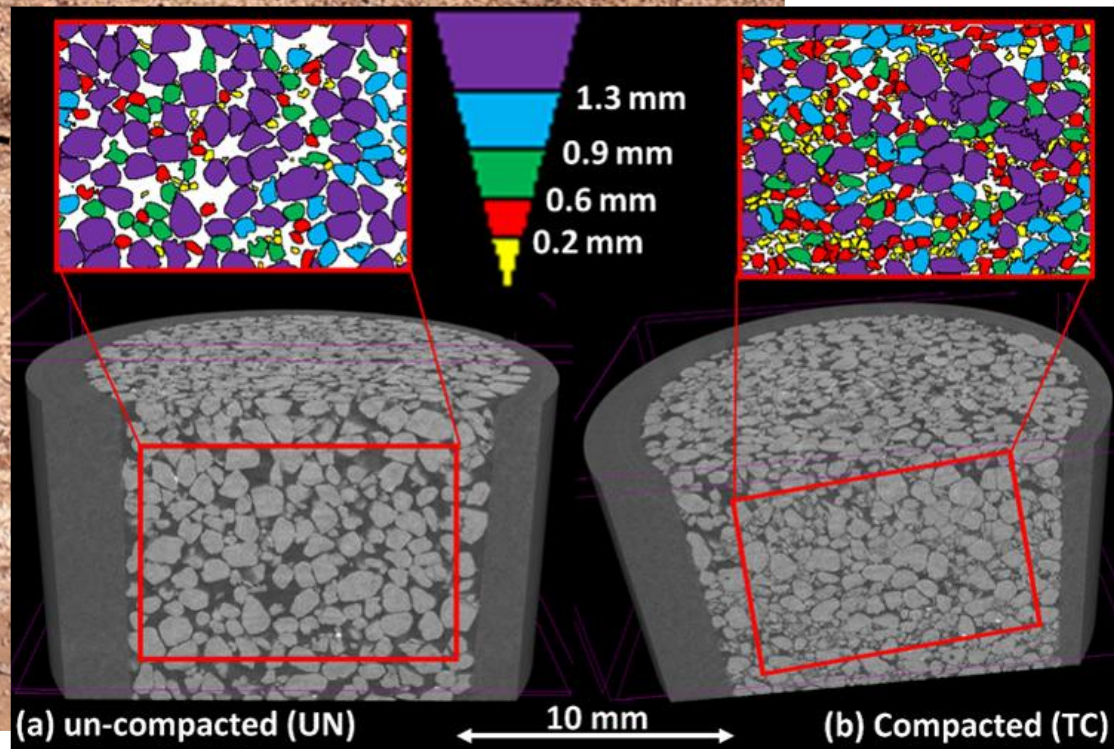
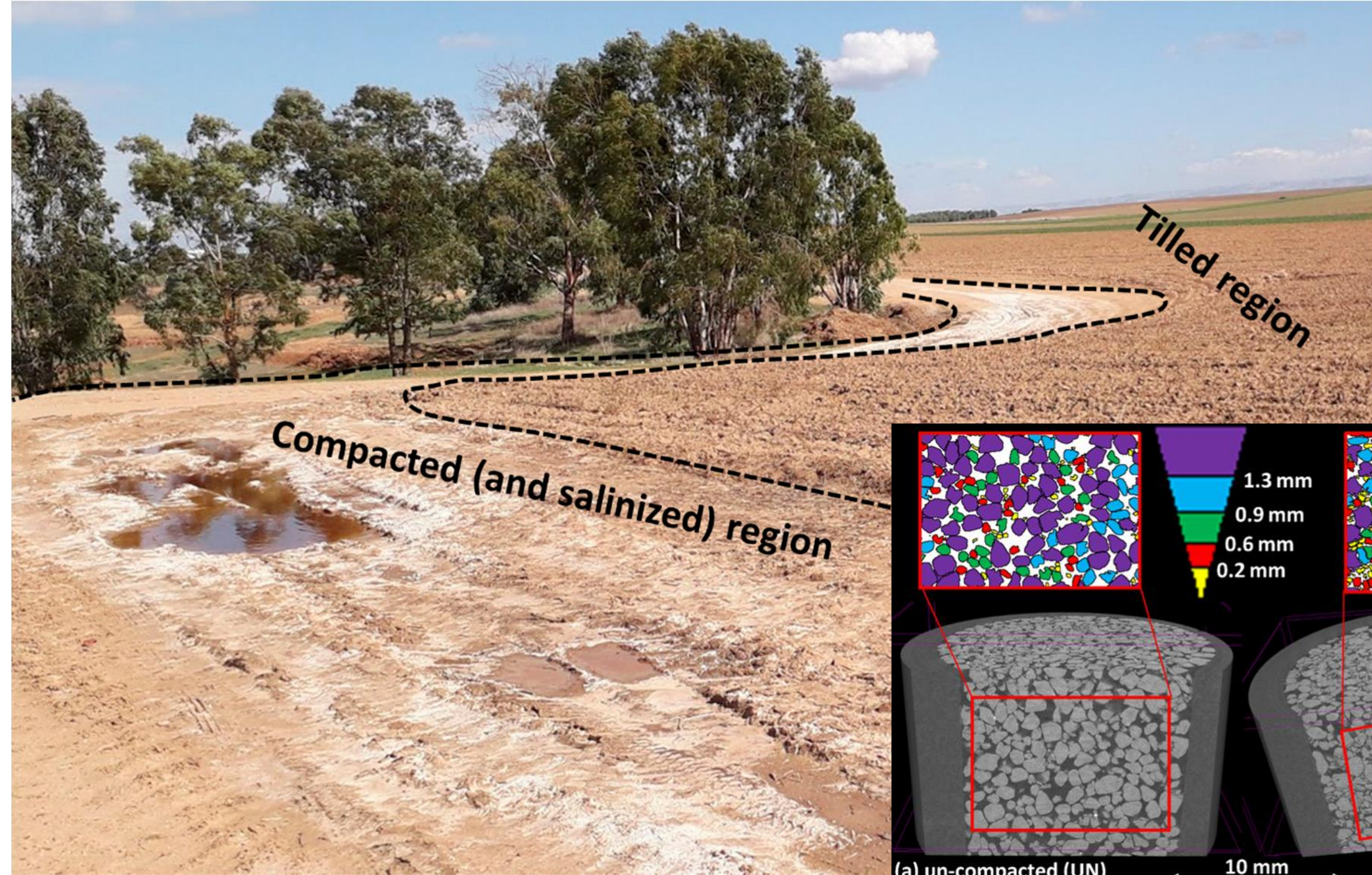


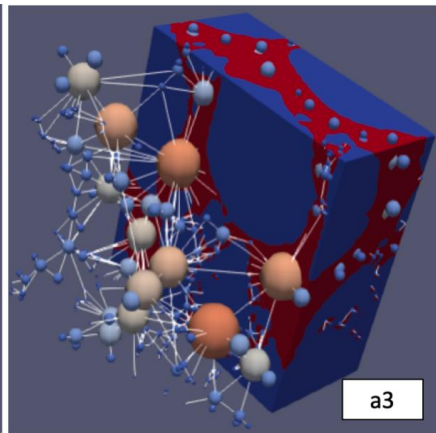
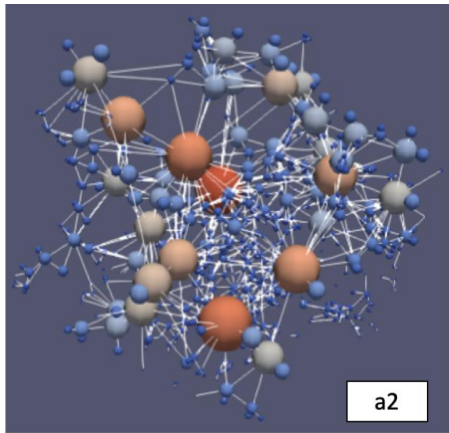
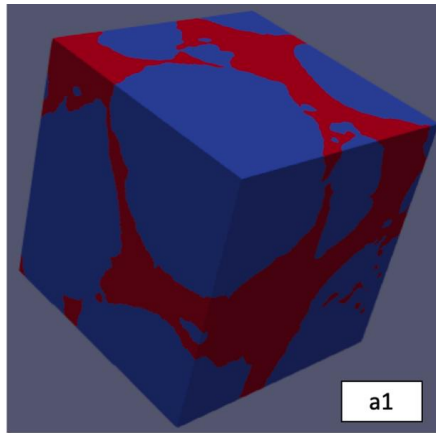
Multi-Scale Dynamics of Root-Induced Soil Compaction (RISC): Sharp Interfaces and Rhizosphere Hydrology

Uri Nachshon, N. Goldberg-Yehuda,
S. Assouline, and Y. Mau

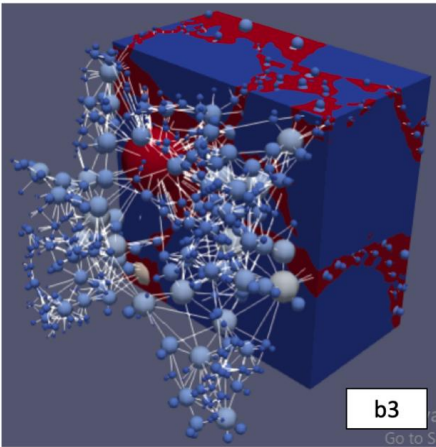
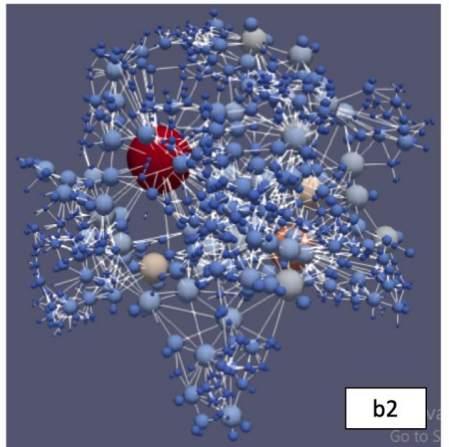
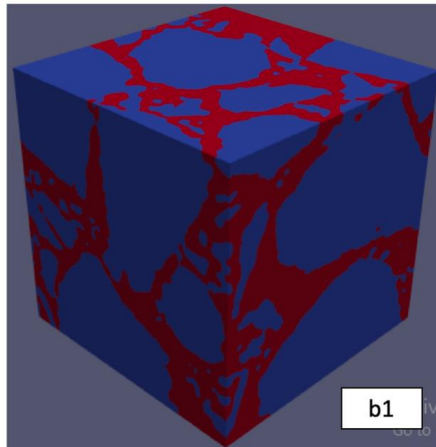




Un-compacted



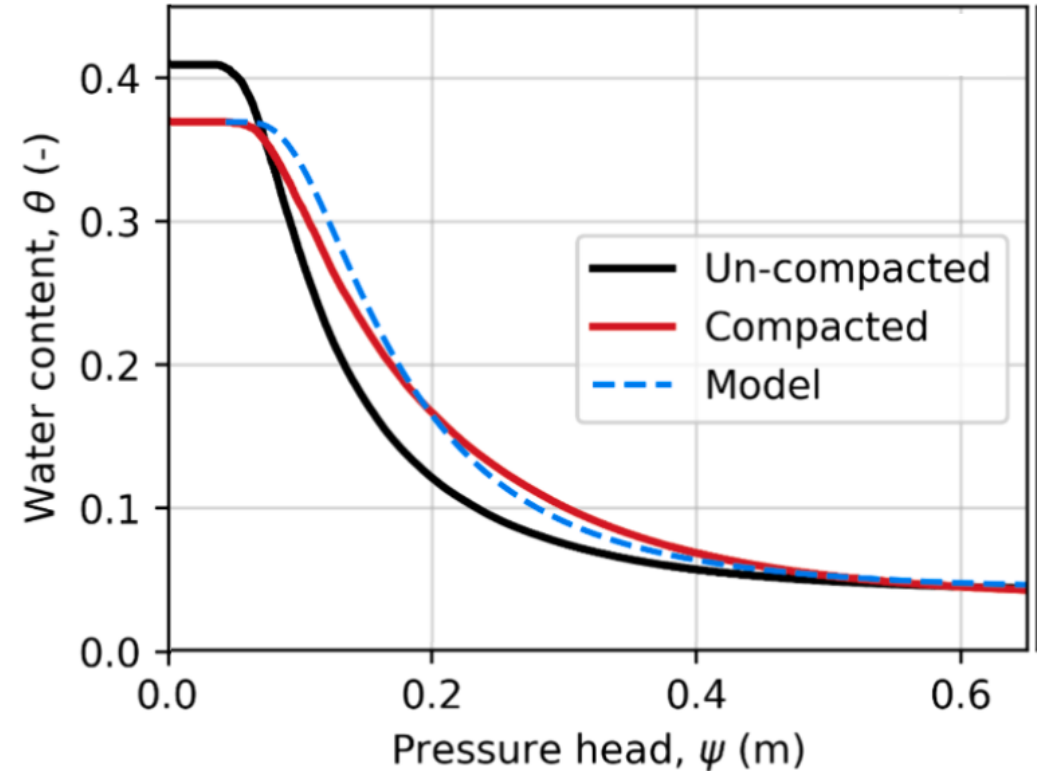
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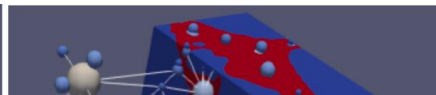
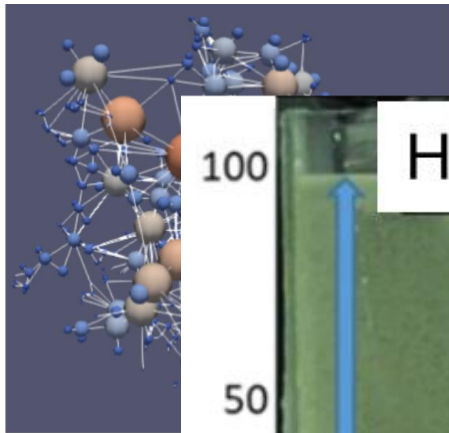
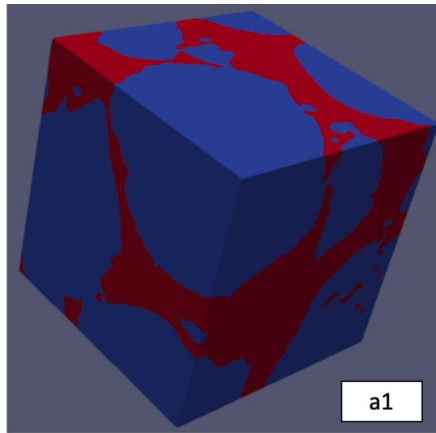
$$S_e(\psi) = \{1 - \exp[-\alpha_a(|\psi|^{-1} - |\psi_L|^{-1})]^{\mu_a}\} \quad ; \quad 0 \leq |\psi| \leq |\psi_L|$$

$$S_e = \frac{\theta - \theta_r}{\theta_s - \theta_r}$$

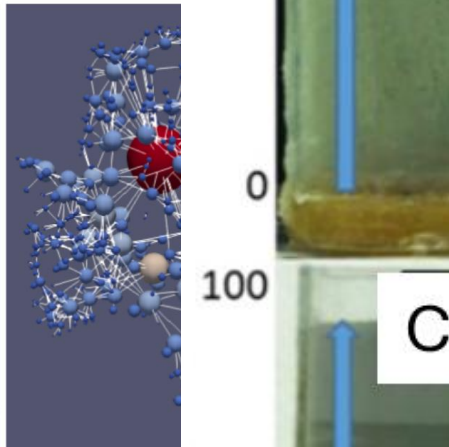
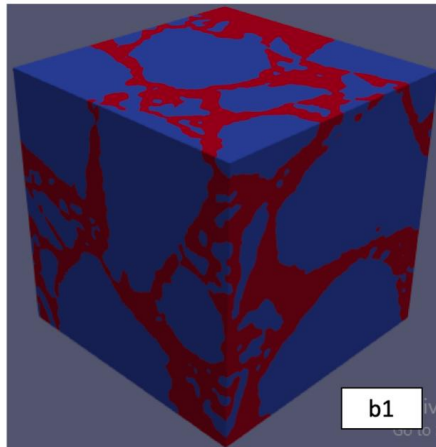
Assouline, S. et al., 1997. Effect of compaction on soil physical and hydraulic properties: experimental results and modeling. *Soil Sci. Soc. Am. J.* 61(2), 390.



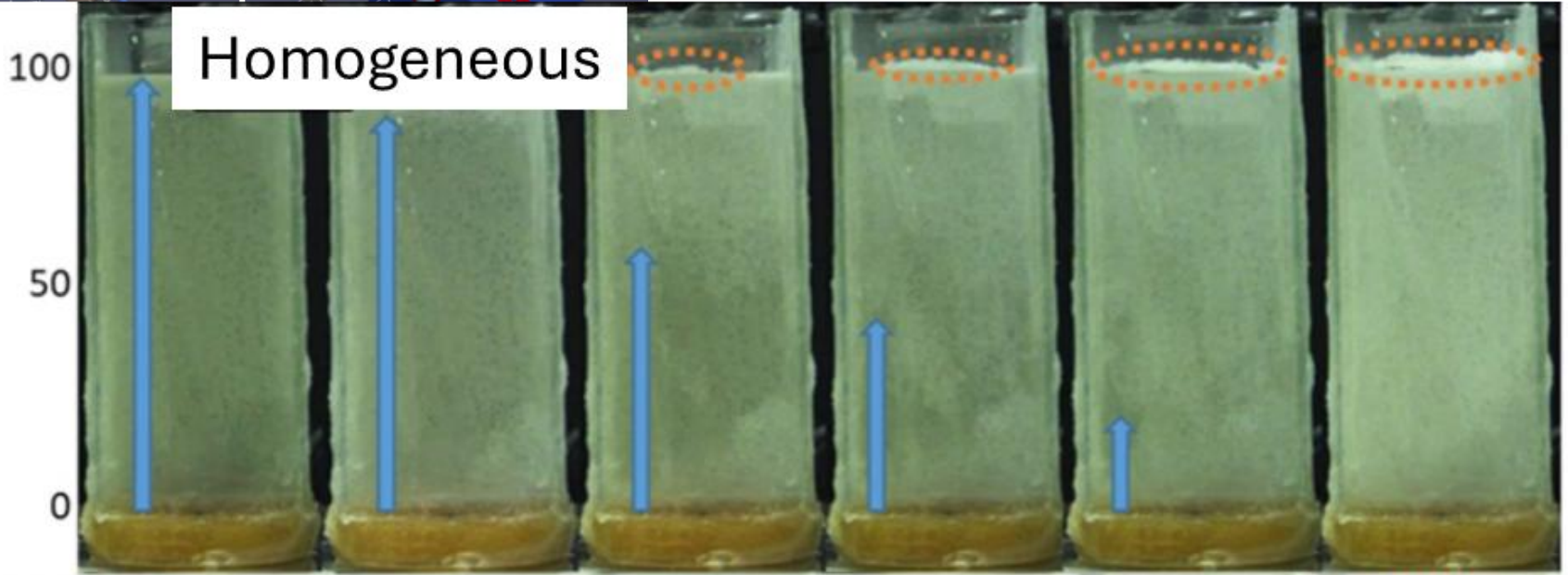
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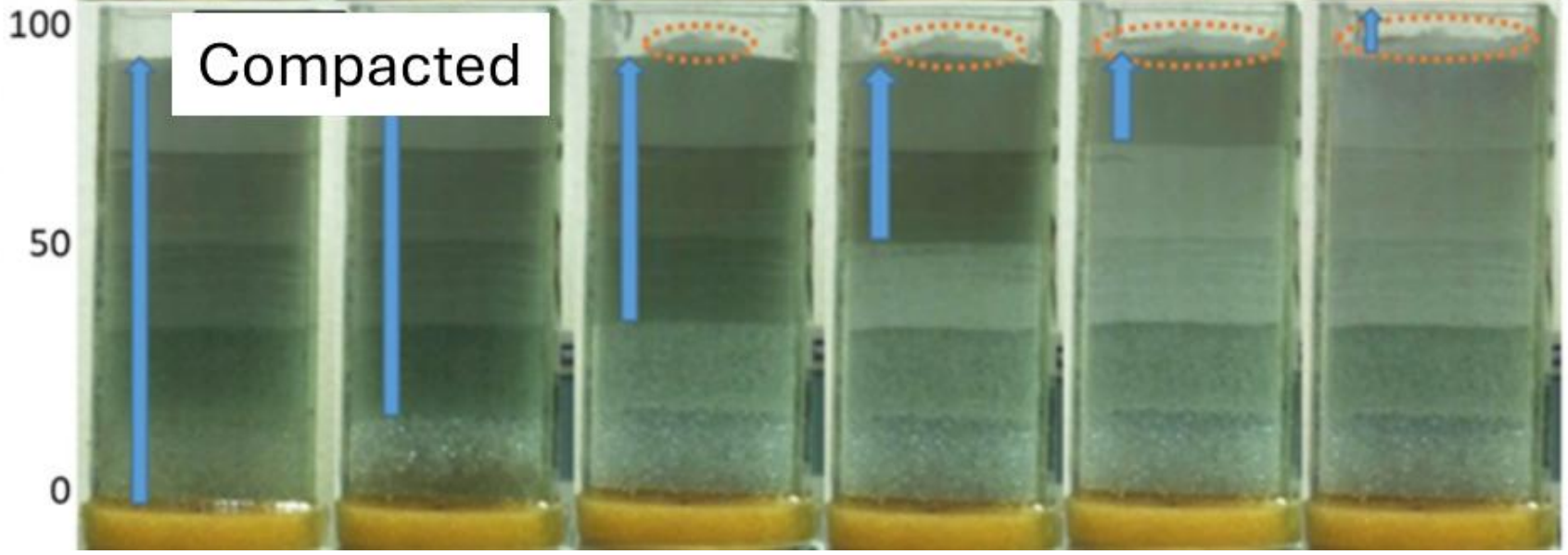
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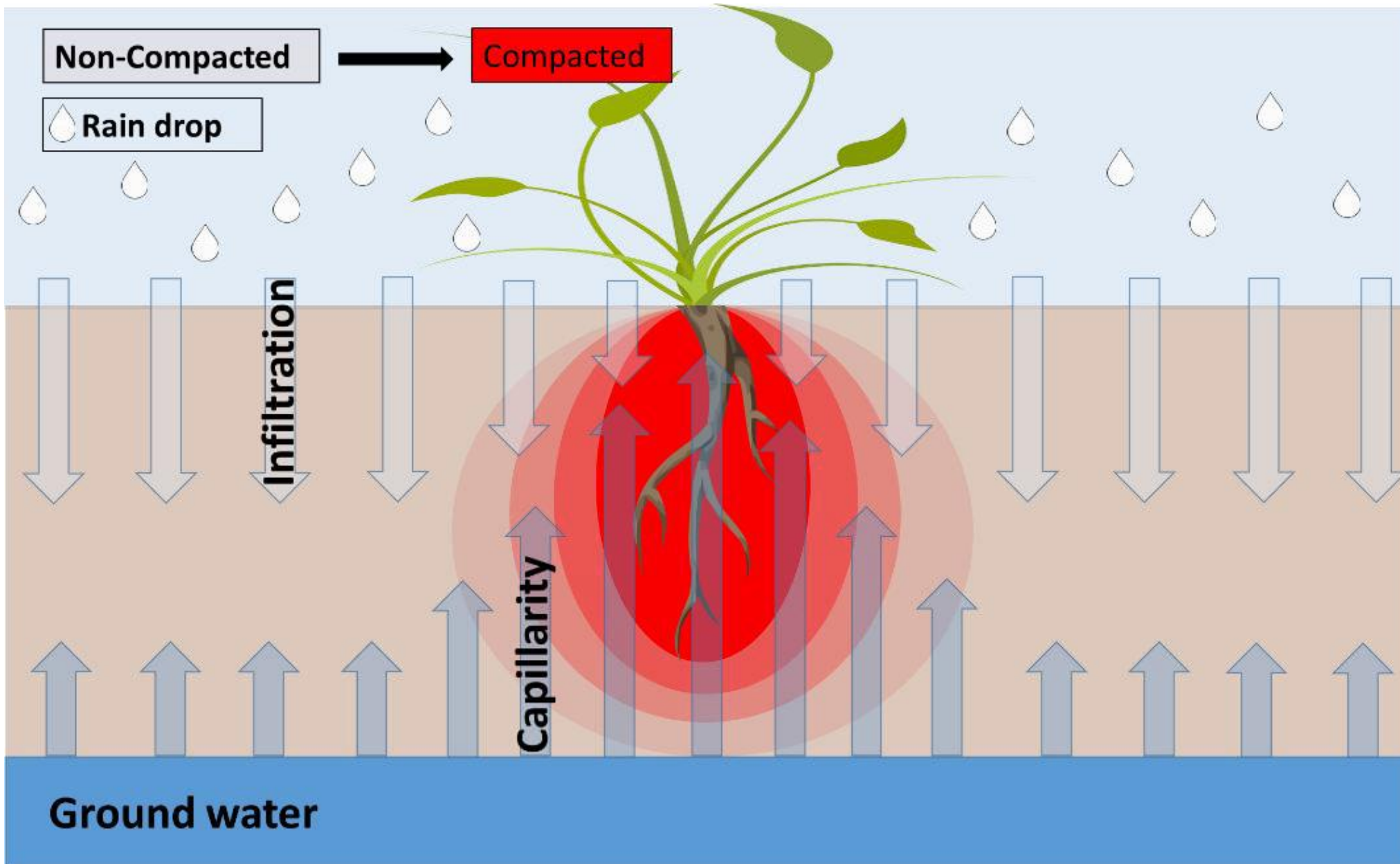
Homogeneous

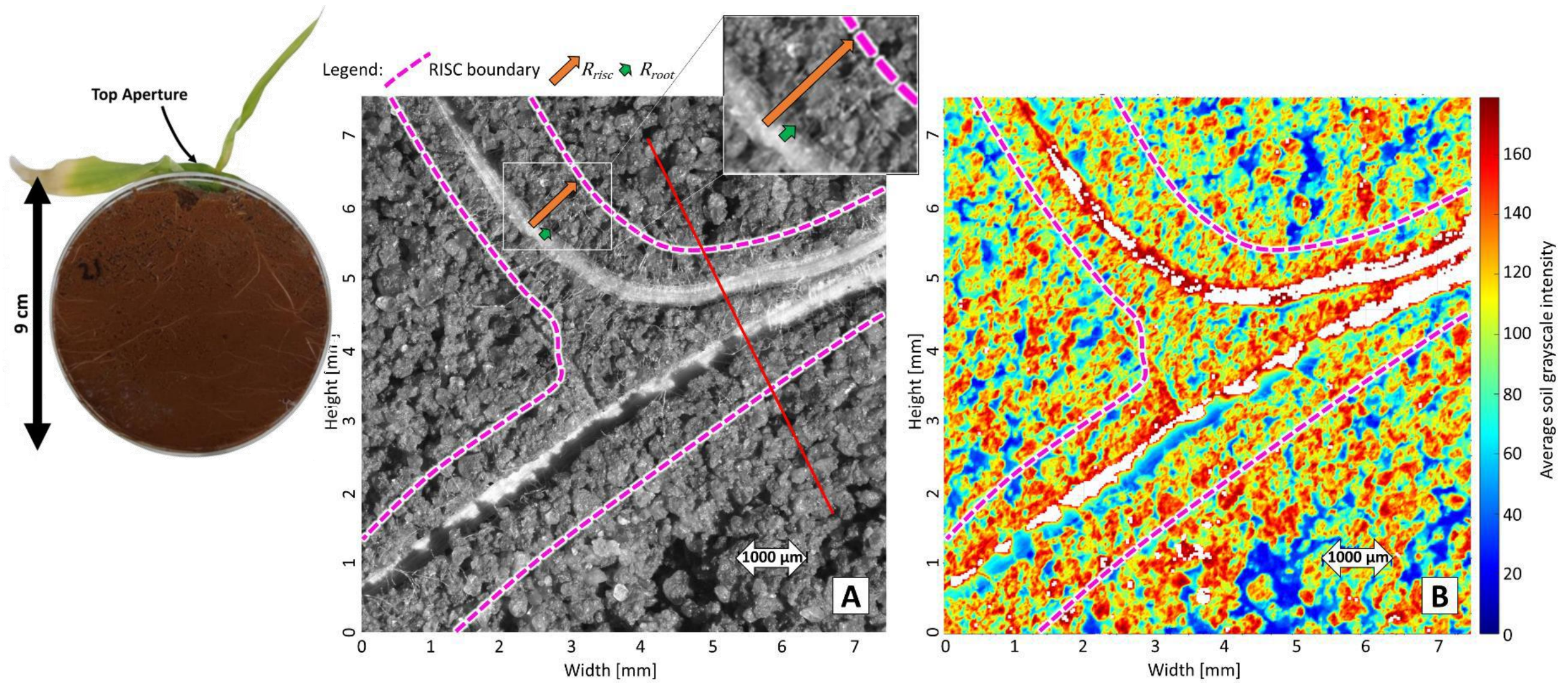


Compacted



RISC: Will it generate favorable conditions for root water (and nutrients) uptake?





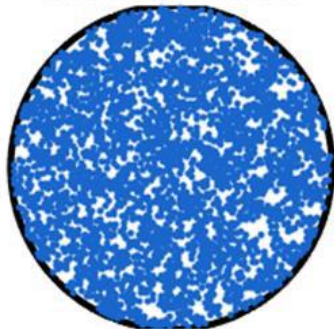
Microscale: 5-10% increase in bulk density of RISC zone

$$\frac{\rho_{risc}}{\rho_i} = \frac{\frac{M}{(V_{risc} - V_{root})}}{\frac{M}{V_{risc}}} = \frac{\pi l R_{risc}^2}{\pi l (R_{risc}^2 - R_{root}^2)} = \frac{R_{risc}^2}{R_{risc}^2 - R_{root}^2} = \frac{1}{1 - \left(\frac{R_{root}}{R_{risc}}\right)^2}$$

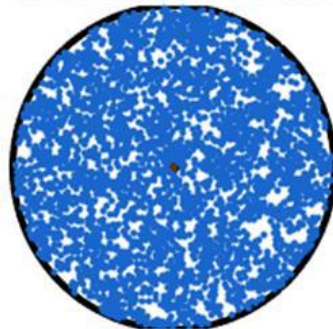
Single root
Model:

A

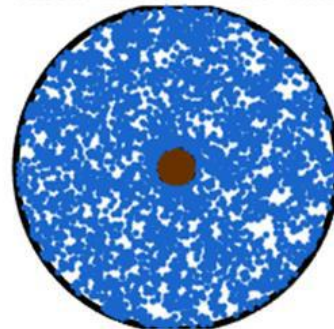
Initial Condition



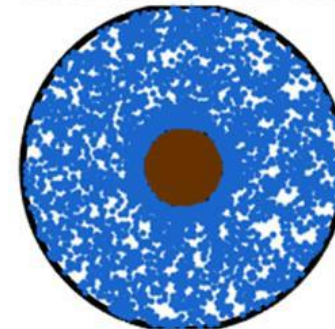
Root Radius: 0.5 mm



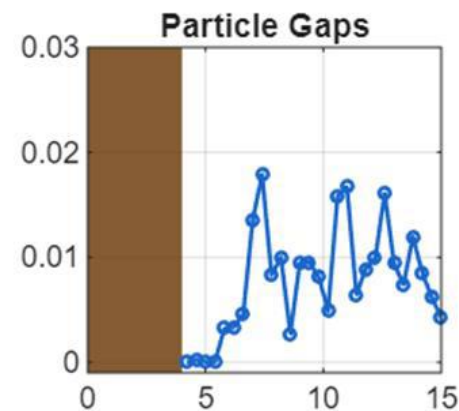
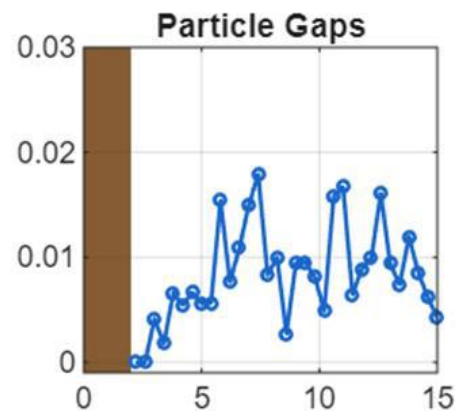
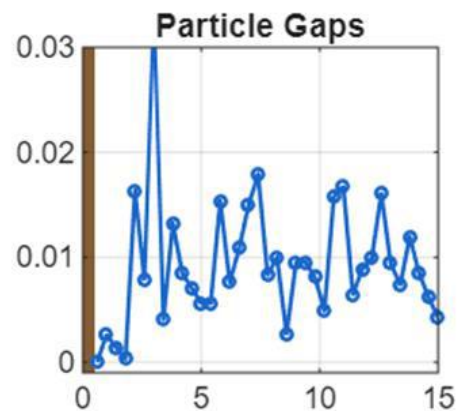
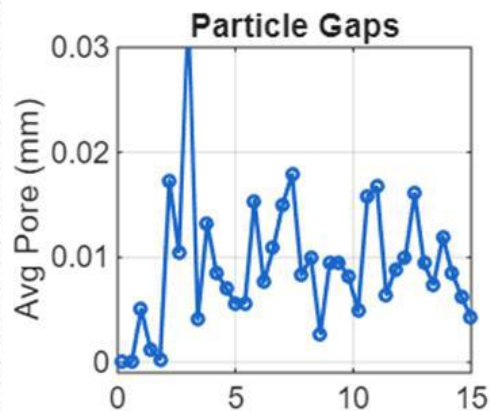
Root Radius: 2.0 mm



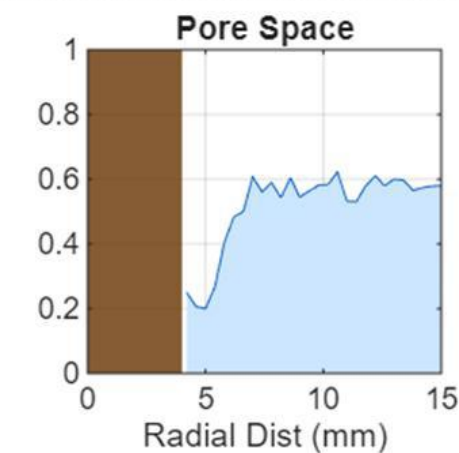
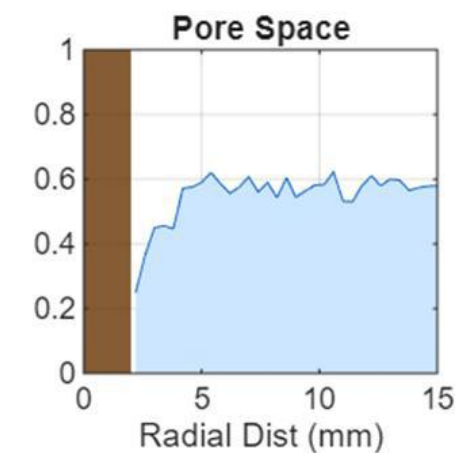
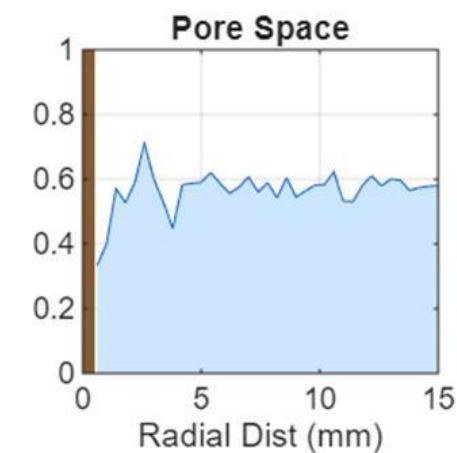
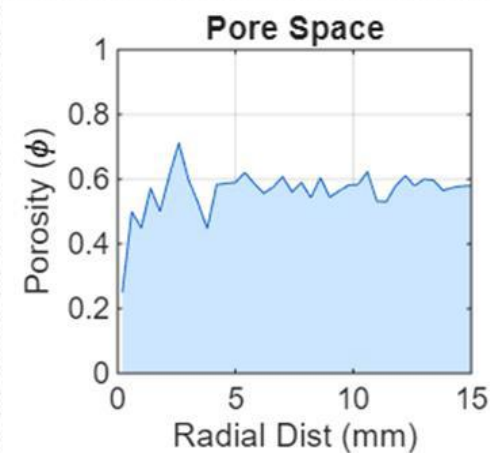
Root Radius: 4.0 mm



B



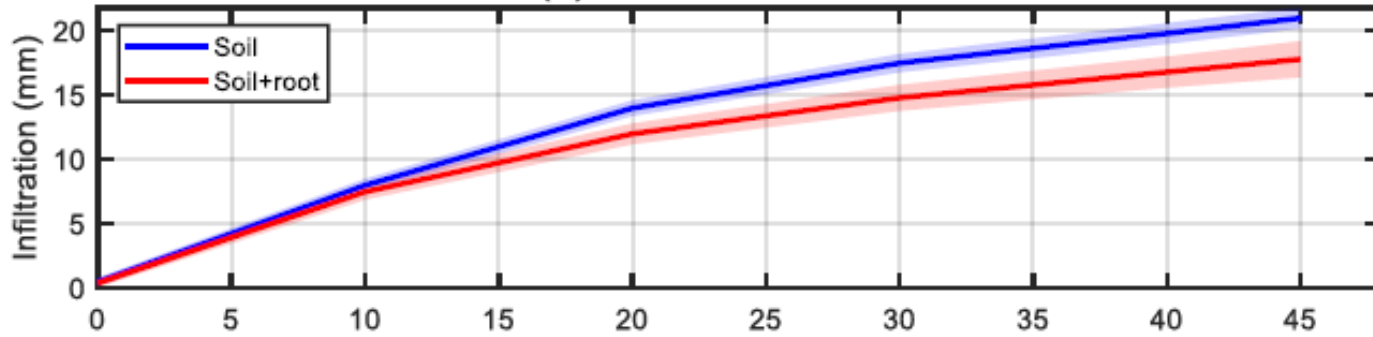
C



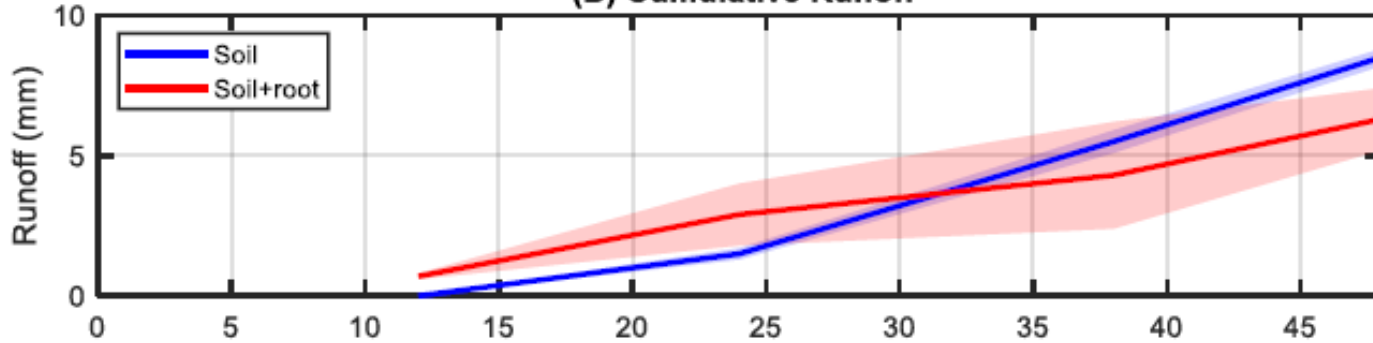


Macroscale – rain simulator experimetns:

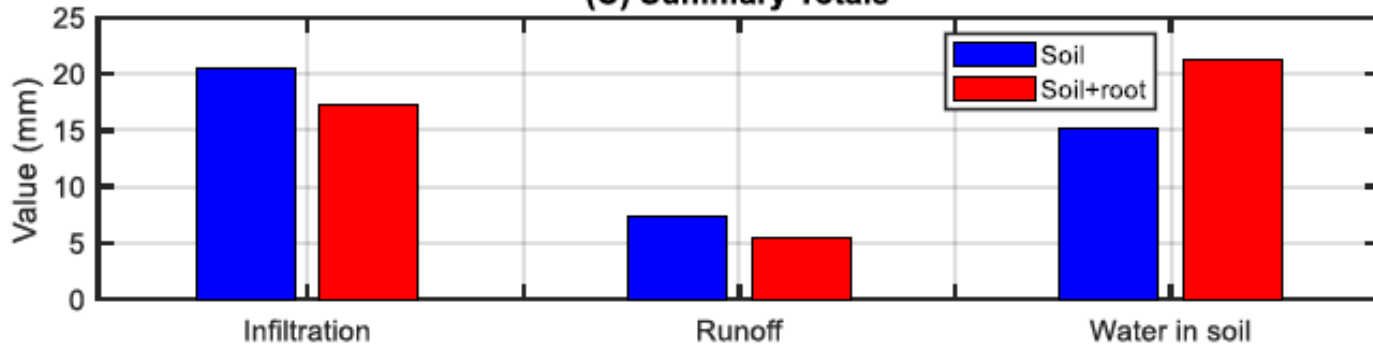
(A) Cumulative Infiltration



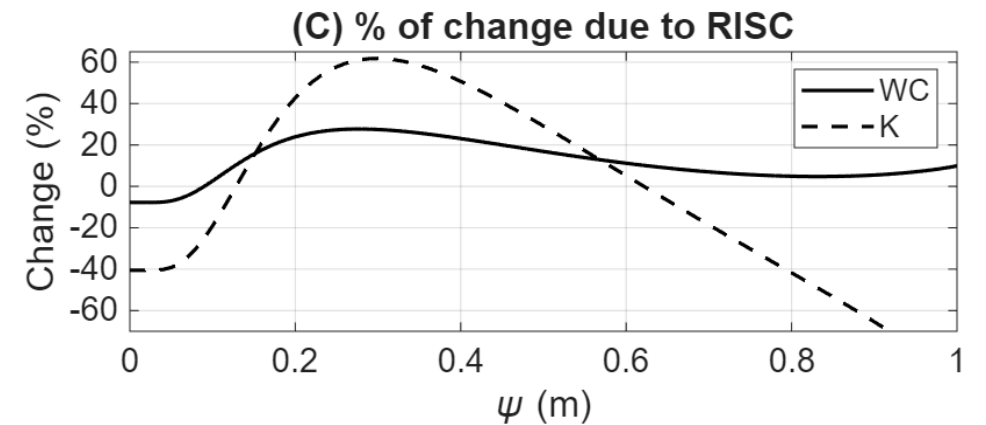
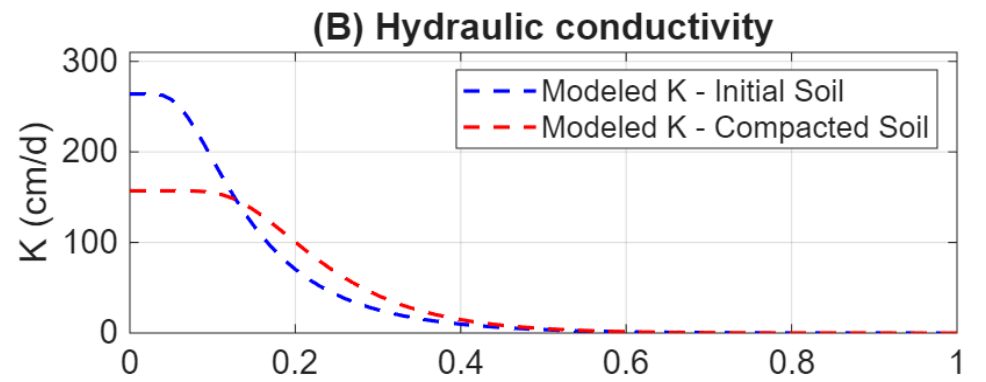
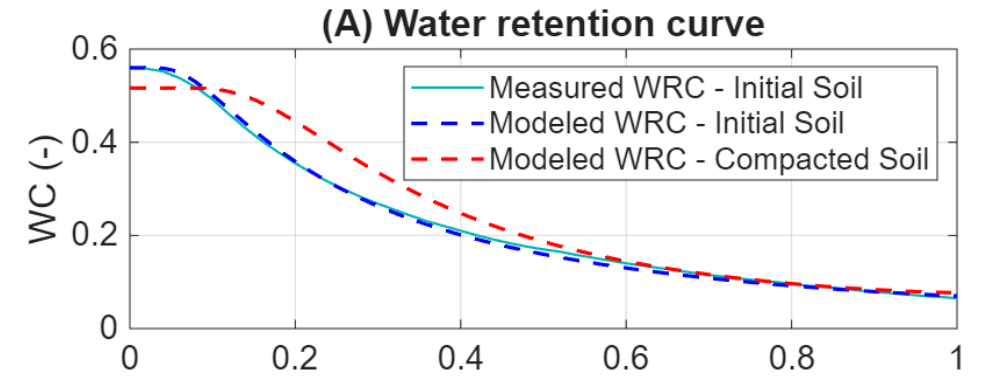
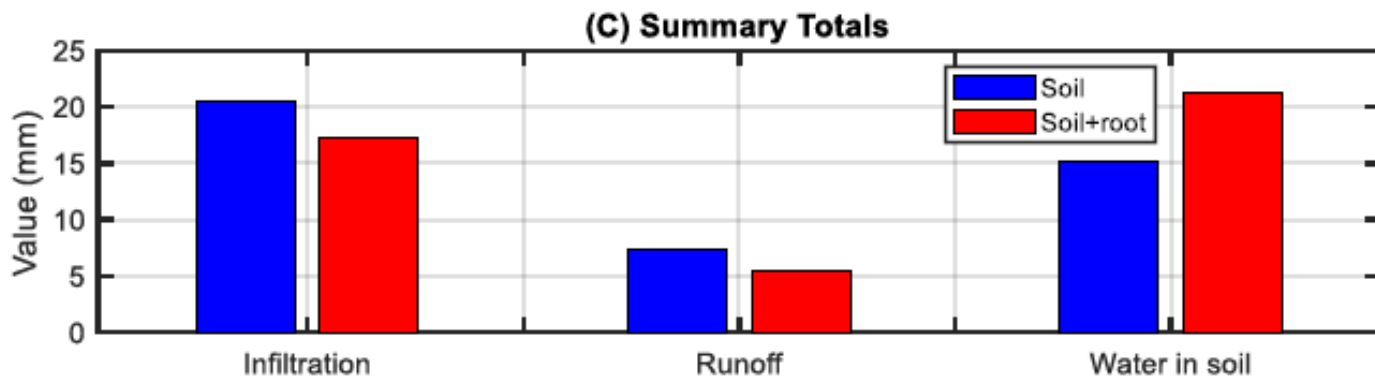
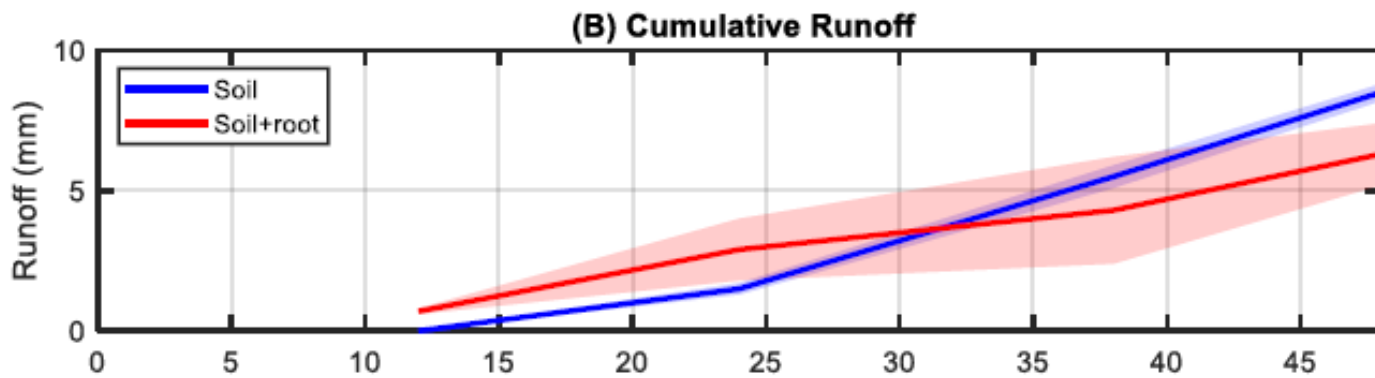
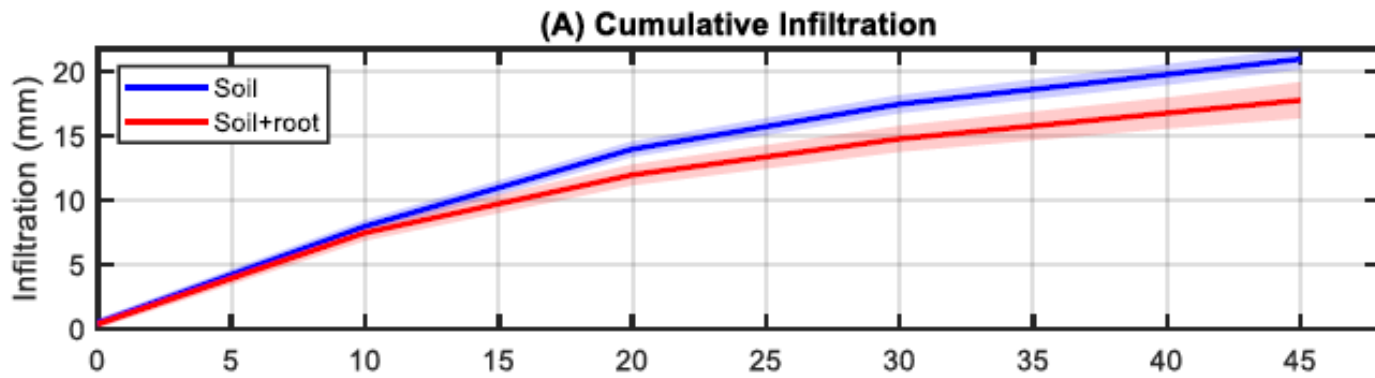
(B) Cumulative Runoff



(C) Summary Totals



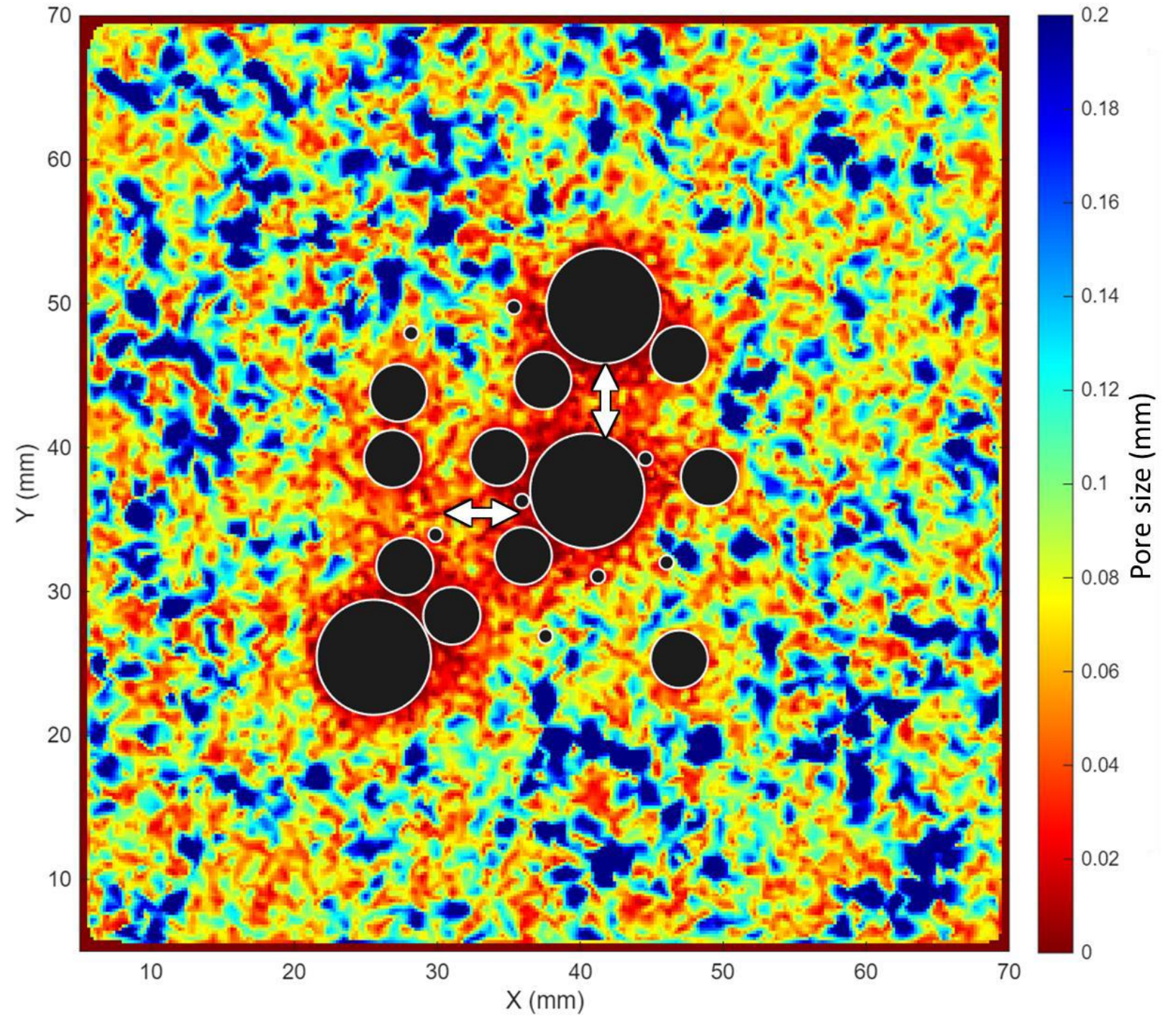
Macroscale – rain simulator experiments: ~40% increase in W.C. for the rooted state.



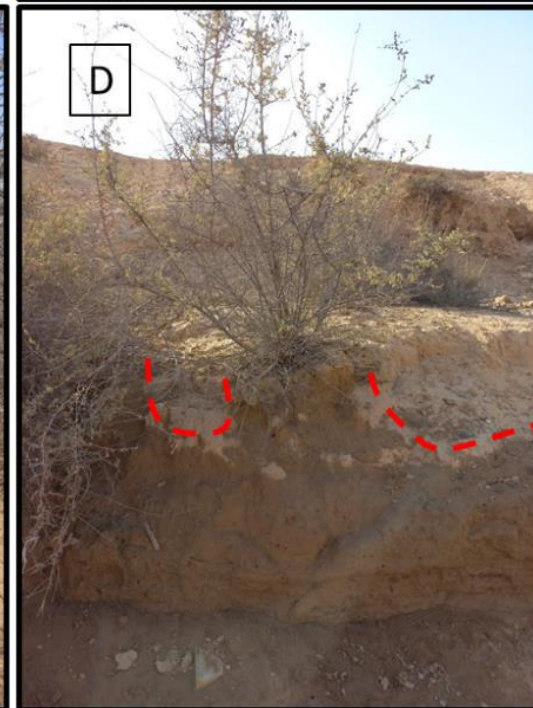
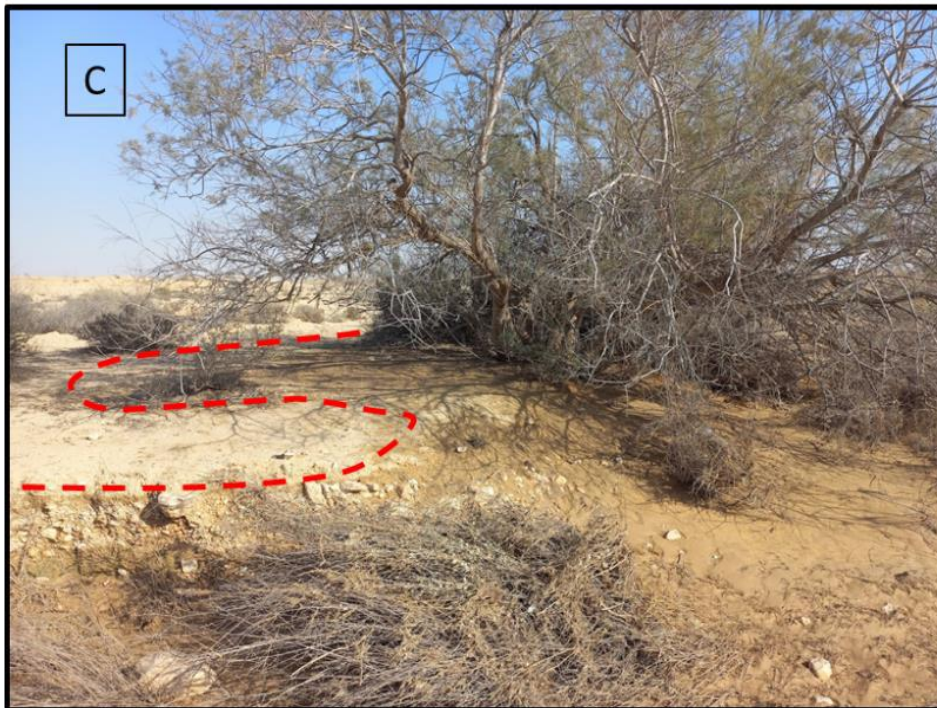
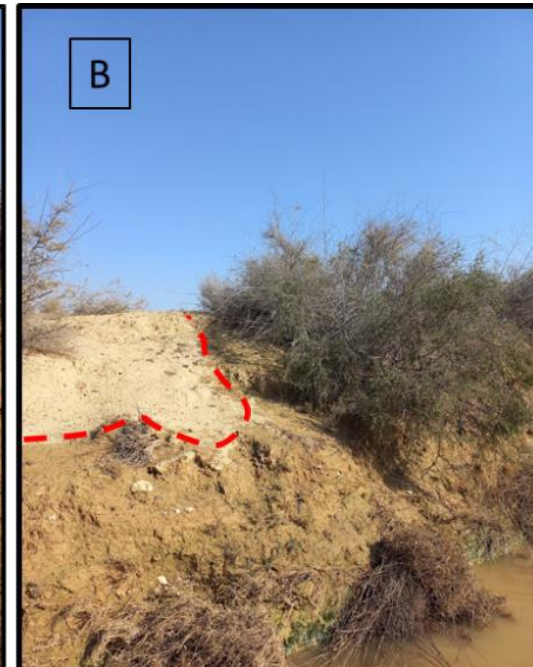
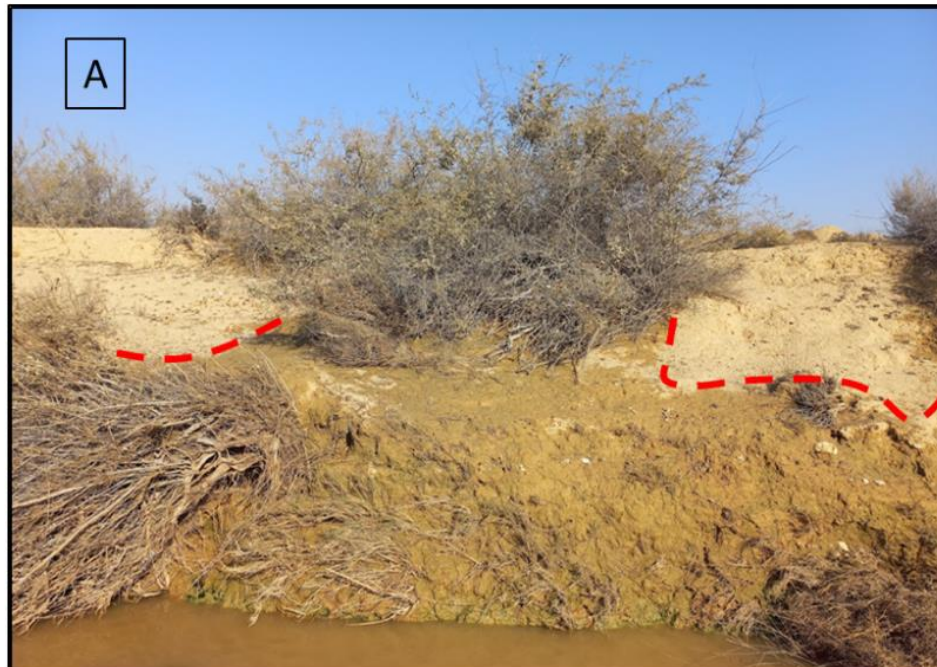
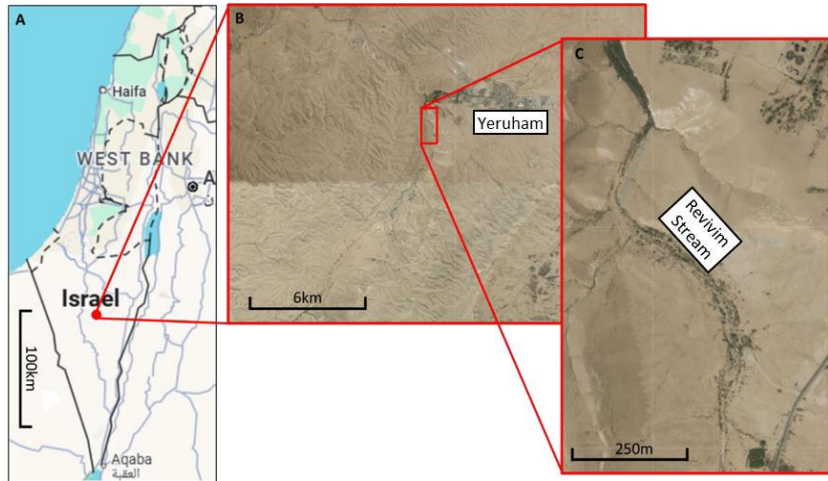
Macroscale – rain simulator experiments: ~40% increase in W.C. for the rooted state. In agreement with Assouline’s model.

Aggregated roots model:

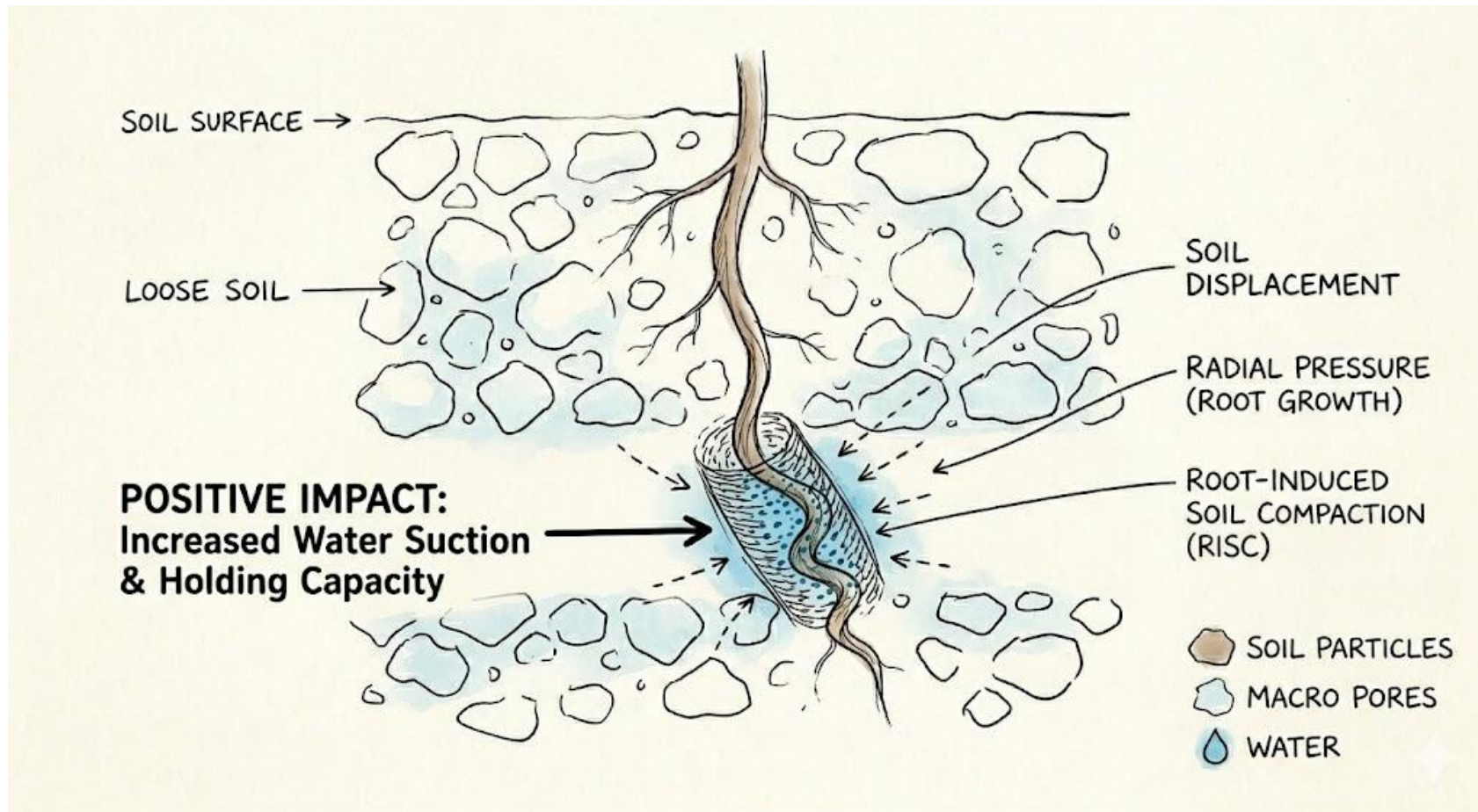
Synergetic effect on the
RISC spatial distribution.



Field scale observations:



In summary, RISC functions as an adaptive plant mechanism that actively maintains favorable hydrological conditions within the root zone. Future studies should further elucidate the aggregated impact of this phenomenon across the entire root system. Ultimately, a deeper understanding of RISC could allow for the targeted modification of root properties to enhance plant resilience against abiotic stresses.



Thank you!

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Institute of Soil, Water, and Environmental Sciences – Volcani Center

