KANSAS STATE UNIVERSITY

Urban Tree Transpiration in the Context of Urban Runoff Reduction

Authors

Forough Torabi*
Alireza Monavarian
Alireza Nooraei Beidokhti
Vaishali Sharda
Trisha Moore

*presenting auther

Affiliation

Department of Biological and Agricultural Engineering

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Introduction

- Urban trees are increasingly deployed as nature-based infrastructure to manage stormwater, yet quantitative guidance on how species traits and site context shape transpiration remains fragmented.
- We conducted a meta-analysis to examine the effects of:
  - Wood anatomy
  - Soil type
  - Planting configuration

Objective

- To provide a stronger scientific basis for integrating trees into stormwater management by quantifying how much water trees remove under different conditions.
- To support stormwater modeling, species selection, and the design of effective, tree-based green infrastructure.

Methodology

1 LITERATURE SEARCH & SCREENING

- Conducted a literature search to identify peer-reviewed studies using:
  - Subject: Urban Trees
  - Technique: Heat Pulse Velocity
  - Resolution: Daily Transpiration Rates

2 DATA EXTRACTION & HARMONIZATION

- Extracted 45 datasets from 7 studies.
  - Type I datasets: reported sap flux in outer 2 cm of the sapwood area (J_o in g/cm²/day).
  - Type II datasets: reported depth of water transpired per projected canopy area (E_c in mm/day).

3 FINAL OUTPUT VARIABLE

- Derived daily sap flux density (J_s) by dividing the summed sap flux by the total sapwood area.
- Final Unit: g/cm²/day

Analysis and Results

- The Kruskal-Wallis test was used to identify the differences in tree water use.
- Different letters indicate statistically significant (p-value < 0.05) differences.

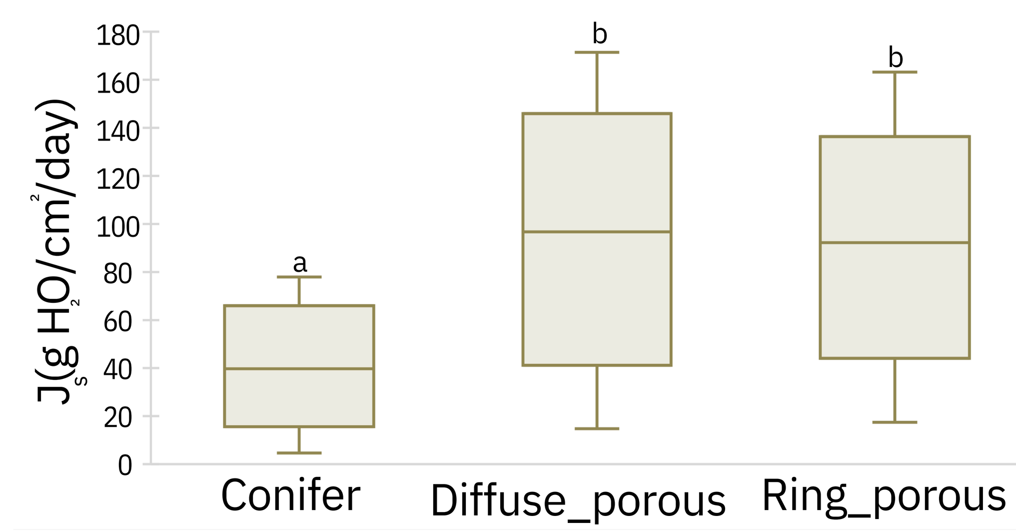

Figure 1
Transpiration distribution by wood anatomy type

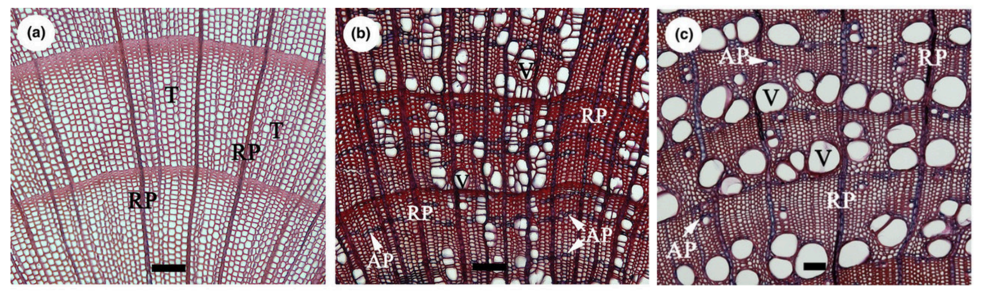

Figure 2: Different Wood Anatomies
a) Coniferous, b) Diffuse-Porous, c) Ring-Porous

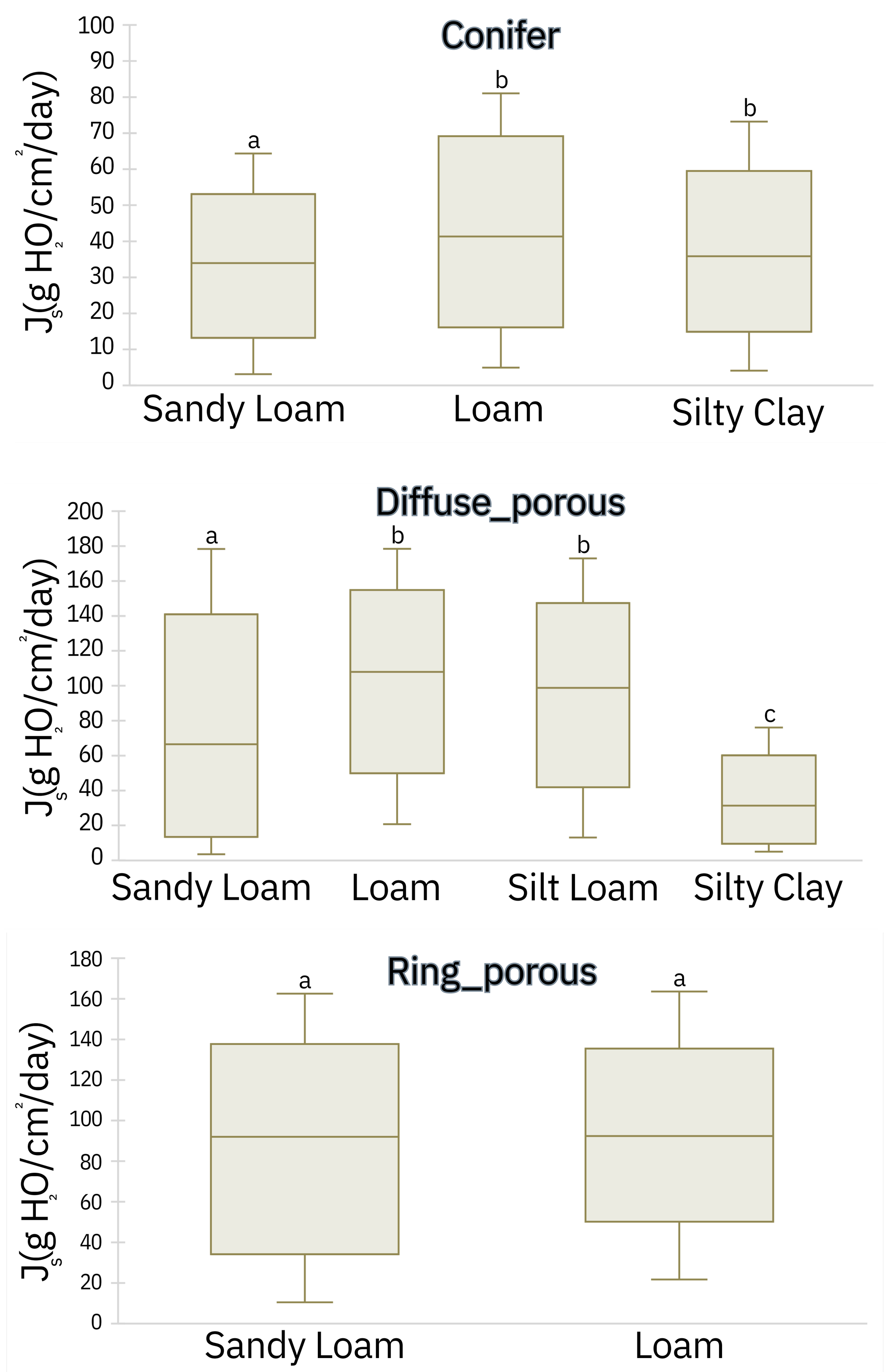

Figure 3
Transpiration distribution by soil type and wood anatomy

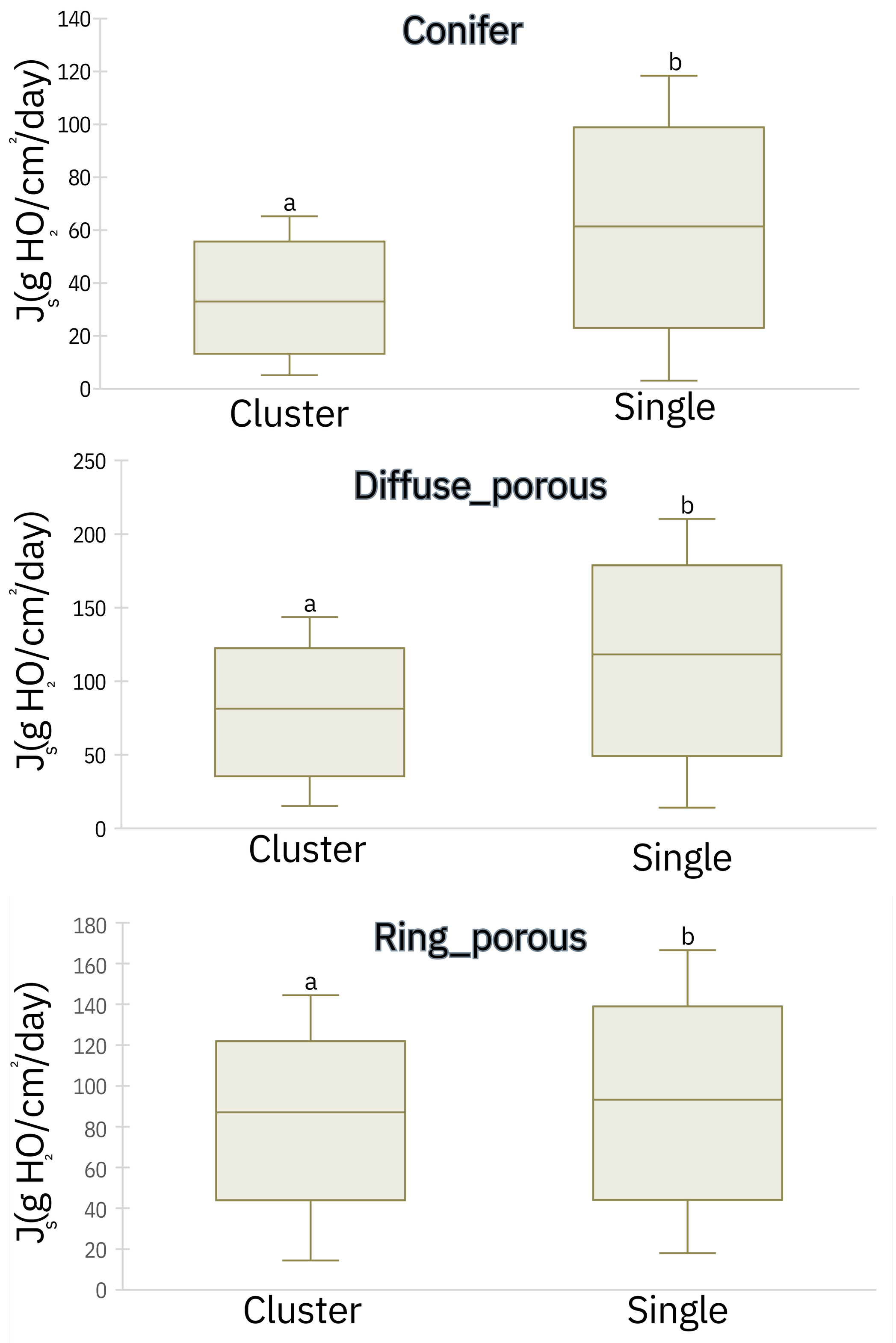

Figure 4
Transpiration distribution by planting configuration and wood anatomy

Conclusions

- In general, ring-porous and diffuse-porous species exhibited higher transpiration rates compared to coniferous species.
- All species show higher transpiration when planted individually rather than in a canopy
- Given the higher transpiration rates for ring-porous species in sandy loam soils relative to diffuse-porous species, ring-porous trees may be advantageous for stormwater management applications like bioretention in suitable climates.

For any questions, please contact:
fforough@ksu.edu