# Investigating the physiological responses of Pecan Trees (*Carya illinoensis*) to water sources and soil properties under extreme climatic conditions in agroecosystems of the Chihuahuan Desert

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## MOTIVATION

Global environmental change has increased the frequency and severity of heat waves (see Fig. 1) increasing water consumption in agriculture (Qu *et al.*, 2024). This phenomenon directly affected dryland agriculture worldwide, particularly in the US southwest (Ramirez-Valle *et al.*, 2022).

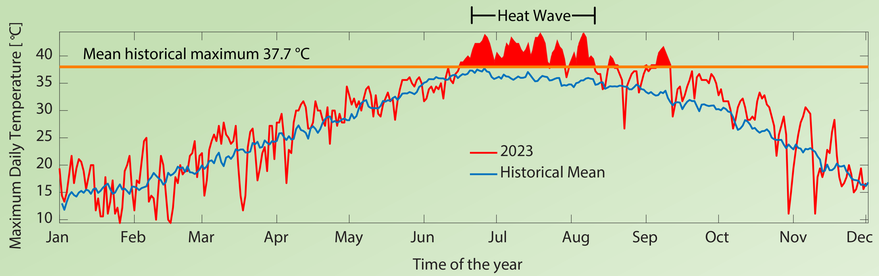


**Fig. 1.** Heat wave during the year 2023 in El Paso, Texas.

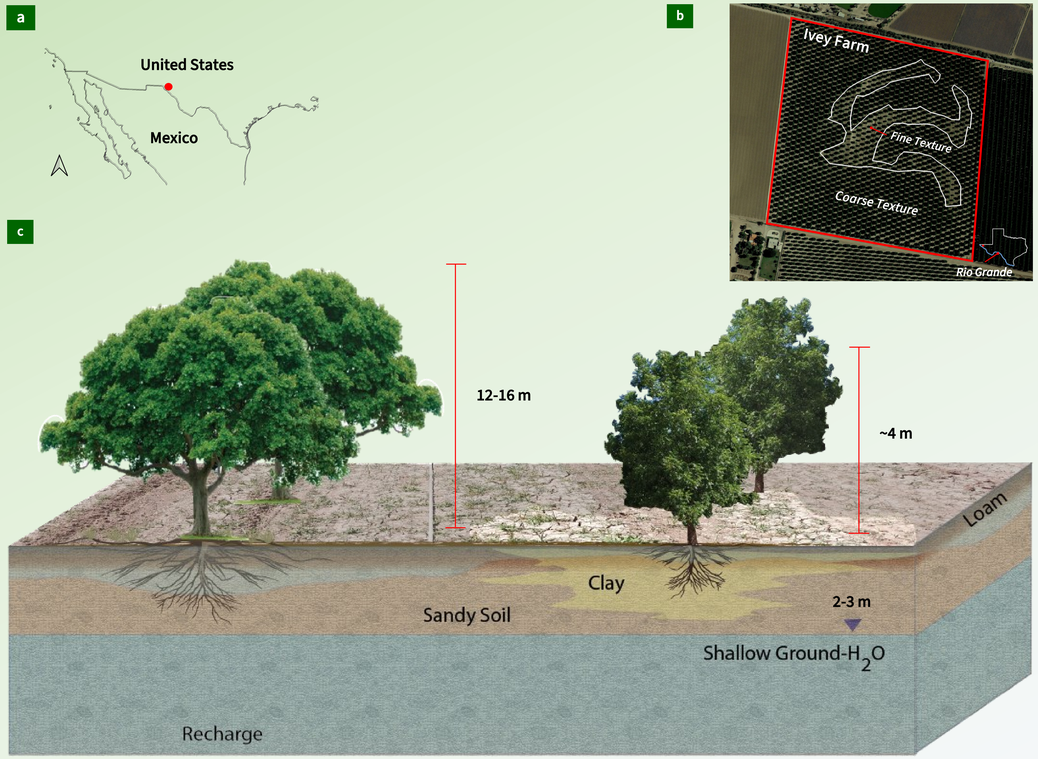


**Fig. 2.** Ivey Farm in Tornillo, Texas, US. **a)** Mexico-US Location , **b)** Ivey Farm, and **c)** Schematic diagram of two types of soils (pecan coarse and fine), pecan trees and water levels in the Ivey Farm. ***Flood irrigation practices:*** Every 2-3 weeks (March to October), water sources: Rio Grande (wet years) and Groundwater (drought years), and irrigation rate: ~1.5 m of water annually. ***Age of trees:*** ~45 years.

## RESEARCH QUESTIONS

1) What are the ecophysiological changes in pecans due to their critical zone architecture?
2) Do trees change their ecophysiological traits at the leaf level in response to stress from extreme climatic events in previous years? In other words, do trees have memory and adapt their leaves to become more or less water-use-efficient depending on their previous season conditions?

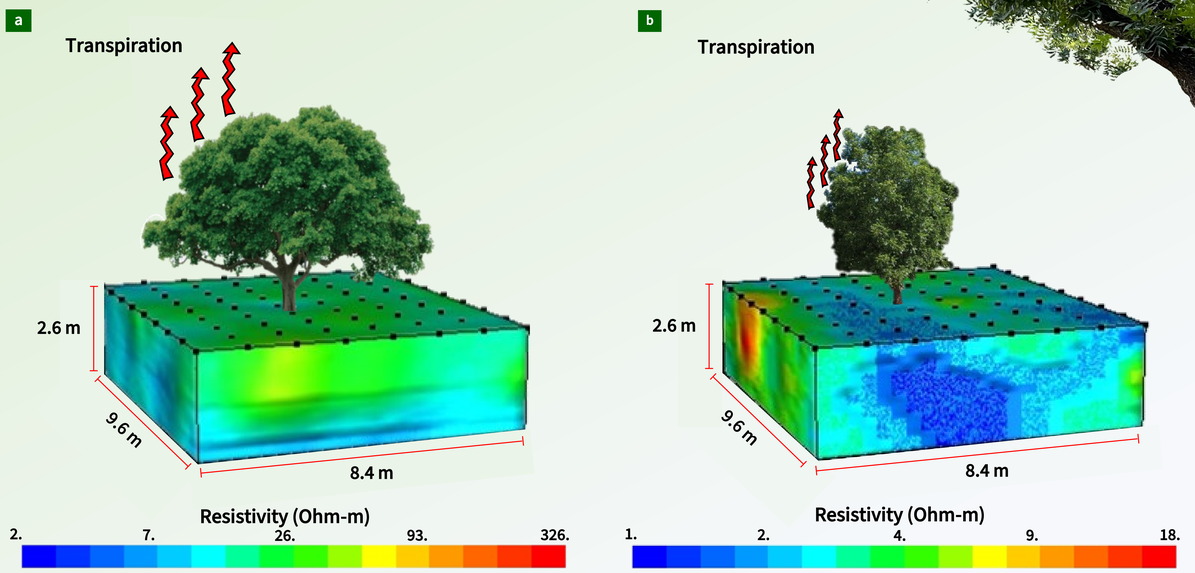


**Fig. 3.** Inverted resistivity 3D images of **a)** Pecan Coarse and **b)** Pecan Fine.

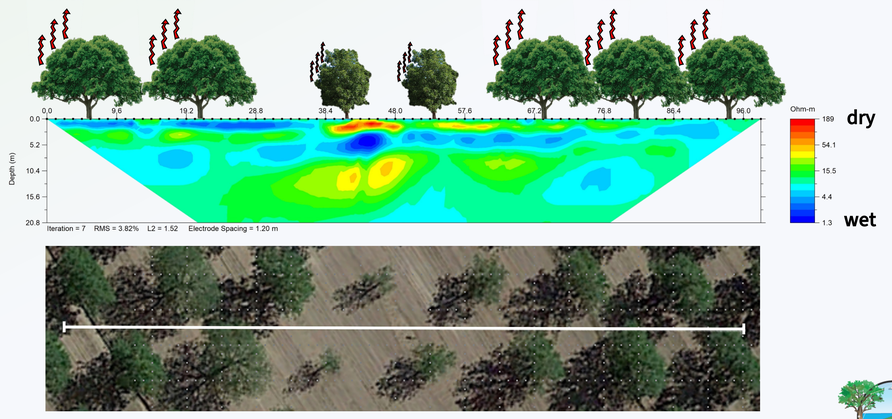


**Fig. 4.** Soil tomography of a west-east resistivity transect crossing a clay soil patch with evident changes in tree canopy development.

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## METHODOLOGY

### Plant Water Potential

Pressure Chamber

Every sample was stored in Ziploc bags and at mid-day aluminum foil was used.

Representation of first drop



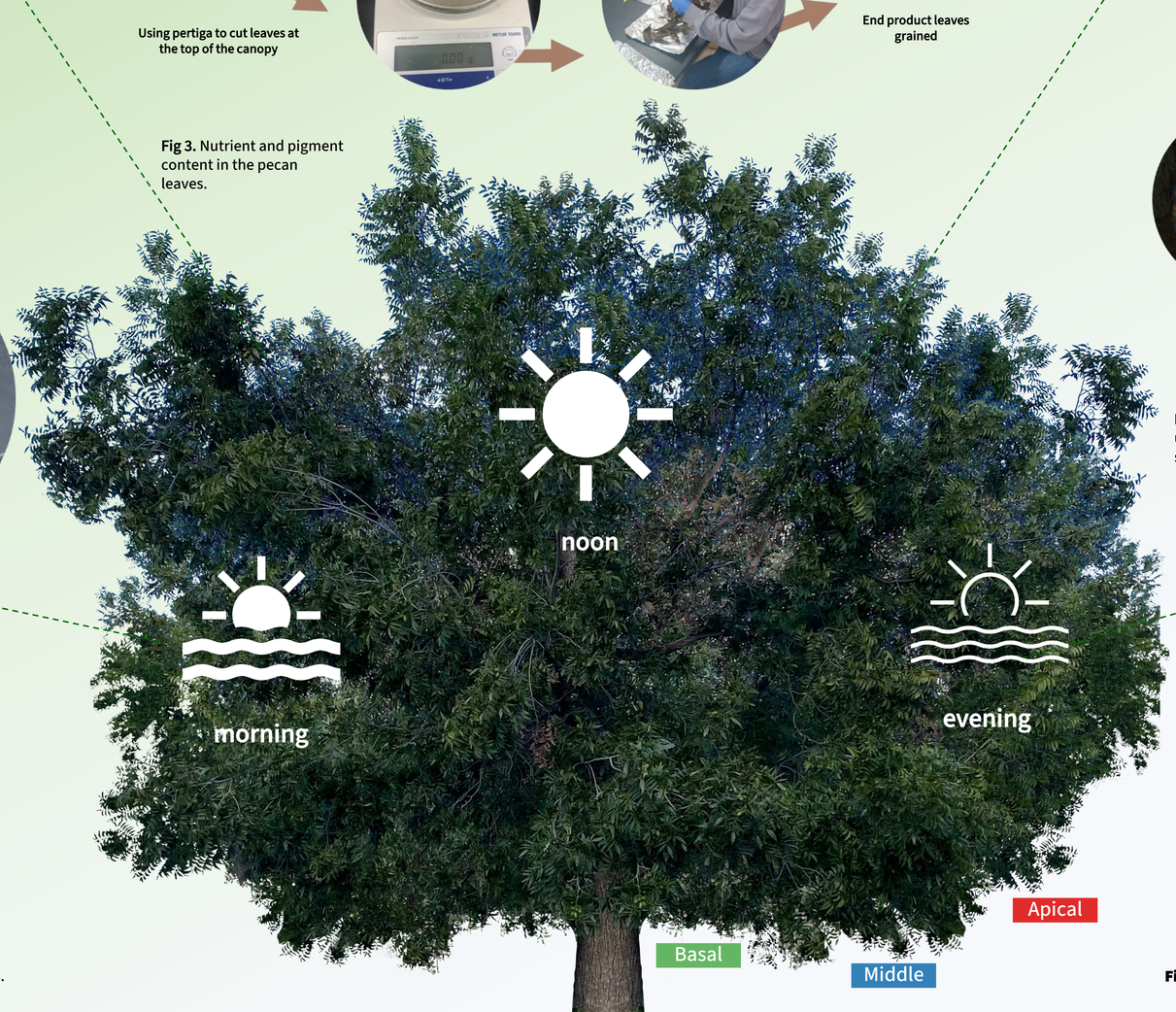
**Fig 1.** Using pressure chamber to measure the water potential in pecan leaves.

### Nutrient & Pigment Content

Using pertiga to cut leaves at the top of the canopy

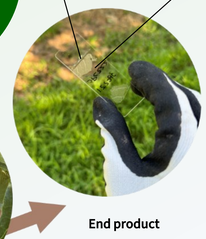
End product leaves grained

**Fig 3.** Nutrient and pigment content in the pecan leaves.




### Leaf Traits

Label leaf print



End product

**Fig 4.** Taking leaf prints for subsequent analysis under a microscope to obtain trichome density, stomatal density, and area.

### Stomata Conductance

Porometer device

**Fig 2.** Measuring the degree of stomatal opening and its use as an indicator of plant water status.

### Photo-chemical Activity

MINIPAM II device

**Fig 5.** Using a MINI-PAM to measure the photosynthesis rate of pecan leaves.

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## RESULTS

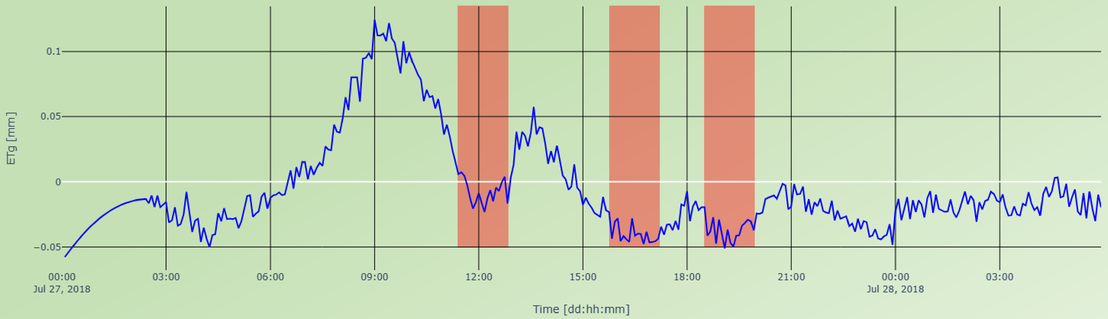
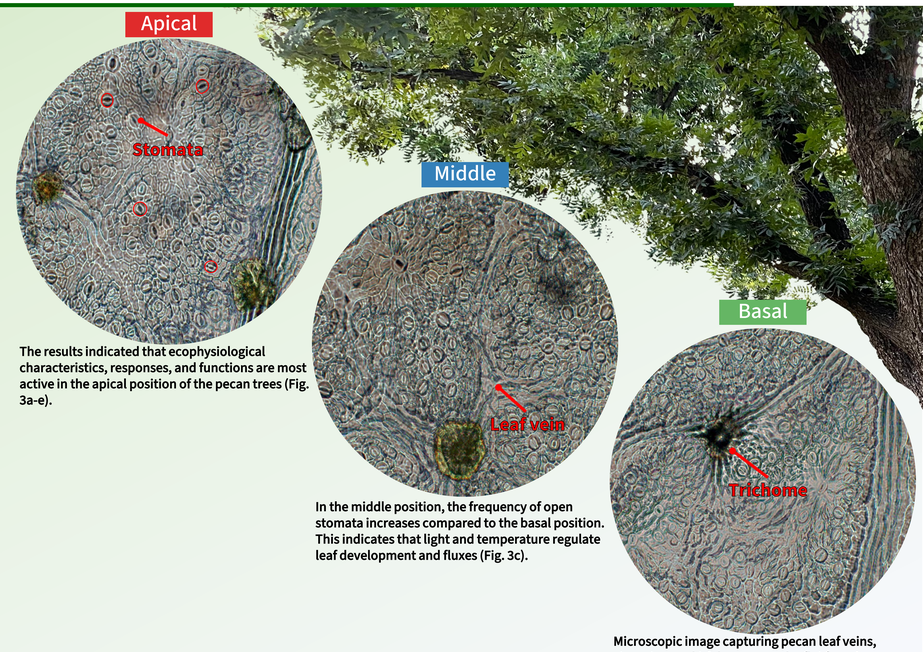



**Fig. 1.** Evapotranspiration time series (eqn. 7 in Loheide, 2008). Red squares show the stress depletion throughout the day and its water-using effect by pecan trees at Ivey Farm in Tornillo, Texas, during the summer of 2018.




The results indicated that ecophysiological characteristics, responses, and functions are most active in the apical position of the pecan trees (Fig. 3a-e).

In the middle position, the frequency of open stomata increases compared to the basal position. This indicates that light and temperature regulate leaf development and fluxes (Fig. 3c).

Microscopic image capturing pecan leaf veins, stomatas, and trichomes on a leaflet from Ivey Farm, magnified at 20x by ZEISS, showcasing three branch positions: basal, middle, and apical (Fig. 3a and 3b).

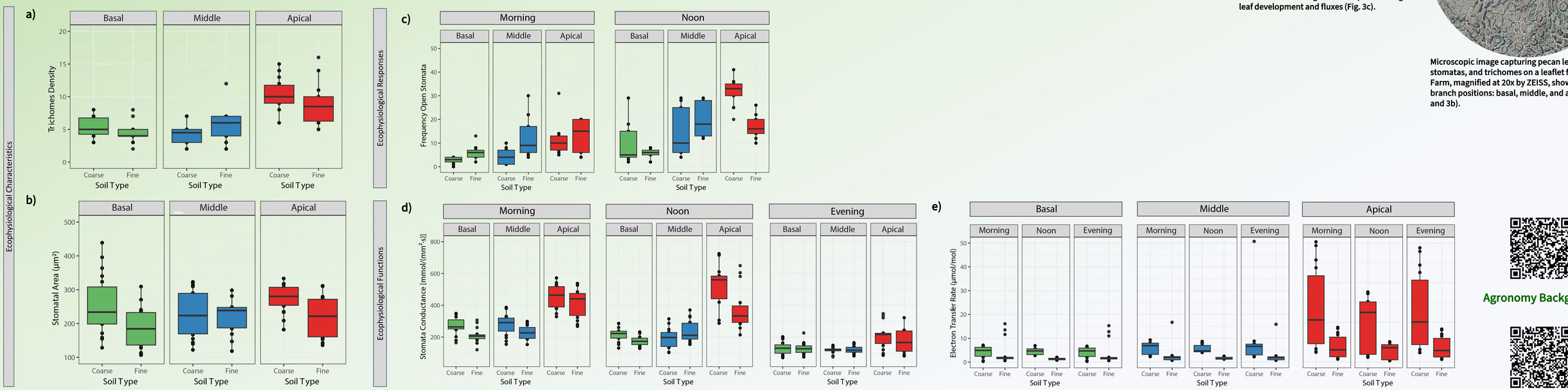



**Fig. 2. a)** Trichomes density: Position of the branch (*P<0.05*) , **b)** Stomatal area; Soil Type (*P<0.05*), **c)** Frequency open stomata; Position of the branch *P<0.05*), and Time (*P<0.05*), **d)** Stomata conductance; Soil Type (*P<0.05*), Time (*P<0.05*) , and Position of the branch (*P<0.05*), and **e)** Electron transfer rate; Soil Type (*P*<0.05), and Position of the branch (*P<0.05* ) in the pecan trees under two soil types in the Ivey Farm, Texas.

Agronomy Background

References

## ACKNOWLEDGMENTS

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