Designing a Rain Garden for The Sonoran Desert

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Introduction

- Rain gardens are valuable sustainable structures used in high precipitation areas but could greatly benefit areas suffering from water scarcity because they help replenish water tables (Nemirovsky et al 2015).
- The Sonoran Desert has an average ~6mm/yr increase of the water table from Nov 2014- Nov 2017 and an average total yearly precipitation from 2011-2020 of 7.01 inches, meaning it could benefit from rain gardens to help replenish the water table (Ojha 2020 & U.S Department of Commerce).
- Because rain gardens depend solely on rain for their irrigation, a crucial metric to understand for the plants in the garden is their water use efficiency (WUE).
- The object of this study therefore is to take three preselected plants with extensive root systems, aesthetic appeal, and some sort of productive yield (harvestable food or material), and measure their WUE to determine how they should be implemented into the Sonoran Desert rain garden.

Methods

Materials

- Ciras-3 Infrared Gas Analyzer
- CO_2 Canisters
- Ruler

Methodology

- The project was done in the Sonoran Preserve, where the palo verde data (*Parkinsonia florida*) was collected, and on the ASU west campus, where the oleander (*Nerium oleander*) and mesquite (*Prosopis glandulosa*) data was collected.
- A Ciras-3 gas analyzer (Picture 3) was used to measure photosynthesis, transpiration, and then calculate WUE.
- When measuring mesquite and palo verde, the leaves were not large enough to encapsulate the entire space of the glass clamp attached to the Ciras-3, so a ruler was used to estimate the area of each leaflet which was then multiplied by the number of leaflets to calculate total leaf area for the machine to make accurate measurements.
- Ten samples of each species were taken and then average to produce the figures on transpiration, photosynthesis, and WUE.

Results

The average WUE values for oleander, mesquite, and palo verde respectively were 2.27, 0.68, and 2.4 µmol m^{-2} s^{-1}/mmol m^{-2} s^{-1}. The average photosynthesis values for oleander, mesquite, and palo verde respectively were 8.47, 1.35, and 2.16 µmol m^{-2} s^{-1}. The average transpiration values for oleander, mesquite, and palo verde respectively were 4.092, 1.666, and 1.014 mmol m^{-2} s^{-1}.

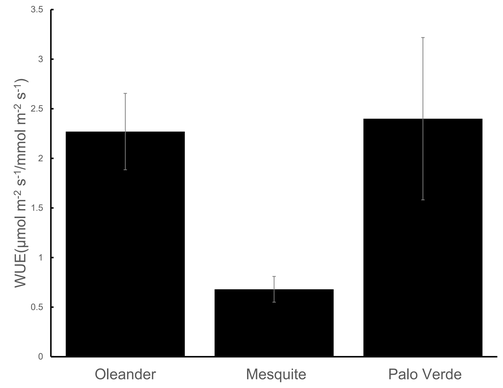

Figure 1. Mean water use efficiency of each of these plants over 10 measurements. The standard error for oleander, mesquite, and palo verde was 0.385, 0.130, and 0.819 respectively.

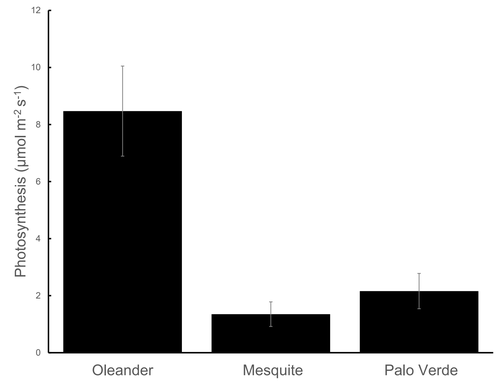

Figure 2. Mean photosynthesis of each of these plants over 10 measurements. The standard error for oleander, mesquite, and palo verde was 1.58, 0.432, and 0.619 respectively.

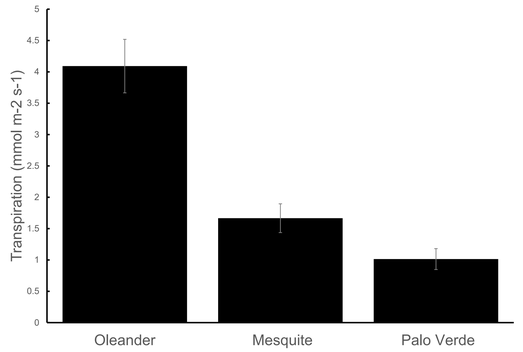

Figure 3. Mean transpiration of each of these plants over 10 measurements. The standard error for oleander, mesquite, and palo verde was 0.427, 0.229, and 0.167 respectively.

Discussion

- Our results found that palo verde had the highest average WUE out of the measured plants, followed by oleander then mesquite.
- Palo verde and oleander did not have a significant difference in their average WUE efficiency, but both had a significantly higher WUE than Mesquite.
- These findings imply a few things for the construction of a rain garden in the Sonoran Desert:
  1. Palo verde and oleander should have a significantly higher distribution and density throughout the garden than mesquite.
  2. Despite that oleander had a slightly lower average WUE than Palo Verde, oleander plants take up significantly less space than palo verde trees, therefore there will need to be a significantly higher distribution and density throughout the garden of oleander.

Picture 1: Site for mesquite data collection (ASU West Campus)

Picture 2: Site for oleander data collection. (ASU West Campus)

Picture 3: Ciras-3 Gas Analyzer

Picture 4: Site for palo verde data collection. (Sonoran Preserve)

Bibliography

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