Environmental monitoring of *Stahlia monosperma* populations established in the "Ciénaga Las Cucharillas" Natural Reserve: An analysis of environmental parameters

[1]Fabiola E. Báez Flores & [2]Wilmer O. Rivera-De Jesús

[1]Department of Fine Arts, Faculty of Humanities, University of Puerto Rico, Río Piedras Campus

fabiola.baez1@upr.edu

[2]Department of Biological Sciences, Faculty of General Studies, University of Puerto Rico, Río Piedras Campus

wilmer.rivera2@upr.edu

Abstract

Climate change impacts on environment promotes challenges that must be addressed from a inter and transdisciplinary approach. The sustainable development includes the conservation of biodiversity through rehabilitation projects and the effective management of natural resources. Under this approach, the course Climate change and the Caribbean ecological systems (CIBI-3027), integrated undergraduate students in rehabilitation projects carried out by community base organizations in Puerto Rico. This research focuses on the environmental monitoring of *Stahlia monosperma* ("Cobana Negra") populations in the Ciénaga Las Cucharillas Natural Reserve in Cataño, Puerto Rico. The objective is to understand the ecophysiological responses of this species under different environmental conditions and offer recommendations for reforestation projects. Our results indicated a variability in microclimatic conditions, in terms of temperature and precipitation, and differences in soil water content between the study areas. The population of *S. monosperma* that develops in zone 2 demonstrated a better state of foliar hydration (g of water) and leaf biomass (g) compared to the populations that develops in zone 1 and zone 3. The findings of this study are shared with the community-based organization, "Corredor del Yaguazo", which develops rehabilitation projects for critical species in the "Ciénaga Las Cucharillas Natural Reserve". Also, we understand more of the ecophysiological performance of this critical species in the context of climate change.

Introduction

Figure 1: Fabiola's artistic collage about "Ciénaga Las Cucharillas" and its biodiversity

Figure 2: Aerial images 2016 (Ikonos) from the UPR-Planning School and retrieved through PR.gov

Stahlia monosperma is a Puerto Rican endemic tree species, listed in the federal endangered species act. Their natural distribution includes the southwest part of Puerto Rico, Luquillo, Vieques, and the eastern part of the Dominican Republic (Carrera & Lugo, 1978). We can find it in elevated zones and wetlands areas close to mangrove forests. The species is notable for its height, reaching up to 50 feet, and for its compound leaves with black dots and glands on the underside. "Cobana Negra" is threatened by habitat destruction due to human development and historical deforestation. Since climate change models for the Caribbean region predict an accelerated sea level rise, frequent drought periods and changes in the intensity, frequency, and distribution of the precipitation events (Lambs et al. 2015; Cardona-Olarte et al. 2013; Erwin 2009; PRCCC 2013), abiotic determinants are and will continue to change in the region. Studies from different estuarine coastal wetlands in the Caribbean and Puerto Rico have recorded frequent and prolonged periods of drought and significant increases in soil and groundwater salinity as a result of the expansion of the marine intrusion and sea level rise (Rivera-De Jesús 2019; Lambs et al. 2015; Colón-Rivera et al. 2014; Bompy et al. 2014; Flower and Imbert 2006). This condition results in hydric and saline stress in plant species associated with these ecosystems. Abiotic factors such as salinity and lack of precipitation are stressors for *S. monosperma*, which may impact its growth and survival. This research focuses on the environmental monitoring of *S. monosperma* populations in the "Ciénaga Las Cucharillas" Natural Reserve in Cataño, Puerto Rico. The objective is to understand the ecophysiological responses of this species under different environmental conditions and offer recommendations for reforestation and conservation efforts.

Methods

A study was conducted at the Ciénaga Las Cucharillas Natural Reserve to evaluate the biotic and abiotic parameters influencing *Stahlia monosperma*. Trees of this species were selected in three study areas, marked with colored ribbons, and their location and environmental conditions were documented. Each group collected leaf samples, measured stem diameter at breast height, and used a chlorophyll meter (SPAD) to assess leaf health. Soil and groundwater sample, obtained from existing wells in the reserve, were collected and properly stored. In the laboratory, the leaves were weighed and dried at 75°C to determine their water content and moisture percentage. Additionally, the pH and salinity of the soil and water samples were analyzed. Meteorological stations were used to gather microclimate data. The data were compiled into tables to facilitate the analysis of the interaction between biotic and abiotic factors in the ecosystem.

Figure 3: *S. monosperma* studied populations and field work

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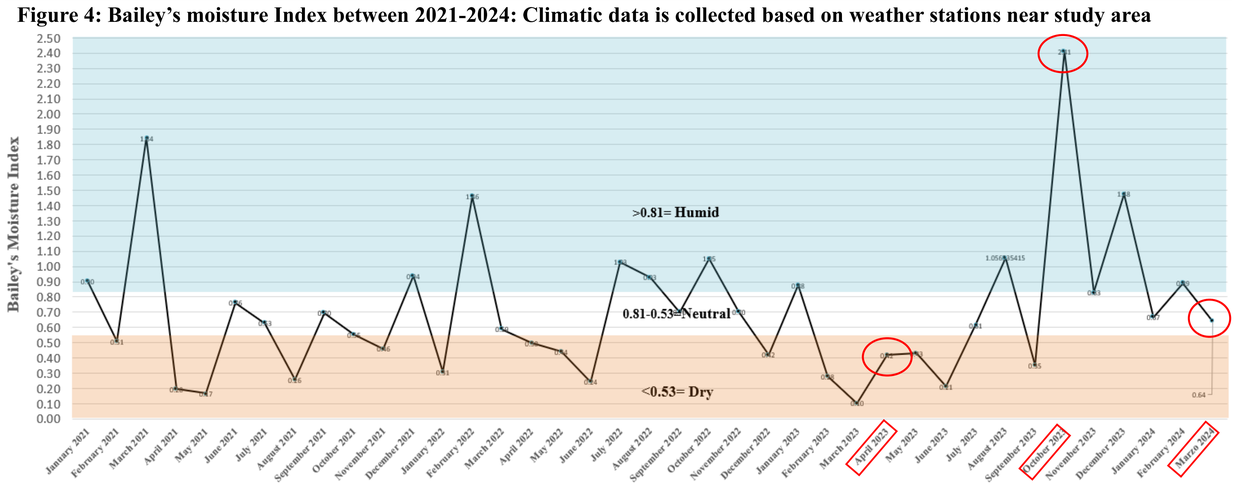
Results

Figure 4: Bailey's moisture Index between 2021-2024: Climatic data is collected based on weather stations near study area



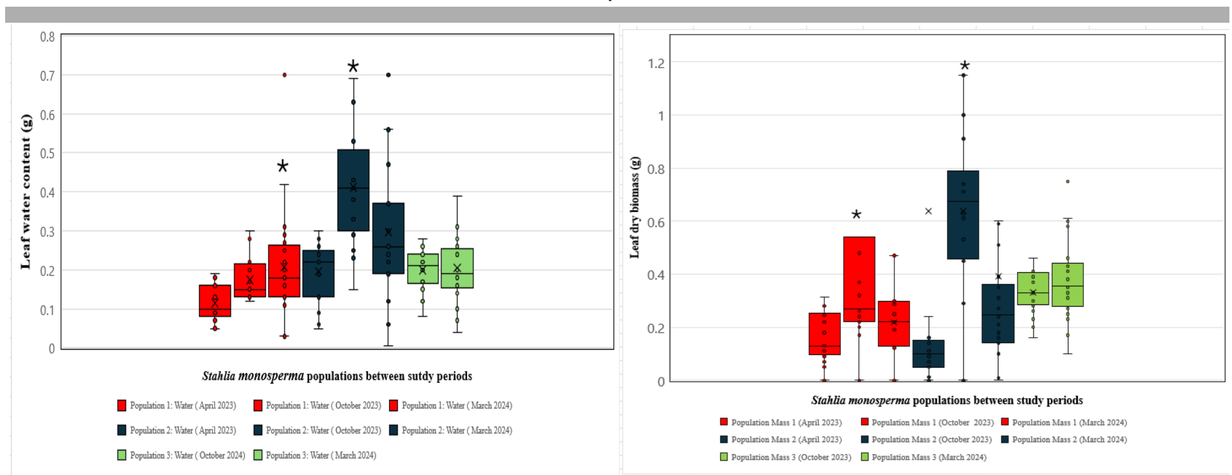


Figure 5: Leaf water content and leaf dry biomass in *S.monosperma* populations between study periods. (*) represent statistical differences ($p \leq 0.05$) by one way ANOVA.

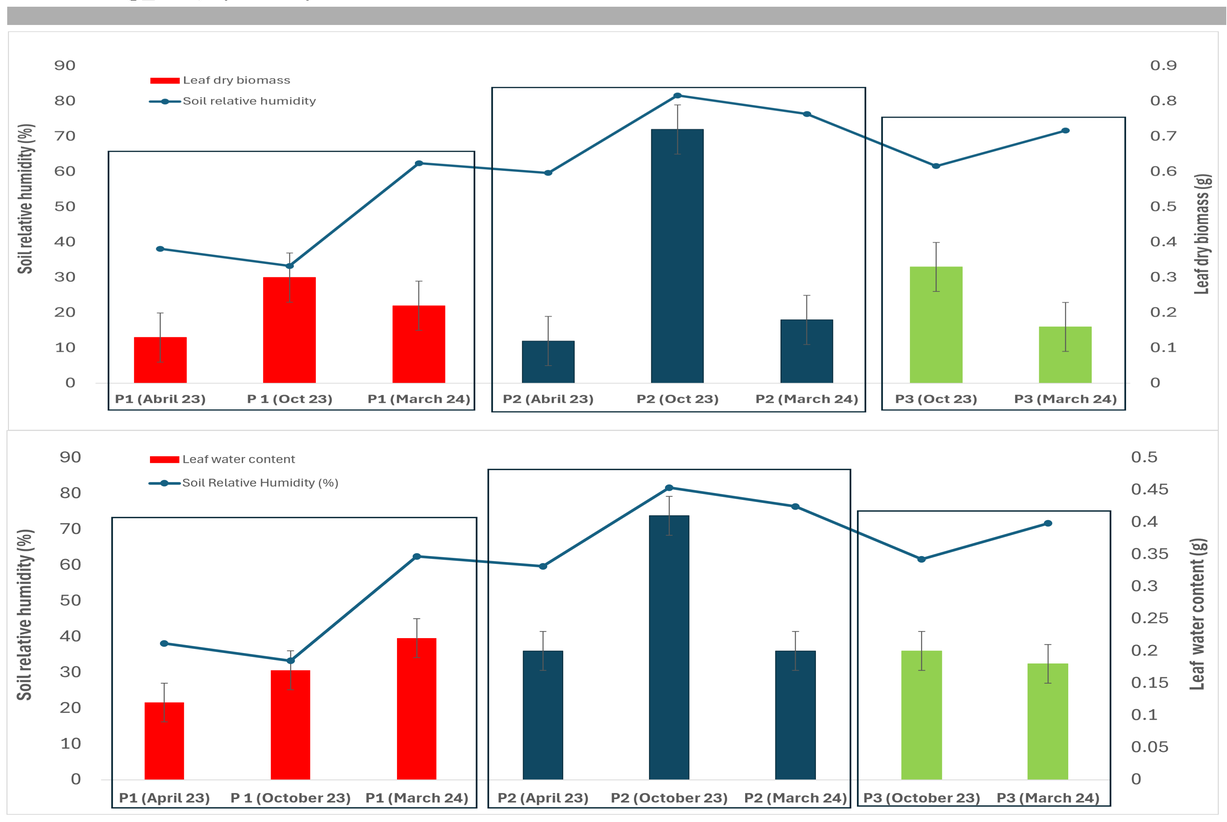


Figure 6: Soil relative humidity and its relation between leaf water content and leaf dry biomass in *S.monosperma* populations between study periods.

Analysis and Conclusion's

Analysis of *S. monosperma* populations reveals a clear interaction between leaf biomass, soil water content, soil relative humidity, and microclimate across populations with varying levels of interplant competition. Population 1, experiencing high competition, exhibits lower leaf biomass and water content, reflecting stress from competition and limited resource availability. Population 2, consisting solely of *S. monosperma*, shows the highest values of leaf biomass and water content, coinciding with higher soil moisture, which suggests a more favorable environment for growth. In Population 3, with moderate competition, intermediate values are observed for both biomass and water content. These results suggest that *S. monosperma* responds positively to low competition and higher humidity conditions, which could be critical for its management and conservation in its natural habitat.

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