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ESTUDO BIOMÉTRICO DE PITAYAS NO SEMIÁRIDO: IMPACTOS DA SALINIDADE E DA INCIDÊNCIA SOLAR

JAQUELINE DE MELO SANTOS SILVA[1]; GABRIELA GONÇALVES COSTA[2]; ANA CÉLIA MAIA MEIRELES[2]; ISADORA ÊDUA DA SILVA LIMA[2]; CARLOS WAGNER OLIVEIRA[2] E MILENA MARIA TOMAZ DE OLIVEIRA[3]

[1] Centro de Ciências Agrárias e da Biodiversidade (CCAB), Universidade Federal do Cariri (UFCA) Campus Crato, Rua Ícaro de Sousa Moreira, 126, Muriti, CEP: 63130-025, Crato-CE, Brasil, Jaqueline.melo@aluno.ufca.edu.br (https://orcid.org/0009-0001-0551-0224).

[2] Programa de Pós-Graduação em Desenvolvimento Regional Sustentável, Universidade Federal do Cariri (UFCA) Campus Crato, Rua Ícaro de Sousa Moreira, 126, Muriti, CEP: 63130-025, Crato-CE, Brasil, agro.gabrielacosta@gmail.com (https://orcid.org/0009-0003-7714-5275); isadora.edua@aluno.ufca.edu.br (https://orcid.org/0000-0002-3968-5639); ana.meireles@ufca.edu.br (https://orcid.org/0000-0002-8860-2043); carlos.oliveira@ufca.edu.br (https://orcid.org/0000-0003-1013-2974).

[3] Department of Plants, Soils and Climate, Utah State University, 4820 OId Main Hill. Logan, UT 84322-4820 UT, United States, milena.oliveira@usu.edu (https://orcid.org/0000-0001-7345-1003).

1 RESUMO

A Pitaya (*Hylocereus* spp.), planta da família das cactáceas, é exótica com grande adaptação ao semiárido. Contudo, conhecer os fatores que podem limitar seu desenvolvimento contribui para o desenvolvimento de técnicas de cultivos que proporcionam maior retorno produtivo. Nesse contexto, objetivou-se analisar biometricamente as plantas de pitayas submetidas a diferentes níveis de sal e sombreamento. O experimento foi conduzido em delineamento experimental inteiramente casualizado, em esquema fatorial 2x5, com condutividade elétrica de 0 adição de sal (T0), 2,5 dS m^{-1} (T1), 5 dS m^{-1} (T2), 7,5 dS m^{-1} (T3) e 10 dS m^{-1} (T4), em ambientes: sombreado – 50% (A1) e pleno sol (A2), com 4 repetições, totalizando 40 parcelas. As variáveis analisadas foram: número de cladódios (NC), soma do comprimento dos cladódios (SCC), diâmetro médio do cladódio (DMC) e diâmetro da costilha (DCOS). O ambiente sombreado proporcionou maior número de cladódio na condutividade elétrica de 5 dS m^{-1} do que o ambiente em pleno sol. O diâmetro da costilha foi maior em pleno sol do que as que estavam sombreadas até a salinidade 7 ,5 dS m^{-1} e o coeficiente de variação foi maior entre o número de cladódios e diâmetro médio do cladódio do que as outras variáveis.

Palavras-chave: Crescimento, sombreamento, morfologia.

SILVA, J. M. S.; COSTA, G. G.; MEIRELES, A. C. M.; LIMA, I. E. S.; OLIVEIRA, C. W.; OLIVEIRA, M. M. T.

BIOMETRIC STUDY OF PITAYA IN SEMI-ARID REGIONS: IMPACTS OF SALINITY AND SOLAR INCIDENCE

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2 ABSTRACT

Pitaya (*Hylocereus* spp.), a plant from the cacti family, is exotic and highly adaptable to semiarid regions. However, understanding the factors that can limit its development contributes to the development of cultivation techniques that provide greater productive returns. In this context, the objective was to analyze pitaya plants subjected to different levels of salt and shading biometrically. The experiment was conducted in a completely randomized experimental design with a 2x5 factorial scheme, with electrical conductivity of 0 addition of salt (T0), 2.5 dS m^{-1} (T1), 5 dS m^{-1} (T2), 7.5 dS m^{-1} (T3) and 10 dS m^{-1} (T4), in environments shaded with 50% (A1) and full sun (A2), with 4 replications, totaling 40 instalments. The variables analyzed were the number of cladodes (NC), sum of the cladode length (SCC), average cladode diameter (DMC) and rib diameter (DCOS). Compared with the full-sun environment, the shaded environment provided a greater number of cladodes at an electrical conductivity of 5 dS m^{-1}. The rib diameter was greater in full sun than in those shaded to a salinity of 7.5 dS $m^{-1,}$ and the coefficient of variation was greater between the number of cladodes and the average cladode diameter than the other variables were.

Keywords: Pitaya, salinity, semiarid, shading.

3 INTRODUCTION

Pitaya (*Hylocereus* spp.*), a member of the cactus family*, is an exotic fruit widely produced in countries such as Colombia, Mexico, and Vietnam (Froes Júnior *et al*., 2019; Araújo *et al*., 2021). Dragon berry, the name commonly used, is known for its ability to adapt well to hot and dry regions (Bicca, 2021), which are the main characteristics of semiarid regions. Therefore, pitaya cultivation has gained prominence in these regions because of its ability to adapt to adverse soil and climate conditions (Costa Júnior *et al*., 2023).

Pitaya has emerged in the fruit market as a super crop with great commercial potential and several cultivation benefits, such as low soil, water and nutrient requirements; easy establishment and maintenance of orchards; and the possibility of multiple fruit harvests per year and high net returns (Trivellini *et al*., 2020; Wakchaure *et al., 2023).* In Brazil, pitaya cultivation has shown promise because of the agricultural and economic potential of the crop. The states of São Paulo, Minas Gerais, Bahia, Paraná, and Goiás are the main producers of fruit; however, the Northeast Region has shown a potential increase in the planted area and pitaya production in recent years (Oliveira *et al*., 2024).

As it is a plant with the crassulacean acid metabolism (CAM) photosynthesis pathway, it adapts very well to the region's soil and climate conditions, making it a resilient crop option with high added value and good economic returns for small producers in the semiarid region of Brazil. Tropical semiarid regions suffer from high temperatures, high water deficit, poorly developed soils, and groundwater sources with a high presence of salts (Batistão *et al*., 2020), making agricultural production vulnerable and leading to significant economic losses (Moraes *et al*., 2019), compromising the sustainability and expansion of agricultural sectors (León; Ramírez; Leal, 2022; Lessa *et al*., 2023).

Low and irregular rainfall levels, combined with high evaporation, reduce the soil water availability for plants. To replenish water in the soil, irrigation is used, with water from deep wells that has high levels of salt, directly contributing to soil salinity through the accumulation of these salts on the surface or in the soil profile (Sousa *et al*., 2017), which can cause toxicity in plants and affect their growth and development (Dias *et al*., 2016).

Excess salt in irrigation water is a recurring problem that limits crop growth and production, especially in semiarid regions. Under saline stress conditions, plants may experience changes in their metabolic and biochemical activities due to the osmotic and ionic effects of excess salts in the root zone, with direct impacts on stomatal conductance and the photosynthetic rate and the inhibition of protein synthesis and enzymatic activities, in addition to increased chlorophyll degradation (Mendonça *et al*., 2022).

In addition, another important factor for good vegetative development is solar incidence, where providing a reduction in direct solar radiation on pitayas can allow for greater growth, as shown by Lone *et al. (2018)* in their experiment with pitaya plants that were under partial shade (between 23 and 42%) and increased the percentage of cladodes. In this context, Sabino *et al*. (2020) reported that shading can be an alternative way to circumvent excess light, since it reduces the amount of solar radiation incident on the surface of the leaves, reduces the temperature, the amount of energy absorbed and consequently the amount of water transpired, and can even help mitigate the harmful effects of salts on plants.

Therefore, analyzing how these salts and solar incidence impact plants is highly important for the development of cultivation strategies that reduce the negative effects of excess salts in the soil, thus increasing the productivity and quality of pitayas. Thus, the present study aimed to analyze pitaya plants subjected to different levels of salinity and shading biometrically.

4 MATERIALS AND METHODS

The experiment was carried out in the experimental field of the Center for Agricultural Sciences and Biodiversity (CCAB) of the Federal University of Cariri (UFCA) in Crato, CE, Brazil, (7°14'08” S latitude and 39°22'07” W longitude), at an altitude of 420 m, from October 2023 to April 2024. According to the Koppen classification, the climate of the region is of the Aw type, tropical with a dry winter (Matos, 2025).

Pitaya seedlings were obtained from adult plants, which were kept in the laboratory for healing for a period of 15 days. A total of 80 pitaya seedlings, with standardized heights between 20 and 30 cm, were planted in perforated polyethylene bags (15 × 25 cm) filled with a 1:1 substrate of washed sand and coconut fiber. The plants remained in a greenhouse with 50% shade and irrigation on alternate days for 90 days. Soon after this time, the seedlings were transplanted into pots with a capacity of 12 dm^3, which were filled with 10 dm^3 of a mixture of washed sand and cured cattle manure at a 1:1 ratio. Two seedlings were placed in each pot, and a drainage layer of approximately 1 cm in height, composed of crushed aggregate, was added. The pots were arranged in two environments with different levels of solar exposure: shaded (A1) and full sun (A2), with 20 pots (totaling 40 plants) allocated to each environment with a spacing of 2x2.

The experimental design used was completely randomized (CRD) in a 2x5 factorial scheme with 4 replications. The treatments included irrigation at different salinity levels, which was performed manually and on alternate days, with 3 L of saline solution per pot. The calculation of the irrigation volume to be applied was based on the pot capacity, previously determined for the container in which the seedlings were implanted, as well as for the substrate used.

The saline solution was stored in water tanks with a capacity of 500 L. The salinity levels adopted in the experiment were 0.26 dS m^{-1} (T0), 2.5 dS m^{-1} (T1), 5 dS m^{-1} (T2), 7.5 dS m^{-1} (T3) and 10 dS m^{-1} (T4), which were prepared via the following method: predilution in a bucket and mixing with the remaining samples in the reservoirs until they reached the ideal concentration; a portable pen conductivity meter was used for measurement.

At 180 days after transplanting (DAT), the development of the plants was analyzed according to the treatments by performing the following analyses: number of cladodes (NC) obtained by counting, sum of the length of the cladodes (SCC), obtained via a tape measure, and mean diameter of the cladode (DMC) and diameter of the rib (DCOS), both obtained with the aid of a digital caliper. The results were subjected to analysis of variance (ANOVA) via Sisvar software (Ferreira, 2019), and Tukey’s test and regression analysis were performed at 5% probability.

5 RESULTS AND DISCUSSION

According to the data obtained via analysis of variance (Table 1), the treatments applied did not promote significant differences in the variables analyzed. This effect may be associated with the high adaptability of the species to adverse conditions because it has the (creassulacean acid metabolism) CAM, which allows the plant to have efficient use of water, making it a crop adapted to these conditions (Mizrahi, 2014), or to the dilution effect of the treatments due to the rainy season in the region, which may have reduced the effect of salt accumulation as well as the incidence of direct sunlight on the plants.

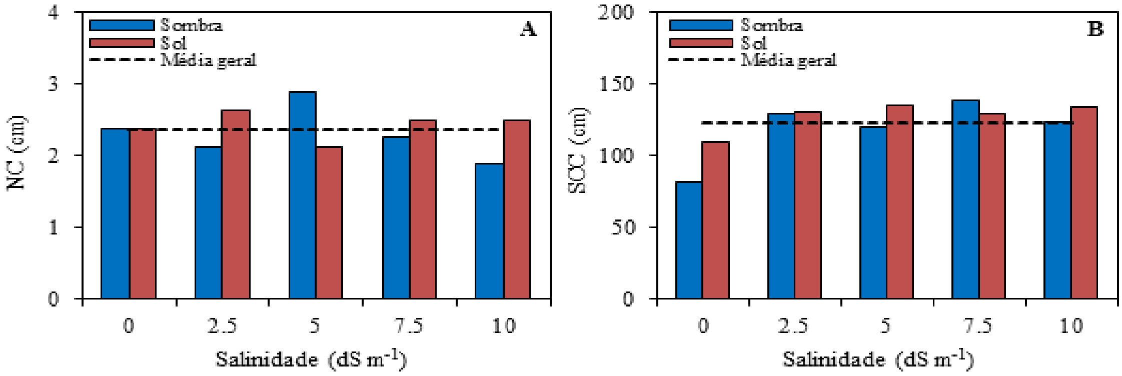
Table 1. Summary of analysis of variance for the number of cladodes (NC), sum of cladode length (SCC), mean cladode diameter (DMC) and rib diameter (DCOS) of pitaya as a function of salinity level and environment type

Source of Variation	**Degrees of Freedom**	**Mean Square**			
		NC	**SCC**	**DMC**	**DCOS**
Salinity (S)	1	0.156 ^{ns}	363,006 ^{us}	85,878 ^{us}	6,336 ^{us}
Environment (A)	4	0.100 ^{us}	544,584 ^{us}	62,525 ^{us}	19,364 ^{us}
S x A	4	0.594 ^{us}	288,241 ^{us}	48,209 ^{us}	15,613 ^{us}
Repetition	3	0.240 ^{us}	1248,290 ^{us}	128,137 ^{us}	42,768 ^{us}
Residue	27	0.865	337,577	52,656	13,634
CV	%	39.4	13.9	11.5	12.0

^{ns,} not significant.

To visually analyze the effects of the treatments on the variables studied, the data are represented in the graphs below. Figures 1A and 1B show the general average obtained for the number of cladodes (NC) and the sum of the lengths of the cladodes (SCC), respectively, as a function of the salinity level and the type of environment.

Figure 1. Overall means of data for the variables number of cladodes (A) and sum of cladode length (B) for pitaya crops as a function of salinity level and type of environment.

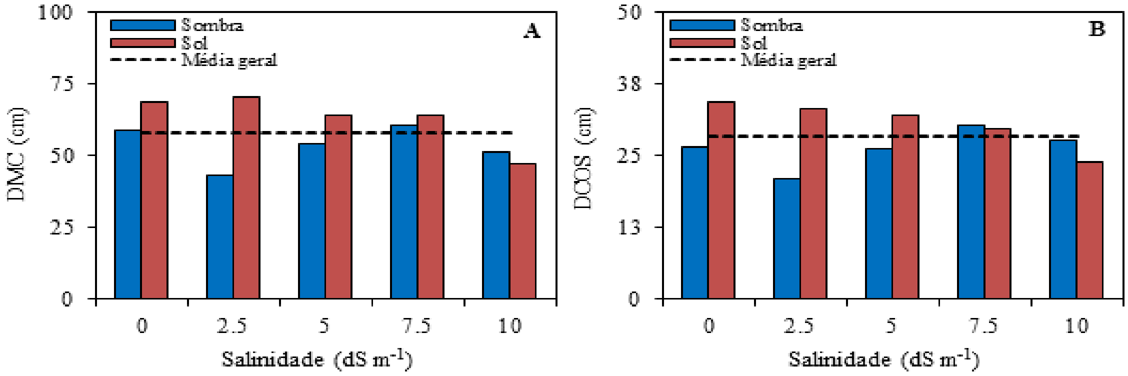


Source: Authors (2025)

The average number of cladodes was approximately 2 units per plant (Figure 1A). At a salinity level of 5 dS m $^{-1}$ in the shaded environment, the value was approximately 3 cladodes per plant (Figure 1A). The overall average length of the cladodes was 122.85 cm, with a maximum value of 138.5 cm obtained at a salinity of 7.5 dS m $^{-1}$ under shaded conditions (Figure 1B). Since neither the salinity level nor the environment statistically influenced the morphological variables analyzed, it is assumed that the pitaya may have presented tolerance to salinity variation, which may be a positive characteristic in semiarid conditions. In this context, Sousa *et al*. (2021) reported that these plants have mechanisms for adapting to adverse conditions due to osmotic adjustment. Osmotic adjustment occurs through the concentration of soluble organic compounds, such as carbohydrates and proline, which increases the efficiency of water and nutrient adsorption, with the solutes being amino acids or sugars (Taiz *et al*., 2017). The authors also state that, at high levels of salinity, plants exposed to the sun performed better.

For the variable mean diameter of cladodes (Figure 2A), the general mean observed was 58.1 cm, with a maximum value of 70.3 cm observed at a salinity of 2.5 dS m $^{-1}$ under full-sun conditions. Similar results were reported by Cavalcante *et al.* (2008), in which the lowest values for the diameter of pitaya cladodes under different salinity conditions were obtained in plants grown in a greenhouse.

Figure 2. Overall average data for the variables mean diameter of cladodes (A) and rib diameter (B) for pitaya cultivation as a function of salinity level and type of environment.



Source: Authors (2025)

For the rib diameter (Figure 2B), the overall average obtained was 28.4 cm, with a maximum value of 34.3 cm observed at a salinity of 0 dS m $^{-1}$ under full sun. In general, the variables related to plant size performed better under shaded conditions, whereas the variables related to cladode thickness were greater under full-sun conditions. These results are possibly related to greater growth in search of light by the plants and greater accumulation of water in the cladodes under shaded and full sun conditions, respectively.

6 CONCLUSIONS

No statistically significant differences were detected for the variables analyzed. However, plants under full sun presented numerically greater values for the average diameter of the cladodes and the rib diameter.

The number of cladodes and the sum of the lengths of the cladodes were highest for shaded plants.

The general averages obtained were 2 units and 122.85 cm for the number of cladodes and the sum of the cladode length, respectively, and 58.1 and 28.4 cm for the average cladode diameter and rib diameter, respectively.

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