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GERMINATION AND GROWTH OF *LUETZELBURGIA AURICULATA* (GERMAN) DUCKE SEEDLINGS ARE INFLUENCED BY WATER REGIME

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ABSTRACT

Objective: The present study aimed to evaluate the germination and growth of *Luetzelburgia auriculata* seedlings, depending on different water regimes.

Theoretical Framework: Global climate change has caused irregularities in rainfall distribution, resulting in reduced water availability, negatively affecting seed germination and plant growth. These factors raise concerns from an environmental and scientific perspective, highlighting the need to understand the behavior of species under adverse conditions of water restrictions.

Method: Five treatments were tested, corresponding to 20, 40, 60, 80 and 100% of the pot capacity, with four replicates of 25 seeds. The tests were conducted in the laboratory, using a gerbox type germination box, 100 g of Tropstrato substrate and a BOD type germination chamber, with a temperature of 25°C. The following variables were analyzed: First Count (PC), Germination (G), Germination Speed Index (IVG), Average Germination Time (TMG), Shoot Length (CPA), Root Length (CR), Diameter and Total Dry Mass (MST).

Results and Discussion: It was observed that *L. auriculata* seeds showed tolerance to low water availability, with higher germination and IVG percentages under 20% of the pot capacity, differing from the length of the aerial part that was more affected by the lower water availability. For root length, 100% of the pot capacity provided significant reductions. As for TMG, diameter and total dry mass did not show significant differences between treatments. Therefore, the germination and vigor of *L. auriculata* seeds demonstrated tolerance to low water levels, but for seedling growth, a new study with a longer duration is recommended.

Research Implications: Possibility of reducing the amount of water used in the germination process of the species under study.

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Originality/Value: Understand the adaptability of *Luetzelburgia auriculata* to water scarcity, a crucial aspect for the sustainability of the Caatinga ecosystem, a region vulnerable to desertification.

Keywords: Caatinga, Pau-Pedra, Climate Change, Water Deficit.

A GERMINAÇÃO E O CRESCIMENTO DE PLÂNTULAS DE *LUETZELBURGIA AURICULATA* (ALLEMÃO) DUCKE SÃO INFLUENCIADOS PELO REGIME HÍDRICO

RESUMO

Objetivo: O presente estudo objetivou avaliar a germinação e crescimento de plântulas de *Luetzelburgia auriculata*, em função de diferentes regimes hídricos.

Referencial Teórico: As mudanças climáticas globais têm causado irregularidades na distribuição de chuvas, consequentemente reduções na disponibilidade de água, interferindo negativamente na germinação de sementes e crescimento das plantas. Tais fatores, proporcionam preocupações do ponto de vista ambiental e científico, evidenciando a necessidade de conhecer o comportamento das espécies sobre condições adversas de restrições hídricas.

Método: Testaram-se cinco tratamentos, correspondendo a 20, 40, 60, 80 e 100% da capacidade de vaso, com quatro repetições de 25 sementes. Os testes foram conduzidos em laboratório, utilizando caixa do tipo gerbox para germinação, 100g de substrato Tropstrato e câmara de germinação tipo BOD, com temperatura de 25°C. Analisou-se as seguintes variáveis: Primeira Contagem (PC), Germinação (G), Índice de Velocidade de Germinação (IVG), Tempo Médio de Germinação (TMG), Comprimento da Parte Aérea (CPA), Comprimento da Raiz (CR), Diâmetro e Massa Seca Total (MST).

Resultados e Discussão: Observou-se que as sementes de *L. auriculata* apresentaram tolerância a baixa disponibilidade hídrica, com maiores percentuais de germinação e IVG sob 20% da capacidade de vaso, diferindo do comprimento da parte aérea que foi mais afetado pela menor disponibilidade de água. Para o comprimento da raiz, 100% da capacidade de vaso proporcionou reduções significativas. Quanto ao TMG, diâmetro e massa seca total não apresentaram diferenças significativas entre os tratamentos. Sendo assim, a germinação e vigor de sementes de *L. auriculata* demonstraram tolerância a baixos níveis de água, mas para o crescimento das plântulas, é recomendado um novo estudo, com maior período de duração.
Implicações da Pesquisa: Possibilidade de reduzir a quantidade de água utilizada no processo germinativo da espécie em estudo.

Originalidade/Valor: Compreender a adaptabilidade de *Luetzelburgia auriculata* à escassez hídrica, aspecto crucial para a sustentabilidade do ecossistema da Caatinga, uma região vulnerável à desertificação.

Palavras-chave: Caatinga, Pau-Pedra, Mudanças Climáticas, Déficit Hídrico.

LA GERMINACIÓN Y CRECIMIENTO DE PLÁNTULAS DE *LUETZELBURGIA AURICULATA* (ALLEMÃO) DUCKE ESTÁN INFLUENCIADAS POR EL RÉGIMEN HÍDRICO

RESUMEN

Objetivo: el presente estudio tuvo como objetivo evaluar la germinación y crecimiento de plántulas de *Luetzelburgia auriculata*, dependiendo de diferentes niveles de regímenes hídricos.

Marco Teórico: El cambio climático global ha provocado irregularidades en la distribución de las precipitaciones, reduciendo consecuentemente la disponibilidad de agua e interfiriendo negativamente en la germinación de las semillas y el crecimiento de las plantas. Estos factores plantean preocupaciones desde el punto de vista ambiental y científico, destacando la necesidad de comprender el comportamiento de las especies en condiciones adversas de régimen hídrico.

Método: Se utilizaron cinco tratamientos, correspondientes al 20, 40, 60, 80 y 100% de la capacidad de vaso, con cuatro repeticiones de 25 semillas. Las pruebas se realizaron en laboratorio, utilizando una caja tipo gerbox para germinación, 100g de sustrato Tropstrato y una cámara de germinación tipo BOD, con una temperatura de 25°C.

Se analizaron las siguientes variables: Primer Conteo (PC), Germinación (G), Índice de Velocidad de Germinación (IVG), Tiempo Medio de Germinación (TMG), Longitud de la parte aérea (CPA), Longitud de Raíz (CR), Diámetro y Masa Seca Total. (MST).

Resultados y Discusión: Se observó que las semillas de *L. auriculata* mostraron tolerancia a la baja disponibilidad de agua, con mayores porcentajes de germinación e IVG por debajo del 20% de la capacidad de campo, a diferencia de la longitud de la parte aérea, que se vio más afectada por la menor de la disponibilidad de agua. Para la longitud de las raíces, el 100% de la capacidad de campo proporcionó reducciones significativas. En cuanto al TMG, el diámetro y la masa seca total no mostraron diferencias significativas entre los tratamientos. Por lo tanto, la germinación y vigor de las semillas de *L. auriculata* demostraron tolerancia a bajos niveles de agua, pero para el crecimiento de plántulas se recomienda un nuevo estudio, con un período de tiempo más largo.

Implicaciones de la investigación: Posibilidad de reducir la cantidad de agua utilizada en el proceso germinativo de la especie en estudio.

Originalidad/Valor: Comprender la adaptabilidad de *Luetzelburgia auriculata* a la escasez de agua, aspecto crucial para la sostenibilidad del ecosistema de Caatinga, una región vulnerable a la desertificación.

Palabras clave: Caatinga, Pau-Pedra, Cambio Climático, Déficit Hídrico.

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1 INTRODUCTION

Water scarcity is currently the main environmental factor limiting plant growth and productivity worldwide. Global climate change is likely to further aggravate the water shortage, making it an even greater constraint factor for production in several regions (Chaves *et al.*, 2003). Climate projections predict stronger droughts and higher temperatures, especially in semi-arid regions such as the Caatinga, which occupies one of the largest areas of Seasonally Dry Tropical Forest (FTSS) in the world (IPCC 2023).

In the Northeast region of Brazil, plant species face several environmental factors that limit their growth and survival. Among these factors, water deficiency in the soil is highlighted as the main conditioning factor of vegetation, resulting from the high spatial and temporal variability of precipitation, combined with high temperatures (Moura *et al.*, 2013).

In this context, water deficiency is a stress factor that promotes changes in various morphological, physiological and biochemical aspects of plants (Sanches & Silva, 2013). Thus, studies concerning water deficiency in plants are fundamental for the understanding of mechanisms involved in drought tolerance by plant species (Silva *et al.*, 2019).

Given the accumulated deforestation caused by anthropic sources, there is currently a great demand for native species used in reforestation programs (Seabra *et al.*, 2022). In order

to speed up and facilitate the process of recovery of these areas, it is necessary to use native species that are well adapted to the environment and that can promote better results.

The *Luetzelburgia auriculata* (German) Ducke, belonging to the Fabaceae family, popularly known as pau-mocó, pau de chapada and pau-serrote (Flora and Funga, 2024). In the semi-arid region of Brazil, this species is used for medicinal purposes, in which it presents antimicrobial and cytotoxic activities (Vasconcelos, 2012), in addition to its wood being used in construction, joinery, firewood and charcoal (Lorenzi, 2008; Nogueira *et al.*, 2012). Added to such utilities, Lopes *et al.* (2021) highlight the species' potential for reforestation of degraded areas.

In view of the need to understand the drought tolerance mechanisms of plant species, such as *L. auriculata*, which are essential for the conservation of biodiversity and for the success of reforestation programs in degraded areas, the objective of the work was to assess the germination and growth of *L. auriculata* seedlings, according to different water regimes.

2 METHODOLOGY

The ripe fruit of *L. auriculata* were collected in 10 selected matrices in a fragment of open tree caatinga, in the rural community of Mocambo, in the municipality of Patos-PB. They were then transported to the Ecodendrology Laboratory of the Rural Health and Technology Center, belonging to the Federal University of Campina Grande, (CSTR/UFCG), where they benefited to obtain the seeds and carried out the experiment.

Initially, the moisture content of the seeds was analyzed by the greenhouse method at 105 ± 3 °C for 24 hours, according to the Seed Analysis Rule (Brazil, 2009), with three samples of 20 seeds, and calculated using equation 1:

$$\% (U) = \frac{100 (P-p)}{P-t} \qquad (1)$$

where:

P = initial weight, weight of the vessel and its lid plus the weight of the wet seed;
p = final weight, weight of container and lid plus weight of dry seed;
t = tare weight of the container with its lid.

For the simulation of the water regimes tested for the germination of seeds, the

maximum capacity (100% c.v.) of the substrate Tropstrato® (composed of vermiculite, pine peel, PG Mix 14-16-18 fertilizer, Potassium Nitrate, Simple Superphosphate and Peat) (Brazil, 2009) was determined for the volume of 100g of it, in which the quantity 80 ml of distilled water is conferred. Based on the amount of water for 100% of vessel capacity, the conditions for the water regimes of 80% (64 ml), 60% (48 ml), 40% (32 ml) and 20% (16 ml) of water available in the substrate were calculated, these being the five treatments tested.

For the germination test, the seeds were disinfested with 70% alcohol for five minutes, followed by washing in distilled water. After this stage, the seeds were arranged in a substrate moistened in the proportions mentioned above, in a container with transparent acrylic boxes of the gerbox type, and placed in a BOD germinator, programmed for a temperature of 25 ºC and a photoperiod of 16 hours.

The first germination count of the seedlings was carried out on the fifth day after sowing, and the evaluation was carried out until the germination stabilization occurred at 12 days after sowing. The Germination Percentage (PG) was obtained by dividing the number of seeds germinated (N) by the total number of seeds placed to germinate (A), calculated by the equation (Brazil, 2009): PG = N/A x 100. To determine the Germination Rate Index (GPI), it was from the sum of the number of seedlings that emerged each day (E1, E2, ..., En), divided by the number of days after sowing (N1, N2, ..., Nn) as proposed by Maguire (1962): GPI =(E1/N1)+((E2/N2)+ ...(En/Nn)

For the Mean Germination Time (GMT), the sum of the number of seeds germinated in a time interval (ni) was multiplied by the incubation time in days (ti), and then divided by the total number of seeds germinated (n), calculated by the equation proposed by Labouriau (1983): $TMG= (\Sigma n_i \times t_i)/ \Sigma n$.

Length of the Aerial Part (CPA) of the seedlings and Length of the Root (CR) were evaluated, both measured with a graduated ruler, diameter of the collection with the aid of a digital caliper and Total Dry Mass (MST) in grams, in which they were packed in kraft paper and taken to an oven at 65°C for 72 hours, followed by weighing in an analytical balance with precision of 0.0001g to determine the dry mass.

The experimental design used was the entirely casualized (DIC), with five treatments, these being the water regimes of 100% (80 ml), 80% (64 ml), 60% (48 ml), 40% (32 ml) and 20% (16 ml) of vessel capacity, considering 100 seeds per treatment, divided in four repetitions of 25. The data were submitted to the analysis of variance and the averages compared through the Tukey test at the level of 5% significance, with the help of the statistical software ASSISTAT version 7.7 (Silva & Azevedo, 2002).

3 RESULTS AND DISCUSSIONS

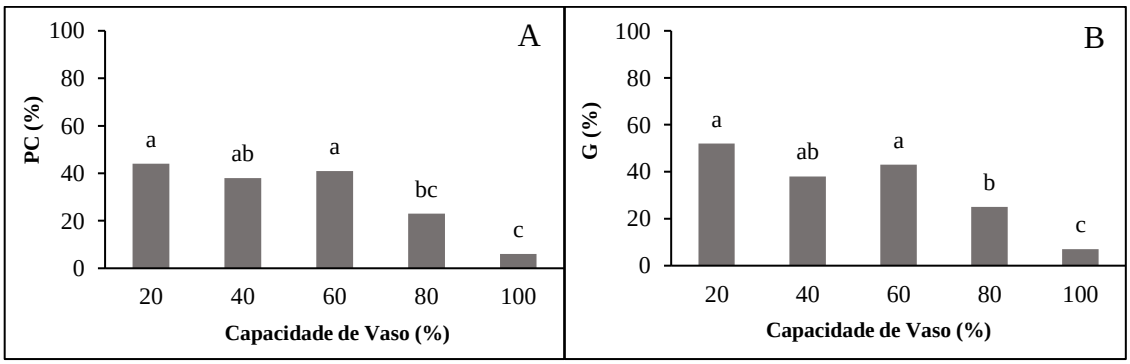
The seeds of *L. auriculata* after collection, presented low moisture content of 9.42%, demonstrating a characteristic found in the seeds of orthodox species. According to Carvalho, Silva and Davide (2006), the orthodox seeds remain viable after the desiccation period, and can reach up to 5% humidity, as well as being stored under low temperatures for a long period.

It was observed that there was a significant effect ($p \leq 0.05$) of water regimes for the variable of first counting carried out on the fifth day after sowing (Figure 1A). In this parameter, the seeds of *L. auriculata* showed a higher percentage when submitted to treatment with lower water availability (20% c.v.), reaching 44% germination. Contrary to seeds, when exposed to higher water availability (100% c.v.), a lower percentage was obtained, with only 6% germination.

This value of the first count reflected directly in the parameter germination percentage as a function of water regimes, in which the seeds submitted to 20% of c.v., at the end of the experiment reached 52% of the germination (Figure 1B). Similar results were also obtained for seeds submitted to 40% and 60% of the vessel capacity, with 38% and 43% of germination, respectively, not differing statistically from the highest percentage of germination.

Figure 1

First Count (PC) (A) and Germination (G) (B) of seeds of L. auriculata submitted to different water regimes.



*Averages followed by the same letter do not differ statistically by Tukey's test at the 5% probability level.

The increase in water availability to 80% and 100% of vessel capacity caused reductions in germination, reaching 25% and 7% of sprouted seeds, respectively. These results demonstrate that the species *L. auriculata* requires smaller volumes of water to trigger the germination process and can be recommended to compose areas of clearings, as highlighted by

Guedes *et al.* (2010). Reductions in the germination percentage of some species due to higher humidity are found in the literature (Ramos *et al.*, 2006; Martins *et al.*, 2012; Silva *et al.*, 2017).

A 45% reduction was observed between the highest and lowest germination percentage, which correspond to treatments with 20 and 100% of the vessel capacity, indicating the negative effect of high water levels on the germination of *L. auriculata* seeds. According to Leo *et al.* (2019), the reduction in germination of seeds under excess water is explained, as there is limitation in oxygen absorption, affecting seed metabolism and leaving more susceptible to attack by pathogens. Such justification affirmed by the aforementioned authors was also proven in the present study, with attack of pathogens, especially of fungi.

By preventing the penetration of oxygen in the seeds, as a consequence of excess moisture, it reduces the entire metabolic process, thus affecting germination (Floriano, 2004), besides influencing other factors, which reduce the viability of the seeds (Silva *et al.*[1]*, 2020).* However, although the treatment with lower water availability (20% c.v.) showed the highest germination percentage (52%), it is still considered low and can be attributed to an effect of the intense proliferation of fungi observed in all treatments during the conduct of the experiment.

Some species have seeds capable of germinating under water stress conditions, such a characteristic being considered as an advantage of the ecological point in relation to others that are sensitive to drought (Rosa *et al.*, 2005; Silva *et al.*, 2017). Possibly, the best results presented for seeds exposed to the most severe condition of moisture (20% c.v.), may be related to adaptations provided by adverse conditions of the environment under the matrices in which the seeds were collected for the germination tests. Furthermore, these results are important, as they make it possible to reduce the quantity of water necessary for the germination of seeds of *L. auriculata*, a primordial fatora at the moment, due to the water scarcity resulting from climatic changes.

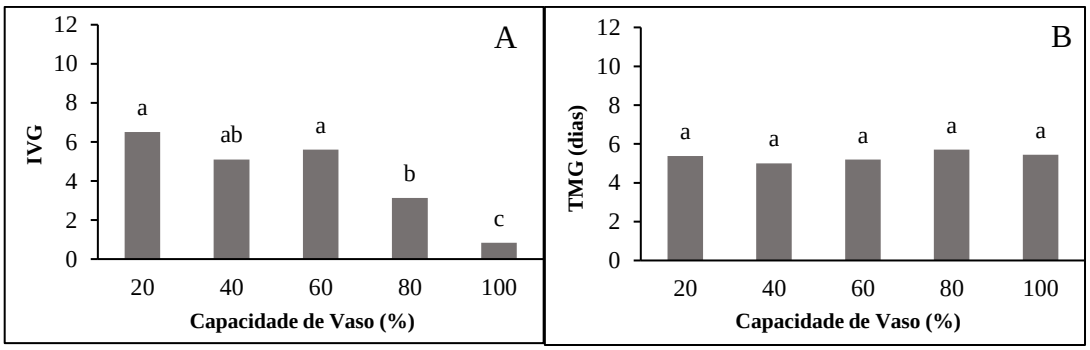
When the IVG was analyzed, similar behavior to that observed in the first count and in the percentage of germination was observed, with the germination process at a lower speed found in the highest levels of water (80% and 100% of vessel capacity), as shown in Figure 2A. This effect of excess water is corroborated by Ribeiro *et al.* (2023), in which *Schizolobium parahyba* seeds submitted to the substrate with higher volume of water, resulted in germination over a longer period of time.

The largest GMT was found for the treatment with 80% of the vessel capacity, in which the seeds took about 5.7 days to germinate (Figure 1B). However, despite the higher GMT presented in this treatment, it did not differ statistically from the other tests. In this way, it is possible to state that for the parameter average germination time in the seeds of the species

under study, it is independent of the amount of water available. It is necessary to highlight that in laboratory conditions germination for prolonged periods can be harmful (Oliveira *et al.*, 2015), and the action of pathogens that can affect the germination process may occur.

Figure 2

Germination Rate Index (IVG) (A) and Mean Germination Time (TMG) (B) of L. auriculata seeds submitted to different water regimes.



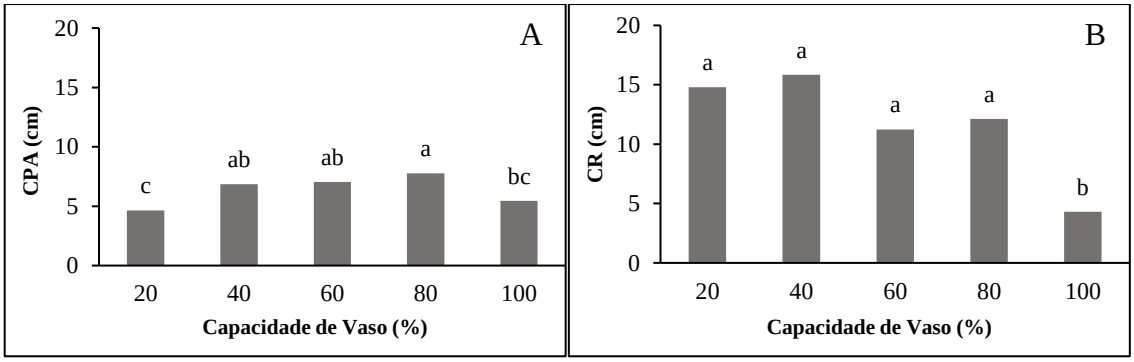
*Averages followed by the same letter do not differ statistically by Tukey's test at the 5% probability level.

In relation to seedlings, the mean values of compliance of the aerial part, the L. *auriculata* seedlings showed different behavior in the different water regimes evaluated, in which treatments with 40, 60 and 80% of vessel capacity obtained the highest values, with 6.85, 7.03 and 7.76 cm, being statistically similar among themselves (Figure 3A). The length of the upper part of the seedlings was negatively affected when the seeds were exposed to 20% of the vessel capacity. When comparing the treatments, it was observed that there was a reduction of 40.23%, indicating the negative effect of the low availability for the length of the part of the seedlings of the species studied.

According to Taiz and Zeiger (2004), one of the main effects caused by water stress is the reduction in growth caused by the decrease in cellular expansion. With this, it is possible to say that the length of the part of the air of the seedlings was more affected than germination, when submitted to extreme conditions of humidity (20 and 100% of the vessel capacity).

Figure 3

Length of the Aerial Part (CPA) (A) and Root Length (CR) (B) of L. auriculata seedlings submitted to different water regimes.



*Averages followed by the same letter do not differ statistically by Tukey's test at the 5% probability level.

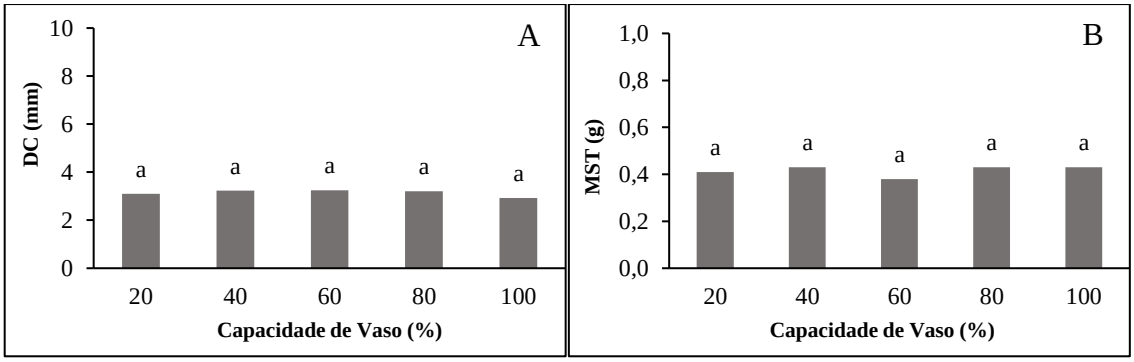
In Figure 3B, it is found that treatments of 20 to 80% of vessel capacity presented the largest root lengths, showing no significant differences among themselves, but differed from treatment with 100% of vessel capacity. When comparing the obtained data, it was observed that root growth is less affected by water restriction than the tissues of the aerial part.

Seedlings when exposed to water deficiency, growth and cellular expansion of the aerial part are inhibited, while root growth is benefited (Hsiao & Xu, 2000). With the reduction of water potential in the roots, osmotic adjustment occurs quickly to enable partial turgescence recovery (Lima & Ribeiro, 2021), such adjustments allow the roots to continue growth even in low water availability.

For the diameter of the collector, it was observed that regardless of the water regime used, the values were statistically equal (Figure 4A). However, the use of water simulating 60% of the vessel capacity made it possible to obtain the largest diameter (3.2 mm).

Figure 4

Diameter (A) and Total Dry Mass (MST) (B) of L. auriculata seedlings submitted to different water regimes.



*Averages followed by the same letter do not differ statistically by Tukey's test at the 5% probability level.

When the total dry mass was analyzed, the same behavior was observed as the variable mentioned above, in which regardless of the water regime used, the values were statistically equal (Figure 4B). This non-significance for total dry mass between treatments may be related to the short driving time and analysis of the study, due to the volume of substrate of the gerbox boxes, besides that, between the parameters of length of the aerial part and root, the same treatments presented the highest values, so that it provided similar values statistically in the production of total dry mass.

However, unlike the diameter of the colect, the lowest average total dry mass was obtained in the seedlings under 60% water availability. Furthermore, even with the expressive reduction in root length for the seedlings of the treatment with 100% c.v., it was statistically similar to the other treatments for the parameter production of total dry mass.

Based on the results presented it is necessary to highlight that the habitat is a determining factor in the physiology of the species and its establishment (Silva *et al.*, 2016). According to Barros, Dantas and Angelotti (2023), characteristics such as the influence of the habitat can be highlighted by the species of the Caatinga, emphasizing the adaptive potential of these to the climatic conditions.

With this, the higher values found in some parameters for seeds under simulation of 20% of the vessel capacity, was positive, because according to Bewley and Black (1994), water stress, under natural conditions, does not always act in a negative way, being able to act in the establishment of the species and in the distribution of germination over time, thus allowing the species to survive in adverse conditions. Such characteristics are fundamental for environments with problems of water restrictions, like some areas of the Caatinga biome.

4 CONCLUSION

The germination and vigor of *L. auriculata* seeds decreased with increasing amount of water available in the substrate, demonstrating tolerance to low water levels.

The results regarding the parameters of seedling growth varied according to the water regime tested, and a new study with a longer evaluation period was needed that would last until the seedling phase.

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