

## Original Research Article

# Overcoming seed dormancy of *Enterolobium Contortisiliquum* (Vell.) Morong

### ABSTRACT

The use of new methods may facilitate the production of seedlings for reforestation since the seed market is scarce, seedlings take time to be produced and the Earpod tree is a native species that can be used for the floristic recomposition of the biome and also with the possibility of using wood for commercial purposes. In this sense, the present work aimed to evaluate different methods of overcoming dormancy of the species *Enterolobium contortisiliquum* (Vell.) ~~Mf.~~ Morong. Seven treatments were performed with 5 replications. T0: Control, T1: Mechanical scarification with a rasp, T2: Mechanical scarification with welding electric appliance, T3: Mechanical scarification with cutting pliers, T4: Chemical scarification with sodium hydroxide 30% for 25 minutes, T5: Chemical scarification with sodium hydroxide 30% for 30 minutes, T6: Immersion in 100 °C water for 7 minutes. The following characteristics were evaluated: percentage of emergence, emergence speed index (ESI), the height of seedlings, number of leaves per seedling, stem diameter, and length of a root system. The mechanical scarification method with cutting pliers was the most efficient, with an emergence percentage of 96% and plant emergence speed indexes of 9.79. The treatments, chemical scarification with sodium hydroxide 30% for 30 minutes, chemical scarification with sodium hydroxide 30% for 25 minutes, and Control showed low efficiency in overcoming dormancy, with an emergence percentage of 2, 6, and 4% and emergence rates of 0.14, 0.37 and 0.24.

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Keywords: Germination, emergence, growth, seedlings.

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### 1. INTRODUCTION

The Earpod tree of the scientific name *Enterolobium contortisiliquum* (vell.) Morong belongs to the family Fabaceae and can be found in several regions of Brazil. Its height can reach up to 35 m presenting loss of leaves during winter in dry regions. This species can be indicated even for the recovery of degraded areas because it provides greater efficacy in the use of water and soil nutrients by biological nitrogen fixation [1].

Earpod tree seeds show behavior with 90% germination when stored from 3° C to 5° C and 92% RH (relative humidity) and 50% germination after nine years of storage [2]. In addition, they present dormancy, which is a characteristic that causes seeds to germinate in the period more appropriate to their development, allowing plant species to survive conditions that hinder or prevent their vegetative growth. Dormancy is considered a strategy for perpetuation of the species, especially those in the early stage of ecological succession. However, it becomes a hindrance outside the natural environment, because this mechanism causes germination to occur in an uneven way, which can subject the seed to fungal attacks, making them unfeasible [3].

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The dormancy mechanism presents particularities, making it difficult to generalize its causes, as there are variations depending on the cultivated species, edaphoclimatic conditions, seed processing, and storage conditions. Thus, the choices of efficient treatments for the overcoming of dormancy also vary, being the most used treatments: chemical, thermal, and mechanical [4].

Earpod tree seeds have tegumentary numbness, a type of numbness that can be interrupted by mechanical or chemical scarification [2]. This is the result of the impermeability of the integuments of the seed or fruit to water. The use of methods to overcome dormancy when performed properly can

facilitate the germination of seeds of species that present impediments in germination. The understanding of germination processes, especially those seeds with tegumentary dormancy, can offer support for seedling production [5].

For each species, there is a more effective dormancy overcoming treatment, because the thickness of the waterproof layer influences the dormancy and efficiencies of pre-germinative treatments. Among the methods, there is scarification, immersion in water or acids, **desponte**, pre-cooling, and stratification. For the treatment used integumentary dormancy, chemical and mechanical scarifications stand out, using sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) and sandpaper, respectively, because they often present the best results regarding the high percentage of germination [4].

Besides providing a higher germination rate, these scarification modalities also induce an increase in germination speed. This is because it is directly associated with the speed with which the water that enters is absorbed, due to the integumentary wear caused by scarifications, accelerating the stages of the embrasure, activation of metabolic processes, and germination [6].

Thus, the use of new methods can facilitate the production of seedlings for reforestation, since the seed market is scarce, seedlings take time to be produced and the Earpod tree is a native species that can be used for the floristic recomposition of the biome and also with the possibility of using wood for commercial purposes. In this sense, the present work aimed to evaluate different methods of overcoming dormancy of the species *Entererolobium contortisiliquum* (Vell.) Morong

## 2. MATERIAL AND METHODS

The experiment was conducted in the municipality of Alexânia - GO, carried out in protected but uncontrolled cultivation, in a space of 15 m<sup>2</sup>, being five meters long and three meters wide (Figure 1).



**Fig. 1.** - Experimental area for seedling **cultivation**. source: (author himself, 2021).

The seeds were acquired in the Nursery Seed of Brazil. **Soil (dystrophic Red Latosol)** was used for the substrate composition. Seeds underwent different forms of scarification (Table 1).

**Table 1.** Treatments for overcoming dormancy in Earpod tree seeds (*Entererolobium contortisiliquum*) and their respective identifications

Treatments	Identification
T0	Control
T1	Mechanical scarification with rasp
T2	Mechanical scarification with electric welding apparatus
T3	Mechanical scarification with cutting pliers
T4	Chemical scarification with sodium hydroxide 30% for 25 minutes
T5	Chemical scarification with sodium hydroxide 30% for 30 minutes
T6	Immersion in water at 100 °C for 7 minutes

Seven treatments were performed with 5 replications. **In each scarification treatment distributed 100 Seeds of Earpod tree**, being separated into five replicates, each repetition containing 10 containers

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(perforated bags of polyethylene with dimensions of 15x28, is 15 cm in diameter, and 28cm deep; in each container was sold 2 seeds to the depth of 1 cm). Two waterings were performed daily, one in the morning and one at the end of the day, due to the need for water for the initial development of the seedling.

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After 30 days, when the seedling was more developed, the watering was reduced to only once a day until the seedlings reached the point of going to the field after being done a thinning, leaving in each container only the most vigorous seedling, in search of reaching a batch of seedlings with higher quality, enabling better results in the characteristics to be evaluated.

## 2.1 Seedling Reviews

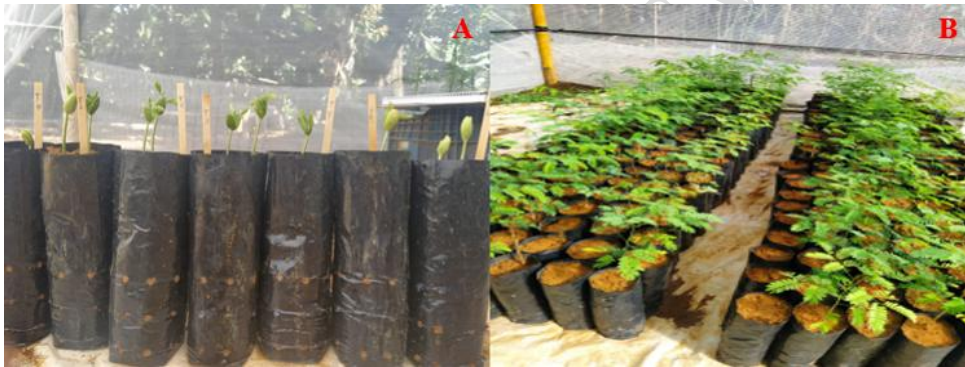
All evaluations on morphological characteristics of the seedlings were evaluated 105 days after sowing, except for the variable's emergence time and emergence speed index. The observation of the emergency time started from the first day after sowing and extended to the twenty-fourth day, being observed every day.

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- **Emergence (%)** – Observation of the emergency time started from the first day and lasted until 24 days after sowing (Fig. 2A). The criterion used was that of normal seedlings that presented the perfect essential structures [7].

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**Fig. 2.** - Seedling emergence assessment (A), Monitoring seedling growth for Emergence Speed Index calculations (B). Source: (Author Himself, 2021).

- **Emergence speed index (ESI)** – after the seedlings emerged, daily observation was carried out until the twenty-fourth day (Fig. 2B), obtained using the formula, suggested by [8].  $ESI = E1/N1 + E2/N2 + \dots + En/Nn$ . Where: E1, E2, ... En = number of normal seedlings computed at the first count, up to the last count. N1, N2, ... Nn. = the number of days from sowing to the first, until the last count.
- **Plant height**– plant height was considered, the distance between the base of the plant and the apical gem with a millimeter ruler (Fig. 3A).



**Fig. 3.** - Plant height assessment (A) and the number of leaves seedling<sup>-1</sup>. Source: (Author Himself, 2021).

- **Number of leaves seedling<sup>-1</sup>**– counting the number of leaves present in each seedling of each treatment (Figure 3B).
- **Stem diameter**– with the aid of a caliper, the diameter of the stem was measured in the region of the plant neck (Fig.4A).



**Fig. 4.** - Evaluation of seedling stem diameter (A) and length of the root seedling system (B). Source: (Author Himself, 2021).

- **Length of root system** - Due to the root system of the plant being pivoting type, the maximum depth that its root will reach 105 days after sowing was evaluated, with the use of a ruler (Fig. 4B).

## 2.2. Statistical Analysis

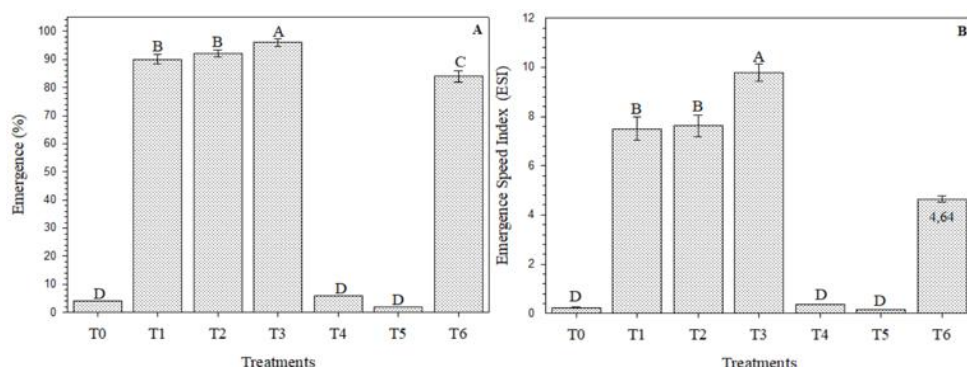
The results obtained were submitted to analysis of variance (ANOVA) and the means compared by the Tukey test ( $P \leq 0.05$ ), using the software Sisvar version 5.6 [9]. The graphics were plotted using sigmaplot software version<sup>®</sup> 10<sup>®</sup> [10].

## 3. RESULTS AND DISCUSSION

The use of different methods of overcoming dormancy in the Earpod tree (*Enterolobium Contortisiliquum* Vell Morong) promoted significant effects ( $p \leq 0.05$ ) with improvement in the initial development of the crop, which directly reflected no plant growth. Thus, about these evaluated characteristics, there was a difference in the characteristics of emergence percentage and emergence speed index, and length of the root system, not statistically different from the results of the other characteristics.

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**Fig. 5.** - Emergence percentage (A) and Emergence Speed Index (B) (24 days after sowing) of Earpod tree seeds (*Enterolobium contortisiliquum* Vell Morong) in different dormancy overcoming methods. T0: Control; T1: Mechanical scarification with a rasp; T2: Mechanical scarification with electric welding apparatus; T3: Mechanical scarification with cutting pliers; T4: Chemical scarification with sodium hydroxide 30% for 25 minutes; T5: Chemical scarification with sodium hydroxide 30% for 30 minutes; T6: Immersion in water 100 °C for 7 minutes.

The emergence of Earpod tree seeds had a lower percentage in the methods, T5: Chemical scarification with sodium hydroxide 30% for 30 minutes with 2% (Fig. 5A), T4: Chemical scarification with sodium hydroxide 30% for 25 minutes with 6%, and T0: Control with 4% both lower than the best result, T3: Mechanical scarification with cutting pliers with 96% germination, which shows an average superiority of 92% over the others, other methods that may be taken into account are T1: Mechanical scarification with rasp with 90%; T2: Mechanical scarification with electric welding apparatus 92% and T6: Immersion in water 100 °C for 7 minutes with 84%.

Performed mechanical scarification techniques using water sandpaper n°120 and puncture on the opposite side of the primary root protrusion with pyrograph and stated that such methods promoted a higher rate of emergence of Earpod tree seedlings, recommending both types of mechanical scarification because they are less costly [11].

Regarding the emergence speed index, the results differed statistically (Fig. 5B). The highest ESI values were observed in scarified seeds using the T3: Mechanical scarification with cutting pliers; with an average amount of plants emerging per day of 9.79. With a total of about 3833.49% higher than the means of the lowest results. This corroborates the results of [12] who found a better response from ESI with the mechanical scarification method, being more efficient in overcoming the dormancy of *Hymenaea stigonocarpa*, with plant emergence rates ranging from 92.31 to 100%, surpassing the other methods.

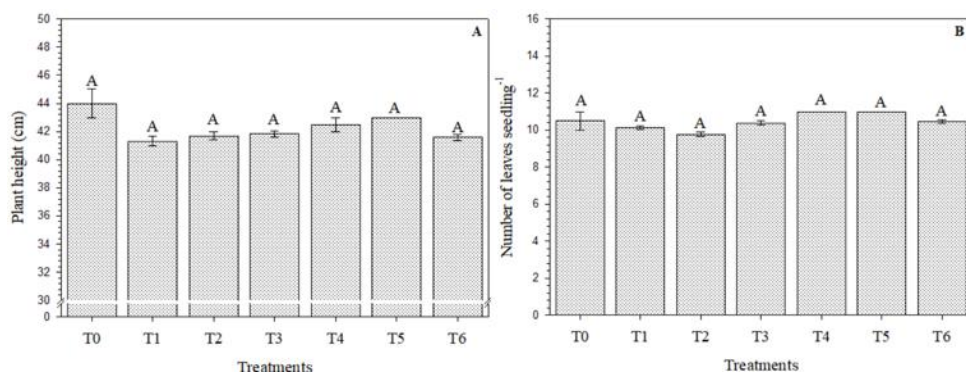
T4 treatments: Chemical scarification with sodium hydroxide 30% for 25 minutes with 0.37 and T0: Control with 0.24 and T5: Chemical scarification with sodium hydroxide 30% for 30 minutes with 0.14 both lower than the best result. In studies conducted by [13] Chemical scarifying with sodium hydroxide in a period of 20 and 40 minutes has negative effects on emergence speed indices in species of the Fabaceae family, resulting in about 900% lower treatments with mechanical scarification. The other methods, T1: Mechanical scarification with rasp presented ESI of 7.50; T2: Mechanical scarification with electric welding apparatus with 7.62 and T6: Immersion in water at 100 °C for 7 minutes with 4.64.

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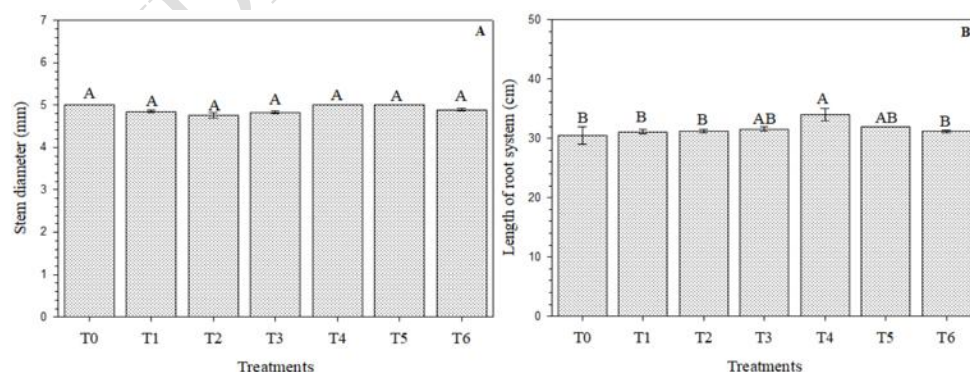
**Fig. 6.** - Plant height (A) and the number of leaves seedling<sup>-1</sup> (B) (*Enterolobium contortisiliquum* Vell Morong) at 105 days of age, in different methods of overcoming dormancy. T0: Control; T1: Mechanical scarification with a rasp; T2: Mechanical scarification with electric welding apparatus; T3: Mechanical scarification with cutting pliers; T4: Chemical scarification with sodium hydroxide 30% for 25 minutes; T5: Chemical scarification with sodium hydroxide 30% for 30 minutes; T6: Immersion in water 100 °C for 7 minutes.

In general, the height of the seedlings **plant height** was not a significant difference between the treatments evaluated (Fig. 6A), being that the treatment T0: Control has the highest height with 44 cm, but given the fact that this was the one that was obtained the lowest amounts of plants making the competition for space was lower about the other treatments that obtained an average of 42 cm in height when analyzing the final results, this variable was not influenced, being statistically **similar** ( $P \leq 0.05$ ).

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What may explain the results of plant height is the fact that the amounts of plants present in the treatments, ends up resulting in competition by space, thus being able to suppress the growth of plants when in larger amounts, so even the variables with the lowest germination rates have sizes similar to the most germinated ones. In a study conducted by [14] with *Enterolobium contortisiliquum* (Vell.) Morong, defined the ideal number of 24 plants for better development of plant height, mainly due to competition for space in its development.

Regarding the number of leaves per earpod tree plant, there was no statistical difference ( $P \leq 0.05$ ) between treatments for these variables, which demonstrates that regardless of the method used are variables that will not be negatively affected (Fig. 6B). Even without variation between treatments it is important to highlight the importance of the number of leaves that is a factor entirely linked to the development of the plant since they are the main place where photosynthesis occurs, and because they are the reserve center, auxin source, and rooting cofactors are transferred to the base, so they also help to form new tissues, such as the roots, so they are more important than the stems [15].



**Fig. 7.** - Stem diameter (A) and length of the root system (B) (*Enterolobium contortisiliquum* Vell Morong) at 105 days of age, in different methods of overcoming dormancy. T0: Control; T1: Mechanical scarification with a rasp; T2: Mechanical scarification with electric welding apparatus; T3: Mechanical scarification

with cutting pliers; T4: Chemical scarification with sodium hydroxide 30% for 25 minutes; T5: Chemical scarification with sodium hydroxide 30% for 30 minutes; T6: Immersion in water 100 °C for 7 minutes.

The means of the variable diameter of the earpod tree seedling stem did not obtain a statistical difference ( $P \leq 0.05$ ) between treatments, which demonstrates that regardless of the method used are variables that will not be negatively affected (Fig. 7A). The stem diameter is an important item to evaluate the survival and growth potential of seedlings of forest species after planting, plants with larger diameters in the same species have a higher survival rate, as they can form and develop new roots. Although the results have not differed between treatments, it is an extremely important variable, because the thickness of the stem is a good indicator of the quality of the seedlings and has a strong correlation with the survival rate of the seedlings [16].

The characteristic length of the root system was where statistical differences were obtained between treatments, being, T4: Chemical scarification with sodium hydroxide 30% for 25 minutes the highest result with 34 cm being on average 11.47% higher than Control (Fig. 7B). Followed by treatments T3: Mechanical scarification with cutting pliers and T5: Chemical scarification with sodium hydroxide 30% for 30 minutes, not failing to highlight that among these, only the T3 treatment obtained high rates of plant emergence.

In this study, we see the treatments with the worst results in germination with the smallest number of plants in the area, demonstrated equality between treatments in root growth, and it is also important to highlight that the higher the volume of soil exploited by the roots, the greater its development and the greater the amount of water absorbed by the plant in addition to that the deeper the root system and the thinner and branched the roots [17].

It is noted that the *species Enterolobium contortisiliquum* Vell Morong responded in different ways to treatments, as well as verified in the same family in kind by [18]. What may explain the results are the characteristics of the seed integument, such as the structure or conformation of the inhibitory tegumentary layer, as well as the level of dormancy that may vary depending on the situation in which the seed is [19]. Therefore, the time required to break the integument and make it permeable varies with the seed lot and the evaluated species [20]. State that the success of dormancy breakage treatment depends on the degree of numbness, which varies according to each species [21].

Taking into account all the data collected, it was verified that the different methods of overcoming dormancy are effective in what is proposed, but only the Method T3: Mechanical scarification with cutting pliers, was superior to the others, being the most effective for the initial development of the culture. However, we emphasize the need for further research that investigates beyond the aspects observed and correlated in this study, aiming to guide the use of these methods in earpod tree culture, presenting the effects promoted in plants and their advantages.

#### 4. CONCLUSION

The mechanical scarification method with cutting pliers was the most efficient in overcoming earpod tree dormancy (*Enterolobium contortisiliquum* Vell Morong), with an emergence percentage of 96% and plant emergence speed rates of 9.79, surpassing the other treatments.

The treatments, chemical scarification with sodium hydroxide 30% for 30 minutes, chemical scarification with sodium hydroxide 30% for 25 minutes, and Control showed low efficiency in overcoming dormancy, with an emergence percentage of 2, 6, and 4% and emergence rates of 0.14, 0.37 and 0.24, respectively.

The variables seedling height, stem diameter, and the number of leaves were not influenced by treatments, not differing statistically from each other.

#### REFERENCES

1. Vasconcelos WM, Lambert ACA, Miranda SC, Souza PB, Barreira S. Alternative tests to evaluate the physiological viability of *Enterolobium contortisiliquum* (Vell.) Morong seeds. Pubvet Magazine, Veterinary Medicine and Animal Science, v. 14, no. 8, p.1-6, 2020.

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2. Melo JLA, Ferreira VM, Araújo JC, Neves MIRS. ~~(2019)~~. Biometric characterization and seed dormancy in giant mimosa [*Mimosa bimucronata* (DC) O. Kuntze]. Australian Journal of Crop Science, v. 12, no. 1, p. 108–115.
3. Silva MF, Silva JN, Alves RF, Silva EF, Silva MAD. Alternative methods to sulfuric acid to overcome dormancy in *Enterolobium contortisiliquum* (Earpod tree) seeds. Research, Society and Development, v. 9, n.8, p. 541986126, 2020.
4. Fonseca DR, Abreu CAA. Seed dormancy: types, importance and factors that affect it. Seminar on use and conservation of southern Mato Grosso do Sul, 6th, 2017, Mato Grosso do Sul. Anais... Mato Grosso do Sul: Federal University of Mato Grosso do Sul, Juti, 2017. p.1-9. ISSN: 23179368.
5. Freire AA, Ataíde DHS, Rouws JRC. Overcoming dormancy of seeds of *Albizia pedicellaris* (DC) L. Rico forest and environment, v. 23 p. 251-257.
6. Araujo AV, Silva MAD, Ferraz APF. Overcoming dormancy of *Libidibia ferrea* seeds. Magistra, v29. no. 4. p. 298-304. 2018
7. BRAZIL. Ministry of Agriculture, Livestock and Supply. Rules for Seed Analysis. Brasília: MAPA/ACS, 2009. 395p.
8. Popinigis, F. 1985. Seed physiology. 2nd ed. Brasília, DF: Abrates, 298p
9. Ferreira DF. Sisvar: a computer statistical analysis system. Science and Agrotechnology, Lavras, v. 35, no.6, p. 1039-1042, 2011.
10. SYST. Sigmplot 10 User Manual, Windows, 2014.
11. Rocha AKP, Da Silva JN, Alves RMA, Freire AS, Pinto MADDC. Impermeability of *Enterolobium contortisiliquum* seeds: pre-germination treatments. II Brazilian Congress of Agricultural Sciences – COINTER, 2017, Recife. Anais... Recife: Federal Rural University of Pernambuco – Recife, 2017.
12. Ribeiro EA, Freitas GA, Freitas MABP, Santos ACM, Bessa NGF, Silva RR. Sustainable methods to overcome dormancy in *Jatobá do Cerrado* seeds. Agricultural Technology & Science, v. 11, no. 6, p. 119–124, 2017.
13. Cipriani B, Garlet J, Lima BM. Dormancy breaking in *Chloroleucon acacioides* and *Senna macranthera* seeds. Journal of Agrarian Sciences, v. 42, no. 1, p. 49–54, 2019.
14. Cargnelutti Filho A, Araujo MM, Gasparin E, Foltz DRB. Sample size for height and diameter evaluation of timbauva plants. Forest and Environment, v. 25, no. 1, p. 1–9, 2018.
15. Taiz L, Zeiger E. Plant physiology and development. 6. ed. Porto Alegre: Artmed, 2017.
16. Marana JP, Miglioranza E, Fonseca EP. Quality of jaracatiá seedlings submitted to different periods of shading in a nursery. Tree Magazine, v. 39, no. 2, p. 275–282, 2015.
17. Pes LZ, Arenhardt MH. Plant Physiology. Santa Maria, RS: Federal University of Santa: Colégio Politécnico, Rede e-Tec Brasil, 2015
18. Braga L, Sousa M, Braga J, Delachave ME. Acid scarification, temperature and light in the germination process of *Senna alata* (L.) Roxb seeds. Brazilian Journal of Medicinal Plants, v. 12, no. 1, p. 1–7, 2010.
19. Oliveira OS. Forest seed technology: native species. Ed. of the UFP ed. Curitiba: Embrapa Forests (CNPf), 2012.
20. Zaidan LBP, Barbedo CJ. Breaking dormancy in seeds. In: Ferreira A, Borghetti F. (Eds.). Germination: from basic to applied - Agrolibros. Porto Alegre: Artmed, 2004. p. 135–146.

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21. Silva AC, Santos JL, D'arède LO, Morais OM, Costa EM, Silva EAA. Biometric characterization and dormancy breaking in *Chloroleucon foliolosum* (Benth.) G. P. Lewis seeds. *Brazilian Journal of Agricultural Sciences*, v. 9, no. 4, p. 577–582, 2014.

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