EVALUATION OF SCHIZOLOBIUM AMAZONICUM SEED GERMINATION AS A FUNCTION OF DIFFERENT DORMANCY-BREAKING TREATMENTS

AVALIAÇÃO DA GERMINAÇÃO DE SEMENTES DE SCHIZOLOBIUM AMAZONICUM EM FUNÇÃO DE DIFERENTES TRATAMENTOS DE QUEBRA DE DORMÊNCIA

EVALUACIÓN DE LA GERMINACIÓN DE SEMILLAS DE SCHIZOLOBIUM AMAZONICUM EN FUNCIÓN DE DIFERENTES TRATAMIENTOS DE ROMPIMIENTO DE LA LATENCIA

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ABSTRACT

Schizolobium Amazonicum, popularly known as Cuiabano Pine or Paricá, is a forest species with accelerated development due to its pioneering nature. It is widely used in reforestation areas to provide conditions for other secondary and tertiary forest species to thrive. Furthermore, it is a species with diverse uses in construction, toys, plywood, and other industries. The seeds have a hard, waterproof seed coat, which naturally makes them very difficult to germinate. Hence, the use of techniques to break dormancy and accelerate the germination process is essential. Mechanical and chemical techniques are among the most common techniques for breaking dormancy in this species' seeds. Given the difficulty of natural seed germination, this study aims to evaluate the effects of different dormancy-

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breaking treatments, seeking the method that results in the highest seed germination percentage using mechanical, mechanical-thermal, mechanical-chemical, and chemical techniques. Thus, the treatments used were: T0 – Control; T1 – Lateral scarification with a grinder; T2 – Lateral scarification with a grinder + immersion in water at 60°C for 15 minutes; T3 – Lateral scarification with a grinder + immersion in water at 90°C for 15 minutes; T4 – Lateral scarification + immersion in sulfuric acid for 10 minutes; T5 – Immersion in sulfuric acid for 10 minutes. The experiment was implemented in an external laboratory at the Colorado do Oeste Campus of IFRO. The seeds were sown in trays containing washed fine sand and covered with paper towels to maintain seed moisture. The effect of the treatments was evaluated by Seedling Emergence (SE) at ten observation times (one per day). A completely randomized design was used, with two replicates of 40 seeds. Treatments involving mechanical scarification alone or in combination showed the best performance (95% to 100%), while exclusively thermal or chemical methods were less efficient. It is concluded that the species' dormancy is predominantly physical, and that mechanical scarification, alone or in combination with sulfuric acid, is highly recommended for seedling production in nurseries, contributing to sustainable forestry in the Amazon.

Keywords: Sustainability. Dormancy. Recovery of Degraded Areas. Reforestation. Amazon.

RESUMO

O *Schizolobium Amazonicum*, conhecido popularmente como Pinho Cuiabano ou Paricá, é uma espécie florestal que tem um desenvolvimento muito acelerado por ser uma espécie pioneira, muito usada em áreas de reflorestamento para dar condições para outras espécies florestais secundárias e terciárias se desenvolverem. Além disso, é uma espécie com diversas empregabilidades na construção civil, brinquedos, compensados e outras. As sementes apresentam o tegumento impermeável à água e duro, por isso que, naturalmente, possuem grande dificuldade de germinação, daí a necessidade da utilização de técnicas para quebrar a dormência e acelerar o processo de germinação. Dentre as técnicas de quebra de dormência das sementes da espécie, as mecânicas e químicas se destacam. Diante da dificuldade de germinação natural das sementes, a presente pesquisa tem como objetivo avaliar os efeitos dos diferentes tratamentos de quebra de dormência, buscando o método que resulte em maior percentagem de germinação das sementes usando técnicas mecânicas, mecânico-térmicas, mecânico-química e química. Assim, os tratamentos utilizados foram: T0 – Testemunha; T1 – Escarificação lateral em esmeril; T2 – Escarificação lateral em esmeril + imersão em água a 60º C por 15 minutos; T3 – Escarificação lateral em esmeril + imersão em água a 90º C por 15 minutos; T4 – Escarificação lateral + imersão em Ácido Sulfúrico por 10 minutos; T5 – Imersão em Ácido Sulfúrico por 10 minutos. O experimento foi implantado em laboratório externo no Campus Colorado do Oeste do IFRO e as sementes semeadas em bandejas contendo areia fina lavada e as sementes cobertas com papel toalha para manter a umidade das sementes. O efeito dos tratamentos avaliado foi por meio da Emergência de Plântulas (EP) em dez momentos de observação (uma por dia). O Delineamento foi o Inteiramente Casualizado com duas repetições de 40 sementes. Os tratamentos que envolveram escarificação mecânica isolada ou associada apresentaram os melhores desempenhos (95 % a 100 %), enquanto os métodos exclusivamente térmicos ou químicos foram menos eficientes. Conclui-se que a dormência da espécie é predominantemente física, e que a escarificação mecânica, isolada ou associada ao ácido sulfúrico, é altamente recomendada para a produção de mudas em viveiros, contribuindo para a silvicultura sustentável na Amazônia.

Palavras-chave: Sustentabilidade. Dormência. Recuperação de Área Degradada. Reflorestamento. Amazônia.

RESUMEN

Schizolobium Amazonicum, conocido popularmente como Pino Cuiabano o Paricá, es una especie forestal con un desarrollo acelerado debido a su naturaleza pionera. Es ampliamente utilizado en áreas de reforestación para proporcionar condiciones para que otras especies forestales secundarias y terciarias prosperen. Además, es una especie con diversos usos en la construcción, juguetes, madera contrachapada y otras industrias. Las semillas tienen una cubierta dura e impermeable, lo que naturalmente dificulta su germinación. Por lo tanto, el uso de técnicas para romper la latencia y acelerar el proceso de germinación es esencial. Las técnicas mecánicas y químicas se encuentran entre las técnicas más comunes para romper la latencia en las semillas de esta especie. Dada la dificultad de la germinación natural de las semillas, este estudio tiene como objetivo evaluar los efectos de diferentes tratamientos para romper la latencia, buscando el método que resulte en el mayor porcentaje de germinación de las semillas mediante técnicas mecánicas, mecánico-térmicas, mecánico-químicas y químicas. Por lo tanto, los tratamientos utilizados fueron: T0 - Control; T1 - Escarificación lateral con un molino; T2 – Escarificación lateral con un molinillo + inmersión en agua a 60 °C durante 15 minutos; T3 – Escarificación lateral con un molinillo + inmersión en agua a 90 °C durante 15 minutos; T4 – Escarificación lateral + inmersión en ácido sulfúrico durante 10 minutos; T5 – Inmersión en ácido sulfúrico durante 10 minutos. El experimento se implementó en un laboratorio externo en el Campus Colorado do Oeste de IFRO. Las semillas se sembraron en bandejas que contenían arena fina lavada y se cubrieron con toallas de papel para mantener la humedad de las semillas. El efecto de los tratamientos se evaluó por Emergencia de Plántulas (EE) en diez momentos de observación (uno por día). Se utilizó un diseño completamente aleatorizado, con dos réplicas de 40 semillas. Los tratamientos que implicaban escarificación mecánica sola o en combinación mostraron el mejor rendimiento (95% a 100%), mientras que los métodos exclusivamente térmicos o químicos fueron menos eficientes. Se concluye que la latencia de la especie es predominantemente física, y que la escarificación mecánica, sola o en combinación con ácido sulfúrico, es altamente recomendable para la producción de plántulas en viveros, contribuyendo así a la silvicultura sostenible en la Amazonía.

Palabras clave: Sostenibilidad. Latencia. Recuperación de Areas Degradadas. Reforestación. Amazonía.

1 INTRODUCTION

Brazil is privileged in many aspects, with numerous and exuberant natural beauties, from North to South of the country. Among the main biomes that constitute it, the Amazon Forest, considered a world reference, is the most admired internationally, being a reason for world speculation for having an undeniable plant biodiversity.

One of the many native trees that make up the rich Amazonian flora is the *Schizolobium amazonicum*, popularly known as cuiaban pine, paricá and others. It is a deciduous tree, part of the botanical subfamily *Caesalpiniaceae* belonging to the Fabaceae family. In the forest, the trees reach 20 to 30 m in height and a diameter of up to 1.2 m (Rossi *et al*., 2001). Originally from Mexico, but present in Brazil, especially in the Amazon region, it shows rapid growth, reaching a production of 38 m³ha/year of volume at six years of age. The species is considered pioneer, so it should be planted in full sun and will provide adequate conditions for other secondary or tertiary forest species, in case of recovery of degraded areas, to develop (Carvalho, 2007).

Seeds of *Schizolobium amazonicum* exhibit physical dormancy (Silva Neto *et al*., 2007). Integumentary dormancy consists of the impediment suffered by tissues that surround the seed, causing impermeability of the seed coat to water and oxygen (Fowler and Bianchetti, 2000), consequently, it causes unevenness and low germination of the seeds.

Thus, the first challenge in the use of the seeds of the species is to identify a method of overcoming dormancy that is efficient, simple and low cost that allows high production of seedlings. Thus, the role that seed technology plays is the development of appropriate technological methods and the improvement of the seed quality standard, aimed mainly at the production of seedlings to assist the rural producer (Guedes *et al*., 2013).

Among the methods successfully used to overcome dormancy of forest species are chemical and mechanical scarification and immersion in hot water. The application and efficiency of these treatments depend on the intensity of dormancy, which varies greatly between species, origins and years of collection (Albuquerque *et al*., 2007).

Thus, there is a need to test practical methods of overcoming dormancy that improve the germination and performance of seedlings in the nursery to accelerate and standardize the initial establishment of plants in the field (Nascimento *et al*., 2009).

Continuous and rapid deforestation in the Brazilian Amazon has brought serious problems of erosion, soil depletion and consequently silting of surface watercourses, changes in precipitation and others. In addition, the region is consuming its timber reserves, greatly reducing genetic variability and putting a large number of species at risk of extinction.

In the Amazon there is a large number of species of proven silvicultural value that can actively participate in reforestation programs or recovery of environmental liabilities on rural property. *Schizolobium amazonicum* is one of these important species, as it produces wood that is used in civil construction, furniture and also, due to its rapid growth, in the recovery of degraded areas. These are some of the factors that interfere with the increase in interest in the use of the species and serve as a partial alternative to reduce the pressure on the native forest.

However, due to the characteristics of the seed of the species, its germination can take years or not even occur, because the process of imbibition by the seeds is dependent on the availability of water, the chemical composition of the seed, permeability of the seed coat, temperature and physiological quality of the seed (Bewley; Black, 1994), and the retention capacity of the absorbed water will determine the success of the germination process.

The most common way to propagate native species is through seeds, which are directly linked to ecosystem recovery and conservation programs. In most native species, seed dormancy is found, as it is a survival mechanism of the species, it has its germination rate in longer periods. For the production of seedlings, this characteristic ends up being a problem, as they are subject to fungal attacks causing losses of several seedlings (Melo *et al*. 2011). Thus, the first problem found in this species was the lack of seed germination due to the impermeability of the seed coat to water.

The use of the species *Schizolobium amazonicum* for logging or forest restoration requires a seedling formation program, which will allow a greater chance of success in the nursery phase, as well as maximize its growth by reducing the transplant time to the field and consequently a good development of the plant until its final phase. In this sense, it is important to define protocols and strategies that favor the production of seedlings with quality and in less time and conditions accessible to small and medium-sized producers (Cunha *et al*., 2005), since they will only be successful when the methods and systems employed prioritize the production of seedlings with quality, low cost and rusticity.

The considerable variation in the methodology and results of the work to overcome dormancy reinforces the need to carry out new studies with the studied species so that there is a discovery of some technique of low complexity and low cost so that it is a reality of option for the recovery of Legal Reserve areas and Permanent Preservation areas for small and medium owners of rural areas.

Thus, in view of this context, problem and importance, this article aimed to evaluate the effects of different dormancy breaking treatments, seeking the method that results in a higher percentage of seed germination using mechanical and mechanical-thermal techniques.

2 THEORETICAL FRAMEWORK

Schizolobium amazonicum is a species very present in Brazil, especially in the Amazon region. It shows rapid growth, reaching a production of 38 m³ha/year of volume at six years of age. The species is considered pioneer, so it should be planted in full sun and will provide adequate conditions for other secondary or tertiary forest species to develop (Carvalho, 2007).

It is a tree native to the Amazon region, with a wide distribution in the states of Pará, Amazonas and border areas with Peru and Colombia. Its wood, which is light and easy to process, is widely used in reforestation, silviculture, and agroforestry systems, contributing to forest restoration strategies and sustainable production (Fernandes *et al*. 2019).

The wood of the species, in addition to being light and easy to process, has high commercial value, which, combined with its rapid growth, makes the species crucial for reforestation programs and recovery of degraded areas, as well as agroforestry systems that promote a sustainable economy based on the forest (Santos; Olive tree; *et al*., 2018)

The use of the species on a scale contributes both to carbon sequestration and to regional income generation, being an emblematic example of responsible forestry in the Amazonian context. As in numerous tropical legumes, seeds exhibit physical dormancy caused by the impermeability of the seed coat, which prevents imbibition and, consequently, the metabolic activation necessary for germination (Fernandes *et al*., 2019)

The imbibition process begins with the absorption of water by the integument, followed by the mechanical or thermal detachment of this layer, necessary to start germination. In a controlled environment, maintaining adequate temperature and humidity is essential to avoid fungal infections that could compromise the viability of seeds (Gatti, 2021)

In addition, due to its rapid growth rate and commercial potential, Paricá stands out as a key element of the green economy in the Amazon, promoting development without causing environmental devastation. Paricá seeds have physical dormancy caused by the impermeability of the integument, a common characteristic in tropical legumes. For germination, it is crucial to have imbibition, absorption of water by the tissue, which triggers metabolic reactions, cell expansion and rupture of the integument, so it is important to keep the substrate uniformly moist during germination tests to avoid delays in germination or fungal growth that compromise viability (Ramos, 2006).

Germination is an essential physiological process for the establishment of plant species. However, some of these species have dormancy mechanisms that hinder this process. In relation to Schizolobium amazonicum, dormancy is predominantly integumentary, due to the impermeability of the seed coat, which prevents water absorption and, consequently, the beginning of germination (Dapont *et al*. 2014).

Overcoming the dormancy of this species has already been the subject of research with the aim of identifying which treatments were capable of accelerating and standardizing the emergence of seedlings. Dapont *et al*. (2014) tested different methods of scarification on their seeds, such as immersion in water at 100°C, scarification with sandpaper, puncture and use of electric grinder. Such treatments resulted in an increase in the emergence index from 5% (intact seeds) to values above 80%.

The studies by Tonini *et al*. (2005) and Rocha and Scotti (2022) highlight the relevance of the species in agroforestry systems, agricultural consortiums, and in areas of conducted natural regeneration. In traditional Amazonian communities, the regeneration of the species is managed intentionally, as in the system known as roça de toco, evidencing its ecological value and interest in the future use of its wood.

Although the study by Rondon (2002) focused on the field development of the species, evaluating the effect of spacing on growth and biomass production, it can be noted that, in order to make the production of seedlings viable, a pre-germination treatment with hot water was employed. In other words, regardless of the final destination of planting, the success of forest production with Cuiabano Pine depends on overcoming seed dormancy.

The seeds of *Schizolobium amazonicum* collected from adult individuals have germination of approximately 28% (Maruyama; Ugamoto, 1989). Management is difficult due to the high water content and susceptibility to attack by microorganisms, which is why they are collected at the beginning of spontaneous dispersion, when they acquire a light coffee color (Sousa; Oak; Ramos, 2005). Under these conditions, germination is low (16%), and rates above 90% can be obtained, but with approximately 2310 days (Cruz; Carvalho, 2006).

All this time, which, by the way, is very extensive, for germination, is strong evidence that the seeds of this species are affected by physical or integumentary dormancy capable of greatly limiting the spread of the species (Cruz; Martins; Carvalho, 2001). In this sense, Shimizu *et al*. (2011) proved precisely the difficulty of these seeds to hydrate when they have an intact integument, with practically zero water content, even after 72 hours immersed in water.

Gatti (2021) evaluated how the change in the thermal regime in the Amazon influences the germination capacity of paricá: average temperatures between 33.1 and 35.3 °C are optimal, but future scenarios with increased temperatures reduce the viable germination window, especially in association with the presence of fungi such as Aspergillus and Penicillium. This highlights the need to consider climate changes in germination protocols, with possible adjustments in temperature, treatment time, and seed health.

3 METHODOLOGY

The experiment was carried out between November 2024 and May 2025 in the external laboratory of the Federal Institute of Rondônia, *Colorado* do Oeste Campus. The seeds were collected from mother trees in September 2024 in the forest garden of the municipality of Colorado do Oeste, coordinates 13° 06' 52'' S and 60° 32' 07'' W at 449m altitude, selected and stored in an airy place at room temperature. Both the location and the storage were done as described above with the intention of representing the reality of a rural producer who does not have the structure to develop the production of seedlings in places and equipment that can control the temperature of the place and the storage of seeds.

The treatments were distributed as follows: T0 – Control (seed submitted only to moisture); T1 – Lateral scarification in emery; T2 – Lateral scarification in emery + immersion in water at 60º C for 15 minutes; T3 – Lateral scarification in emery + immersion in water at 90º C for 15 minutes; T4 – Lateral scarification + immersion in Sulfuric Acid for 10 minutes; and T5 – Immersion in Sulfuric Acid for 10 minutes.

All treatments were prepared simultaneously and then the seeds were sown superficially in Styrofoam trays with drains and with a three-centimeter layer of sand and covered with a triple layer of paper towels to contribute to the maintenance of seed moisture. Soon after the sowing of all the seeds, the first irrigation with manual watering can took place and from then on, three daily waterings were made (morning, noon and afternoon) for 10 days after sowing.

The experimental design was completely randomized, although the environment was uniform. Each treatment consisted of 40 seeds distributed in four trays with ten seeds each and the experiment was developed twice (November 2024 and May 2025), so the total number of seeds per treatment was 80.

The effects of the treatments were evaluated by means of Seedling Emergence (PE) at ten observation moments (one per day at 5 pm). The data analysis was by percentage of PE that followed the model proposed by Labouriau and Valadares (1976), according to the following equation: PE (%) = (N * 100)/A in which N = number of seedlings emerged and A = total number of seeds placed to germinate. Seedlings whose epicotyl was outside the seed and presented the essential structures fully developed at the time of the evaluations were considered emerged. The evaluations were carried out for a period of ten days from the date of sowing.

4 RESULTS AND DISCUSSION

Table 1below presents the results obtained in the experiment.

Table 1

Percentage of germination of Schizolobium amazonicum seeds submitted to different dormancy breaking treatments:

Treatment	Description of treatment	Germination (%)
T0	Witness (moisture)	7,5
T1	Lateral scarification in emery	98,75
T2	Scarification + water 60°C/15 min	95,0
T3	Scarification + water 90°C/15 min	70,0
T4	Scarification + sulfuric acid / 10 min	100,0
T5	Sulfuric acid / 10 min	10,0

Source: The authors (2025).

The evaluation of the different dormancy breaking treatments of *Schizolobium amazonicum seeds* showed significant differences in the percentage of germination between the methods employed. The control (T0), subjected only to moisture, showed germination of 7.5%, a low and expected value due to the integumentary dormancy characteristic of the species, caused by the impermeability of the integument to water (Fernandes *et al*., 2019). Such behavior confirms that, without physical, thermal, or chemical interventions, paricá seeds have difficulty initiating the process of imbibition and metabolic activation (Gatti, 2021).

The treatments that involved mechanical chiseling showed the best germination results. T4 (scarification + sulfuric acid 10 min) reached 100 % germination, followed by T1 (scarification in emery) with 98.75 % and T2 (scarification + water at 60 °C for 15 min) with 95 %. These data corroborate the findings of Shimizu *et al*. (2011), who observed high efficacy of mechanical chiseling in sandpaper and mechanical-chemical methods in overcoming paricá dormancy, resulting in high seedling uniformity. Dionisio *et al*. (2024) also verified germination rates close to 99 % when employing mechanical scarification and moderate heat treatments, reinforcing the potential of these methods in nurseries.

The T4 treatment (mechanical scarification + sulfuric acid for 10 minutes) promoted 100 % germination with high seedling uniformity. This superior performance is due, according to Brancalion *et al*. (2011), of the combined action of physical and chemical mechanisms: mechanical scarification causes cracks in the integument, breaking its physical barrier, while sulfuric acid degrades and softens the impermeable outer layers, facilitating the penetration of water and oxygen. This synergy accelerates the imbibition process, reduces the time for metabolic activation, and ensures faster and more uniform seedling emergence.

On the other hand, the T3 treatment (chiseling + water at 90 °C for 15 min) showed a reduction in germination to 70 %. This behavior suggests that high temperatures can cause physiological damage to the embryo, compromising its viability. Similar results were reported by Oliveira *et al*. (2018), who found a drop in the germination of *S. amazonicum* seeds when subjected to water at temperatures close to the boiling point, evidencing the need for strict control of temperature and exposure time.

Exclusively chemical or exclusively thermal treatments demonstrated low efficiency. T5 (immersion in sulfuric acid for 10 min without chiseling) showed only 10 % germination, a value slightly higher than that of the control. These results demonstrate that simple immersion in acid, in a short period, is not enough to completely rupture the integument, as already highlighted by Cruz, Carvalho and Queiroz (2007), who obtained better results only after longer periods of exposure to acid.

In general, the results indicate that the association of methods is more efficient. The T4 treatment confirms that the mechanical scarification associated with sulfuric acid promotes maximum germination, allowing rapid imbibition and uniform emergence, while T1 and T2 present slightly lower results, but still higher than 95%. For the production of seedlings on a commercial scale, the use of mechanical chiseling alone or associated with moderate chemical treatment is advantageous, reconciling a high percentage of germination, seedling uniformity and operational viability (Neves; Dalchiavon; Cargnin-Stieler, 2015; Dapont *et al., 2014).*

Finally, when relating the data obtained with the literature, it is observed that the results of T1, T2 and T4 are in agreement with classic studies of paricá germination, which report rates above 90% with mechanical and mechanical-chemical methods (Fernandes *et al*., 2019; Shimizu *et al*., 2011). Such findings reinforce the potential of the species in reforestation and sustainable forestry programs in the Amazon, ensuring high efficiency in seedling production and contributing to sustainable environmental and economic management practices.

5 CONCLUSION

In view of the above, the present study demonstrated that the dormancy breaking methods applied to *Schizolobium amazonicum* seeds showed significant differences in germination efficiency. The treatments that involved mechanical scarification, alone or associated with thermal and chemical methods, resulted in the highest germination percentages, especially T4 (scarification + sulfuric acid) with 100 % and T1 (scarification in emery) with 98.75 %, evidencing the efficacy of the physical rupture of the integument to overcome dormancy.

On the other hand, the exclusively chemical or thermal methods showed lower performance, as observed in T5 (isolated sulfuric acid) with only 10 % and in the control with 7.5 %, confirming that paricá dormancy is predominantly physical, requiring mechanical intervention to make imbibition viable.

From a silvicultural and environmental point of view, the results reinforce the potential of the species as a strategy for reforestation and recovery of degraded areas in the Amazon, since simple and low-cost methods, such as scarification in emery, promote high germination and uniformity of seedlings, facilitating production in commercial nurseries and contributing to sustainable forest management practices. In summary, it is recommended the use of isolated mechanical scarification for smaller nurseries, due to operational simplicity and safety, and scarification associated with sulfuric acid for larger-scale productions, where standardization and maximum germination are desired.

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