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Original Article

Maturation and harvest time of *Ateleia glazioveana* Baill. seeds

Maturação e época de colheita de sementes de *Ateleia glazioveana* Baill.

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Abstract

Ateleia glazioveana Baill. is a pioneer, rustic and can be used for forest recovery. This work aimed to study the process of physiological maturation of this species. The research was carried out in the city of Alegre - ES, the trees were identified in the floral anthesis and accompanied during the filling of the fruits and development of the seeds until the complete maturation. The fruits were harvested at the following stages 7, 14, 21, 28, 35 and 42 days after anthesis, and characterized according to: morphometry, moisture, fresh and dry mass of fruits and seeds, germination, germination speed index, shoot and root length and dry mass of seedlings. The regression equations were adjusted for the main characteristics analyzed as a function of the harvest period. The point of physiological maturity of timbó occurred at 42 days after anthesis.

Keywords: forest recovery, morphology, morphometry, physiological maturity, timbó.

Resumo

A *Ateleia glazioveana* Baill. é pioneira, rústica e pode ser utilizada para recuperação florestal. Este trabalho teve como objetivo estudar o processo de maturação fisiológica desta espécie. A pesquisa foi realizada na cidade de Alegre - ES, as árvores foram identificadas na antese floral e acompanhadas durante o enchimento dos frutos e desenvolvimento das sementes até a completa maturação. Os frutos foram colhidos nos seguintes estágios 7, 14, 21, 28, 35 e 42 dias após a antese, e caracterizados quanto à: morfometria, umidade, massa fresca e seca dos frutos e sementes, germinação, índice de velocidade de germinação, comprimento da parte aérea e da raiz e massa seca das plântulas. As equações de regressão foram ajustadas para as principais características analisadas em função do período de colheita. O ponto de maturidade fisiológica do timbó ocorreu aos 42 dias após a antese.

Palavras-chave: recuperação florestal, morfologia, morfometria, maturidade fisiológica, timbó.

1. Introduction

The species *Ateleia glazioveana* Baill., popularly known in Brazil as timbó, cinamomo bravo, and maria preta, belongs to the Fabaceae family and occurs naturally in the northwest of Rio Grande do Sul and in the western region of Santa Catarina (Gava et al., 2021), being classified as an arboreal, pioneer, and showing intense natural regeneration behavior (Fontoura et al., 2017). This species is recommended for the composition of degraded areas and urban afforestation, providing wood material for internal works, crates, firewood, and other light objects (Lorenzi, 2016).

In view of the potential of this species for the recovery of degraded areas, the search for information on its propagation methods, germination pattern, and maturation period is justified, especially given the fragmentation of native forests increased by human action, mainly through the use of land for food production and housing construction. Also, forest fragmentation leads to losses such as the degradation of biodiversity, negative effects on ecosystem services provided to man, and the extinction of different plant and animal species (Mengist et al., 2022).

The timbó is characterized as a deciduous plant, of medium size, formed by compound, alternate and imparipinnate leaves. Its flowers are small, yellowish and gathered in terminal panicles. The fruit is indehiscent, and its color varies according to the maturation period, being light yellow (young fruits), light brown (intermediate fruits) and dark brown (ripe fruits), in addition to color variation during the maturation process the fruits increase their degree of twisting. It is added that this fruit has a visible central seed, reddish and orthodox, maintaining its viability longer after harvesting. The germination potential of the seeds of the species ranges from 80 to 100%, flowering from November to January and fruiting from April to July (Lorenzi, 2016).

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Seeds that have a variable physiological maturity point, as well as those of *A. glazioveana*, can be harvested before this event occurs, as they can complete their *ex-planta* ripening cycle without being affected by deleterious effects (Ellis, 2019). Orthodox seeds most likely fulfill this requirement better, as they withstand a greater degree of dehydration and can be stored for longer periods (El-Maarouf-Bouteau, 2022).

To carry out the harvest in advance or at the point of physiological maturity, it is necessary to precisely know this event. The asynchronous maturation of hardy species (Schubert and Walters, 2022), such as *A. glazioveana*, makes it impossible to harvest a greater number of seeds within the same period at the same degree of maturation. Thus, the possibility of post-harvest maturation makes it possible to gather a greater number of seeds, which will be viable after a period of storage (Santos et al., 2019).

The seeds of *A. glazioveana* have slow germination after sowing (Lorenzi, 2016), becoming clear that germination involves a sequence of physiological events conditioned by different light, oxygen, water, and temperature conditions, which influence metabolic reactions and, consequently, the germination process (Nascimento et al., 2022). In this scenario, the point of physiological maturity indicates the moment when the seeds reach their maximum germination potential and vigor as well as their ideal point of harvest (Marcos-Filho, 2015; Barroso et al., 2022).

From this perspective, seedling establishment in this and other forest species is usually hampered by the lack of knowledge about the ideal harvesting point, which is determined according to maturation indices, i.e., physical and chemical values that change during development, e.g., fruit diameter, weight, and CO_2 and ethylene quantification (Milanez et al., 2016). In this scenario, this study aimed to investigate the physiological maturation process of the species *Ateleia glazioveana*.

2. Material and Methods

The experiment was carried out at the Seed Analysis Laboratory of the Center for Agricultural Sciences and Engineering of the Federal University of Espírito Santo (CCAE-UFES) in Alegre - ES. The seeds used in the study come from Atlantic Forest fragments and areas around Caparaó, in the region of Alegre - ES, Brazil (Figure 1).

Twelve mother trees were selected for their vigor, health and height. The chosen individuals had strong vigor and health and height ranging from four to nine meters. After selection, approximately 2,000 inflorescences were marked with a string attached to the floral peduncle, a period in which approximately 50% of these inflorescences were present. Seeds were harvested from the lower third of the panicle, due to the height of the selected individuals, during six development stages 7, 14, 21, 28, 35 and 42 days after anthesis. After harvesting, the seeds were packed in thermal boxes and taken to the Seed Analysis Laboratory where they were stored for one day in a refrigerator 4°C, being subsequently evaluated after each collection for morphometric, morphological and physical characteristics.

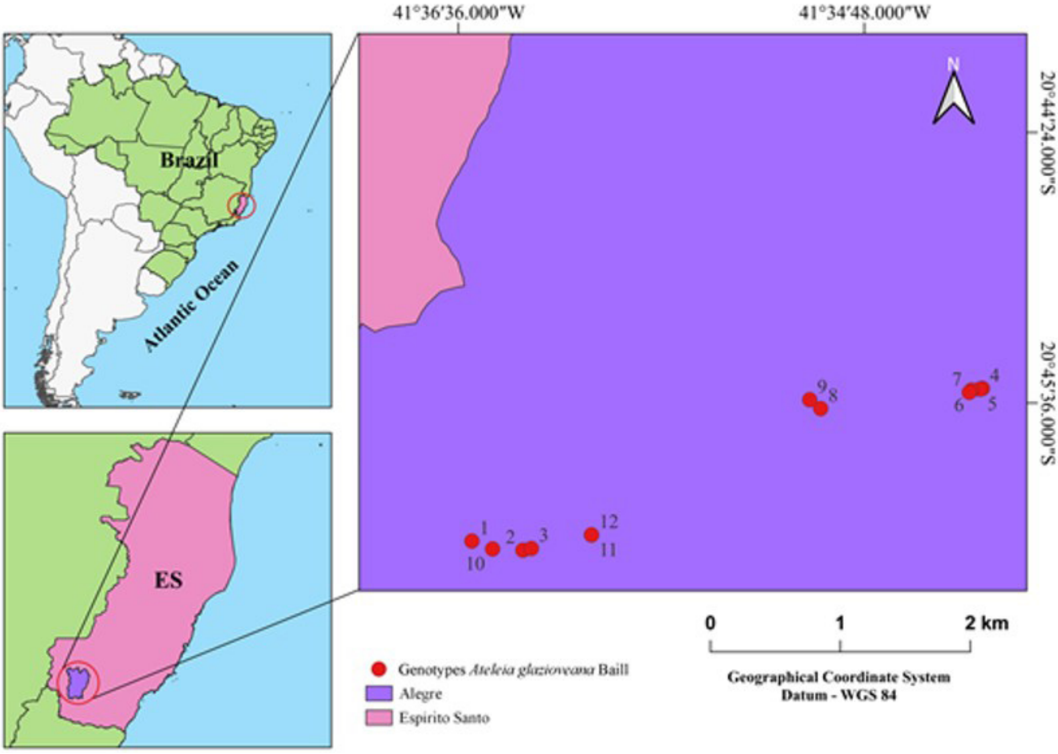

Figure 1. Location of the 12 parent trees (genotypes) selected for the seed maturation study of *Ateleia glazioveana* Baill.

Immediately after harvesting, fresh (MF) and dry (DM) mass of fruits and seeds was evaluated. For MF and MS of the fruits, a sample of 50 fruits was used, and for the seeds, 50 seeds benefited with the aid of a scalpel and tweezers were used. The fresh and dry mass of fruits and seeds were determined together with the water content, obtained by the oven method at 105 ± 3 ºC for 24 hours using two replications of 25 seeds (Brasil, 2009). For the biometric and physiological analyzes of the seeds, the same seed processing protocol reported for MF and MS of seeds was used. The length and width of fruits and seeds were determined with two replications of 50 seeds using a digital caliper (0.01 mm).

After the biometric analysis of the fruits and seeds, the germination was evaluated out with four replications of 25 seeds each. These seeds were initially disinfected with 70% alcohol for 1 min and 2.5% sodium hypochlorite for 5 min. And after, were in Petri dishes lined with germitest® paper previously moistened with distilled water at a ratio of 2.5 times the mass of the dry paper. After sowing, the dishes were kept in a biochemical oxygen demand (BOD) incubator set at 30 ºC and with a photoperiod of 8/16 hours (Brasil, 2009), for 15 days. The germination speed index (GSI) was determined concomitantly with the germination test. Also, the number of seeds with primary root protrusion equal to or greater than 2 mm was computed daily using the equation proposed by Maguire (1962).

The seeds, kept in petri dishes, that germinated and formed seedlings after 15 days of sowing were analyzed at the end of this period for the length of the shoot, using a millimeter ruler by measuring the length from the base of the plant to the apex of the last leaf in each plant (mm). How much to the root length measured from the base of the plant to the tip of the largest root (mm). What how about the dry mass (mg), for that the seedlings were placed in paper bags, kept in a convection oven at 72 ºC for 72 hours (constant mass).

The statistical design used in this study was completely randomized, with two replications of 50 seeds for the biometric analyses, two replications of 25 seeds for the analysis of fresh and dry mass and water content of fruits and seeds, and for the analysis of germination and vigor four replications of 25 seeds were used. The data generated were subjected to analysis of variance when they met the assumptions of normality by the Shapiro-Wilk test and homogeneity of variance by the Bartlett test at 5% significance. Quantitative data that showed significant differences were submitted to regression analysis. Statistical calculations were performed using the R software (R Core Team, 2023).

3. Results

The fresh fruit mass increased continuously during the first 21 days, stabilizing after this period. The dry fruit mass increased constantly up to 35 days, followed by invariability after this period. On the other hand, the variables of fruit length, width, and fresh mass stabilized after 21 days. Fruit moisture remained stable during the first 28 days, followed by a decrease from 80% (seven days) to approximately 20% (42 days) (Figure 2).

At the initial stage of the analyses, between zero and 14 days, the seeds had a mass close to zero, making their extraction, in fact, impracticable. During the maturation phase, the seeds gained mass and reached their maximum point 35 days after anthesis, gradually increasing in length and width and stabilizing after 28 days. The moisture content initially showed high percentages (around 80%), after which this parameter decreased and reached 20% after 42 days (Figure 3).

Germination at the beginning of the analysis was null, with fruit formation beginning 21 days after fertilization and the first germination count beginning 28 days after anthesis. Germination occurred gradually, reaching a maximum point 42 days after anthesis, with about 80% of the germinated seeds, all germinated seeds resulted in normal seedlings, which, associated with the low seed water accumulation, is indicative of maturity. The GSI also showed an increasing behavior, starting at 21 days after anthesis and reaching its maximum after 42 days (3.0). Root and shoot lengths were similar at the beginning of seedling development, ranging from 25 to 30 mm and 50 mm 42 days after anthesis, respectively, however, in quantitative terms, the aerial part presented greater investments in growth when compared to the root length. The first seedling mass value was measured 28 days after anthesis and reached its peak at 42 days, with 20 mg (Figure 4).

4. Discussion

The seeds of *A. glazioveana* had high moisture and zero germination percentage from seven to 21 days after anthesis. However, after 28 days, seed germination began to increase as moisture decreased, which continued during maturation, suggesting a possible inverse relationship between the aforementioned variables (Figures 3 and 4). The data obtained in this study are corroborated by Schulz et al. (2017), who evaluated germination and moisture content of seeds of *Luehea divaricata* (Malvaceae), a species characterized by dry and dehiscent fruits, as well as *A. glazioveana*, and concluded that the increase in germination percentage coincided with the reduction in moisture. Furthermore, the high water content in early development of the seeds is linked to the synthesis and metabolism of reserve substances such as proteins, starch, and lipids. However, as the seeds mature, they lose water and accumulate dry mass (Marcos-Filho, 2015; Barroso et al., 2022; Mello et al., 2022).

Seed moisture is closely linked to physiological quality. Therefore, this analysis is indispensable to determining the point of physiological maturity (Sarmento et al., 2015). In addition, high moisture is indicative that the seeds are not suitable for harvest at this stage, showing low germination power and high respiratory rates, which can lead to seed death due to the action of undesirable microorganisms (Carvalho and Nakagawa, 2012; Garcia et al., 2014).

Other indicators of physiological maturity are the color and appearance of the fruits. Ripe fruits of *A. glazioveana* are dark brown in color and have a twisted appearance.

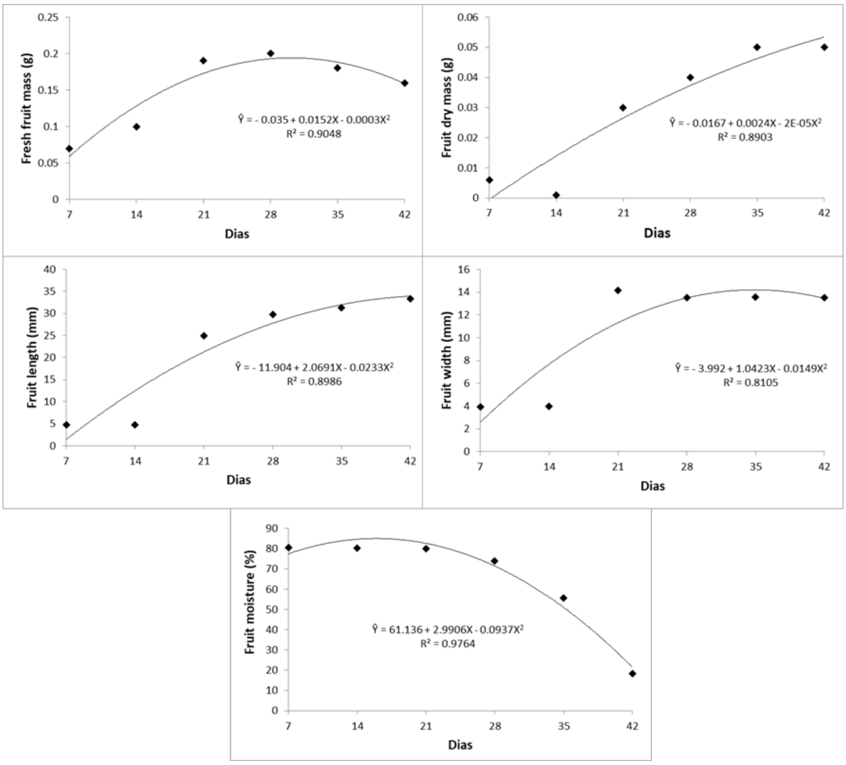

Figure 2. Fresh mass (g), dry mass (g), length (mm), width (mm), and moisture (%) of timbó fruits (*Ateleia glazioveana*) seven, 14, 21, 28, 35, and 42 days after anthesis (DAA).

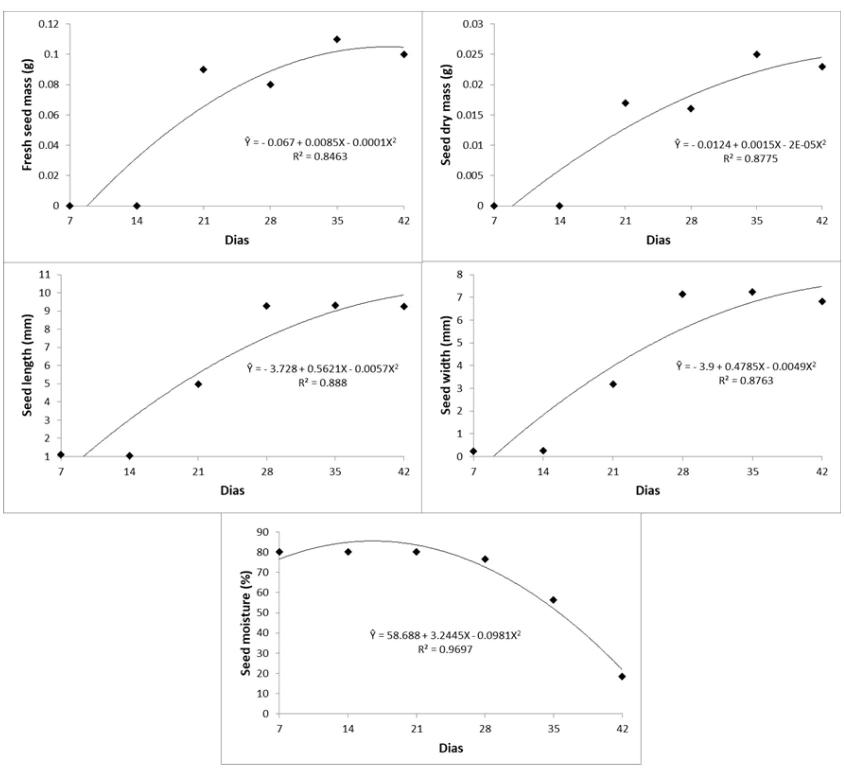

Figure 3. Fresh mass (g), dry mass (g), length (mm), width (mm), and moisture (%) of timbó seeds (*Ateleia* glazioveana) seven, 14, 21, 28, 35, and 42 days after anthesis (DAA).

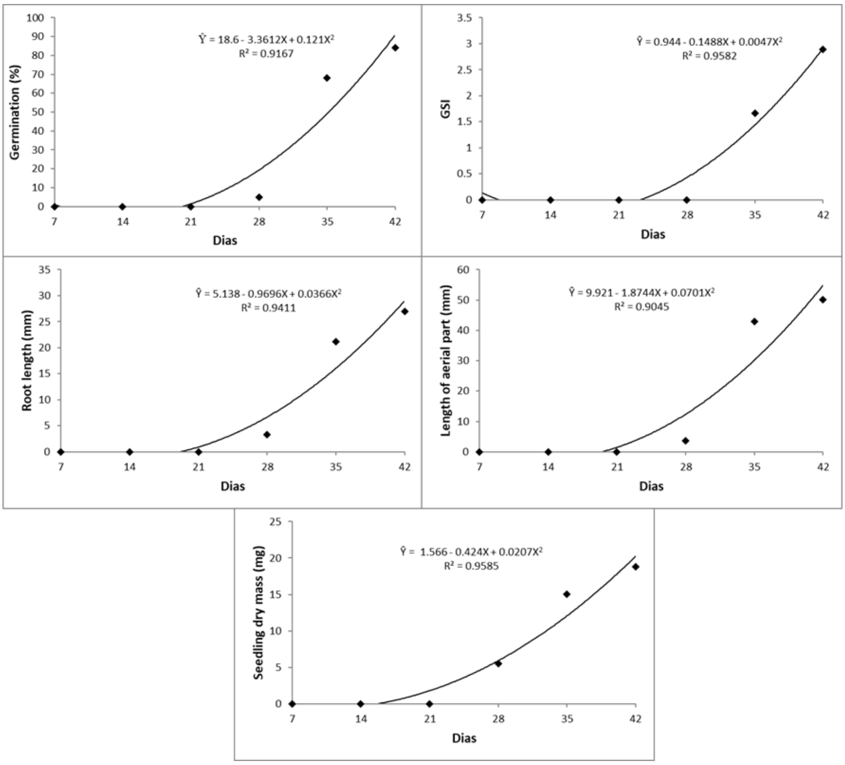

Figure 4. Germination (%), germination speed index (GSI), root length (mm), length of aerial part (mm), and dry mass of timbó seedlings (mg) (*Ateleia glazioveana*) seven, 14, 21, 28, 35, and 42 days after anthesis (DAA).

Cenostigma pluviosum (DC.) E. Gagnon & G.P. Lewis (sibipiruna), another species of the Fabaceae family, which also has legume-type fruits, also shows this change in color and shape in its fruits during maturation, mature fruits of this species are brown and slightly twisted (Costa et al., 2021).

The point of seed physiological maturity is also marked by dry mass accumulation and moisture reduction, which results in size reduction and changes in fruit and seed color (Marcos-Filho, 2015). The mean seed dry mass increased after 21 days of anthesis, stabilizing after the 35th day, along with a sharp reduction in the water content, which showed its greatest reduction until 35 days after anthesis, reaching values close to 60%, and after 42 days, reaching 20%.

In general, the point of maximum seed quality is reached together with the maximum germination capacity and vigor (Barroso et al., 2022), as seen in Figure 2. The GSI increased significantly between the 28th and 35th day, reaching its maximum 42 days after anthesis. The GSI is one of the most used methods to measure the mean seed germination speed per day by assuming that seeds with higher physiological potential will germinate faster and more uniformly than those with low potential. On the other hand, the shoot and root length and the dry seedling mass showed similar performance (Figure 4), increasing gradually after 28 days of anthesis and peaking after 42 days when the seeds reached physiological maturity.

Knowledge about morphological and physiological transformations is essential to support studies on germination, and the width and length of fruits and seeds, for example, can be used as practical indicators of physiological maturity (Lopes and Soares, 2006; Leonhardt et al., 2008). In Figure 3, it is possible to notice the greater stability in fruit length and width after the 21-day phase of anthesis.

The analysis of biometric variables indicates the most favorable point for harvest, with higher values for the germination count. However, some studies indicate that, at this point, seeds may or may not have reached the maximum germination and vigor values (Lopes and Soares, 2006; Ellis, 2019). Fruits at physiological maturity tend to be heavier due to the greater accumulation of reserves, photoassimilates, sugars, and carbohydrates at this stage, indicating the ideal point for harvesting seeds with higher quality and less damage in the field (Lopes and Soares, 2006; Marcos-Filho, 2015). In this study the maturation period is evidenced by the progressive and gradual seed growth and the significant moisture reduction from 80 to 20% after 42 days of maturation.

The seed maturation process provides information about the growth and development of plant species in relation to their production, which makes it possible to predict and establish the most appropriate time for harvest (Lopes and Soares, 2006; Carvalho and Nakagawa, 2012; Marcos-Filho, 2015; Ellis, 2019). This prediction avoids harvesting at inappropriate times, which could result in considerable damage to seed quality and cause quantitative losses, mainly because seed harvest at early maturation stages could lead to a complete loss of viability (Bewley et al., 2013).

In view of this, one must know perfectly the seed maturation process of their respective species and their relationships with the recommended time for harvesting (Carvalho and Nakagawa, 2012; Marcos-Filho, 2015).

Native species such as timbó are difficult to study in the field, as, in addition to being little researched, their seedling production is hampered due to obstacles in seed acquisition (Lopes and Soares, 2006), related to their variable physiological maturity point. In addition, access to the places with the highest occurrence of these species is also difficult. However, in this research it was possible to establish the point of physiological maturity of the species based on morphological parameters (color and shape of the fruits and length of the root and aerial part), morphometric (length and width of the fruits and seeds) and physiological (humidity, germination, fresh and dry mass of fruits and seeds, dry mass of seedlings and GSI).

5. Conclusion

The point of physiological maturity of *Ateleia glazioveana* occurs 42 days after anthesis.

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