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QUALITY OF *Brosimum gaudichaudii* Trécul SEEDLINGS AND SEEDS COLLECTED IN TWO DIFFERENT LOCATIONS

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ABSTRACT - The seed provenance can interfere with their size, as well as in the growth of saplings and susceptibility to stress. The aim of this study was to evaluate the quality of *Brosimum gaudichaudii* Trécul seeds and seedlings obtained from two different locations. Seeds were collected in two municipalities in the state of Goiás - Iporá and Jataí, in 2018. Individual seed size mass and dimension, seedling emergence percentage and speed, as well as initial growth, leaf chlorophyll index, biomass and seedling quality index (SQI) were determined. Such parameters were determined at 40, 70, 100, 130, 160 and 190 days after sowing (DAS). Individual size mass and dimension of seed collected in Iporá were superior to those collected in Jataí. Despite this, the seedling emergence percentage and seedling mortality were not affected by the different origins of seeds. As expected, there was increase in height, stem diameter and number of leaves of seedlings during the analyzed period, on the other hand, the chlorophyll index remained constant. The initial growth of seedlings differed between origins. The dry biomass did not vary between seedlings from the different origins, with greater allocation of biomass in roots. The SQI of seedlings produced from seeds collected in Iporá was higher than those collected in Jataí. Despite the quality verified for seeds and seedlings from the two origins, seeds collected in Iporá presented larger dimensions than those collected in Jataí, generating seedlings with greater initial growth and higher quality.
Keywords: Mama-cadela, initial seedling growth, seedling emergence, dickson's quality index, seed morphometry.

QUALIDADE DE SEMENTES E MUDAS DE DUAS PROCEDÊNCIAS DE Brosimum gaudichaudii Trécul

RESUMO - A procedência de sementes pode interferir em seu tamanho, bem como no crescimento das mudas e na suscetibilidade ao estresse. Objetivou-se com este estudo avaliar a qualidade de sementes e mudas de duas procedências de *Brosimum gaudichaudii* Trécul. As sementes foram coletadas em dois municípios goianos - Iporá e Jataí, em 2018. Foram determinadas a dimensão e a massa individual das sementes, a porcentagem e velocidade de emergência das plântulas, bem como o crescimento inicial, índice de clorofila das folhas, biomassa e índice de qualidade das mudas (IQD). Tais parâmetros foram determinados 40, 70, 100, 130, 160 e 190 dias após a semeadura (DAS). A dimensão e massa individual das sementes coletadas em Iporá foram superiores às obtidas em Jataí. Apesar disso, a porcentagem e velocidade da emergência e a mortalidade das plântulas não foram afetadas pelas diferentes procedências das sementes. Como esperado, houve aumento da altura, diâmetro do colo e número de folhas das mudas durante o período analisado, por outro lado, o índice de clorofila manteve-se constante. O crescimento inicial das mudas diferiu entre as duas procedências. A biomassa seca não variou entre as mudas das duas procedências, com maior alocação de biomassa nas raízes. O IQD das mudas produzidas a partir de sementes coletadas em Iporá foi superior ao das coletadas em Jataí. Apesar da qualidade verificada para as sementes e mudas oriundas das duas procedências, as sementes coletadas em Iporá apresentaram maiores dimensões que as coletadas em Jataí, gerando mudas com maior crescimento inicial e qualidade superior.
Palavras-chave: Mama-cadela, crescimento inicial de mudas, emergência de plântulas, índice de qualidade de Dickson, morfometria de sementes.

INTRODUCTION

Brosimum gaudichaudii Trécul. (Moraceae) is a shrub species native to Brazil, known as “mama-cadela”, which occurs in the Cerrado, Amazon and Atlantic Forest biomes (FONSECA et al., 2017; SILVA et al., 2015). This species has been indicated for the composition of mixed reforestation and intended for the recovery and enrichment of the vegetation of degraded areas (FONSECA et al., 2017), in addition to being widely used by the population as a medicinal species (SILVA et al., 2020). *B. gaudichaudii* fruits are milky, have thick pulp layer and are edible, rich in vitamin C (JESUS, 2014). The roots present the main active constituents with proven photosensitizing activity (SILVA et al., 2015). *B. gaudichaudii* is irrationally exploited due to its medicinal potential, requiring actions that contribute to the preservation of the species (SILVA et al., 2020).

B. gaudichaudii seeds have high germination capacity (QUEIROZ and DIAS, 2021) and recalcitrant

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physiological behavior, that is, they have short longevity and do not tolerate desiccation (MAYRINK et al., 2016; SCALON et al., 2012). Seeds of forest species, in general, show variability within the species itself, influenced by abiotic factors (soil-climatic conditions) and/or by genetic variability (SILVA, 2015). This was verified with *Pseudobombax loniflorum* seeds, which influenced seedling germination and emergence (LADEIA et al., 2012). In fact, tests to evaluate the physiological quality of seeds and evaluation of seedlings used in this study were efficient to differentiate the origins of *Cedrela fissilis* seeds in vigor levels (LAZAROTTO et al., 2013). Thus, combining the origin of seeds with studies that involve the initial seedling growth over time can subsidize the use of seeds in ecological restoration plantations, either through seedling planting or no tillage (SILVA et al., 2020).

The soil-climatic characteristics that occur in the site of origin of seeds can influence their physical and physiological quality and, consequently, seedlings originated from them. Thus, it is to be expected that populations occurring in different ecological conditions have different adaptive abilities (NAVROSKI et al., 2016). The effect of seed size on germination and seedling growth has been investigated in several species (DEB; SUNDRIYAL, 2017; FOLAKE; OLUSOLA, 2020). This is because seed size characterization can be an instrument for understanding and describing the germination process (DEB; SUNDRIYAL, 2017), as well as for associating the characteristics of seedling dispersal and establishment (KUMAR et al., 2016).

Thus, the aim of this study was to evaluate the quality of *Brosimum gaudichaudii* Trécul. seeds and seedlings from different origins based on the analysis of their dimensions and individual weight, as well as aspects of seedling emergence, initial growth and seedling quality.

MATERIAL AND METHODS

Brosimum gaudichaudii Trécul. (Moraceae) fruits were collected from seven mother trees in the municipalities of Iporá (16º28'S and 31º06'W) and Jataí (17°55'S and 51°42'W), state of Goiás, in September and November 2018, respectively. Ripe orange-colored fruits were manually collected from the mother tree or from the ground, when they had just been detached from the tree. All fruits were packed in plastic bags and transported to the Laboratory of Forest Seeds at the Federal University of Jataí (UFJ) to be processed. Fruits were immersed in water for 12 hours to soften the pulp and, later, they were passed through a sieve to remove pulp from seeds. Seeds were distributed on a flat surface protected from the sun for natural drying at ambient air temperature and humidity, for 36 h.

Iporá is located in the western region of Goiás and is under the domain of the Cerrado biome. The climate of the region is classified as savanna tropical (Köpeen and Geiger), with two well-defined seasons and temperature ranging from 20 to 33°C, with average annual rainfall of 1550 mm. The municipality of Iporá has average altitude of 575 m a.s.l. (ALVES and SPECIAN, 2009). Jataí, in turn, is located the southwest region of Goiás and has the same climate as Iporá. The municipality has annual rainfall of 1648.9 mm and average temperature of 22.4°C, according to its historical average from 1981 to 2010 (INMET, 2020), which can reach values below 0°C in the winter (VASQUES and BARROS, 2016). Jataí has average altitude of 755 m a.s.l. (IBGE, 2020). In 2018, the year in which *B. gaudichaudii* seeds were collected, the annual rainfall in Iporá was 1,597 mm and the average temperature was 25°C. In Jataí, the annual rainfall in 2018 was 1,651 mm and the average temperature was 23°C. In both municipalities, microclimatic data were similar to those expected, according to the historical average of annual rainfall and temperature (average, minimum and maximum) (INMET, 2020).

The dimension (length, thickness and width) and the individual mass of *B. gaudichaudii* seeds were determined, respectively, with the aid of digital caliper and precision scale. For this, 300 seeds from each collection site were used and, later, the mean, standard deviation and standard error of the mean were calculated for each parameter. Through data obtained, the frequency distribution of seed dimensions and mass was performed, which were subsequently plotted in histograms.

Seeds from both origins were sown in substrate composed of soil, sand and tanned manure (2:1:1) kept in polyethylene plastic bags for seedling production (0.004 m^3). About 100 medium-sized seeds from each origin were sown at depth of 1 cm, which were daily irrigated. To evaluate seed quality, seedling emergence was daily observed after one week of sowing, and the emergence of eophylls was considered as emergence. The determination of the seedling emergence percentage, as well as the emergence speed index (ESI) was performed 45 days after sowing. To determine ESI, the methodology proposed by Maguire (1962) was used. The seedling mortality percentage was also obtained, as well as the beginning and end of seedling emergence. The beginning of emergence was obtained when the first seedling emerged, while the end of emergence was determined after successive counts in which no more seedling emergence was observed.

Seedlings were daily irrigated in the morning. The initial seedling growth was obtained by measuring stem diameter (mm) and seedling height (from the stem to the apical bud, in cm). Digital caliper was used to measure stem diameter and a graduated ruler was used to measure seedling height. The number of leaves per seedling was also quantified. To determine the initial seedling growth, the variables above were measured at 40, 70, 100, 130, 160, and 190 days after the sowing of seeds collected in Iporá and Jataí. The total chlorophyll index was also obtained and in the same collection period with the aid of portable electronic chlorophyll meter (Clorofilog1030, Falker, Brazil).

The fresh and dry biomass of seedlings produced from seeds collected in Jataí and Iporá was determined at 70, 130 and 190 days after sowing, in 20 seedlings from each origin. For this, all substrate present in the root system of seedlings was removed and then there was separation into three compartments: leaf, stem and root, which were weighed on a precision scale. Thus, the total fresh biomass

and its compartments (in grams) and the biomass percentage of compartments in relation to the total biomass were obtained. Seedling compartments were placed in bags and kraft paper, properly identified, in an oven with forced circulation and air at temperature of 65 °C until reaching constant weight, and then the second weighing was performed to obtain the dry biomass. Dry biomass was also determined in grams and as total biomass percentage. Seedling quality was obtained from the Dickson quality index (DQI) formula, according to Dickson et al. (1960).

Descriptive data were presented in the form of a histogram, with frequency distribution in nine classes for variables seed dimension and seed mass. A completely randomized design was used, with two treatments (origins) and four replicates of 25 seeds/5 seedlings. To compare the means of variables under study, data were submitted to the t-test at 5% significance level. The R software (R Core Team, 2018) was used. Quantitative data referring to the initial seedling growth and quality were analyzed from repeated measurements over time and submitted to regression analysis.

RESULTS AND DISCUSSION

Biometry and quality of B. gauduchaudii seeds

Nine classes were observed in the frequency distribution of dimensions (length, width and thickness) and mass of *B. gauduchaudii* seeds (Figure 1) collected from mother trees located in Iporá and Jataí, Goiás. The length of seeds collected in Iporá ranged from 11.5 to 22.63 mm, and from 10.47 to 20.91 mm for those collected in Jataí. About 69.33% of Iporá seeds had length between 17.68 and 21.39 mm, while 64.31% of Jataí seeds had length between 15.26 and 18.65 mm.

The width variation was wider in seeds collected in Iporá (6.42 - 19.34 mm) than in Jataí (8.80 - 19.93 mm). While 88.00% of seeds collected in Iporá had width from 13.60 to 17.90 mm, 82.77% of those collected in Jataí varied between 11.27 and 14.98 mm.

Thickness was the variable associated with seed size with the smallest amplitude, both for Iporá (8.43 to 14.44 mm) and for Jataí (6.54 to 12.24 mm), with about 60% of seeds with thickness from 11.10 to 12.44 and from 9.71 to 10.97 mm, respectively. The individual mass of seeds collected in Iporá presented values from 0.55 g to 3.82 g, while for seeds collected in Jataí, values were from 0.44 g to 2.71 g. Thus, in general, seeds collected in Iporá are larger and heavier than those collected in Jataí. Seed size can be an instrument for understanding and describing the germination process (DEB; SUNDRIYAL, 2017), which are associated with characteristics of seedling dispersal and establishment (KUMAR et al., 2016).

The mean values of variables associated with the dimensions and weight of *B. gaudichaudii* seeds collected in Iporá were significantly higher ($p < 0.05$) than those found in seeds collected in Jataí (Table 1). In *B. gaudichaudii* seeds with different dimensions, Queiroz e Dias (2021) found a lower width and thickness than in this study, particularly in seeds collected in Iporá. Variations in seed dimensions can influence germination percentage (SILVA, 2015), since the size of seeds can influence their physiological quality. Larger seeds tend to have more energy and nutrient reserves than smaller ones, while smaller seeds show greater dispersal probability and ability to form seed banks in persistent soils (KUMAR et al., 2016).

The size and characteristics of seeds are of great relevance for studies on a given species, as they are related to knowledge about seed dispersal and establishment (PEREIRA et al., 2017). Furthermore, studies involving seed biometrics constitute an important instrument to detect genetic variability within populations of the same species and the relationship between this variability and environmental factors, being useful for the improvement of these characteristics for promoting increased productivity and seedling production uniformity (GONÇALVES et al., 2013). Soil-climatic conditions (light, temperature and humidity) where seedlings are produced are more important in seed germination (BEHLING et al., 2013), directly influencing seedling emergence, as well as uniformity.

Regarding the mass of *B. gaudichaudii* seeds collected in the state of Mato Grosso, Faria et al. (2013, 2017) found lower mean values (1.47 and 1.53 g) than those found for seeds collected in Iporá and similar to those collected in Jataí (Table 1). Seed mass has been used as an indicator of seed size, maturity stage and health, in addition to being useful for determining the number of seeds per package and purity analysis (QUEIROZ and DIAS, 2021). Additionally, seed mass is a factor that may be associated to a strategy of survival to water stress (ALMEIDA et al., 2014). This is because the greater the amount of water in seeds, which makes them denser and heavier, the greater their ability to tolerate dry environments for longer periods of time. The different masses identified in this study may have been influenced by climatic conditions of the different environments, such as rainfall in the week when fruits were collected; therefore, providing different water contents inside the tegument, in addition to variability between origins. *B. gaudichaudii* has deciduous behavior and phenological events of the species are conditioned to the seasonality of climatic variations, mainly rainfall (FARIA et al., 2015). However, as the time of fruit collection varied among origins, other factors such as edaphic factors, in addition to microclimatic variations, may help to understand the phenological differences found.

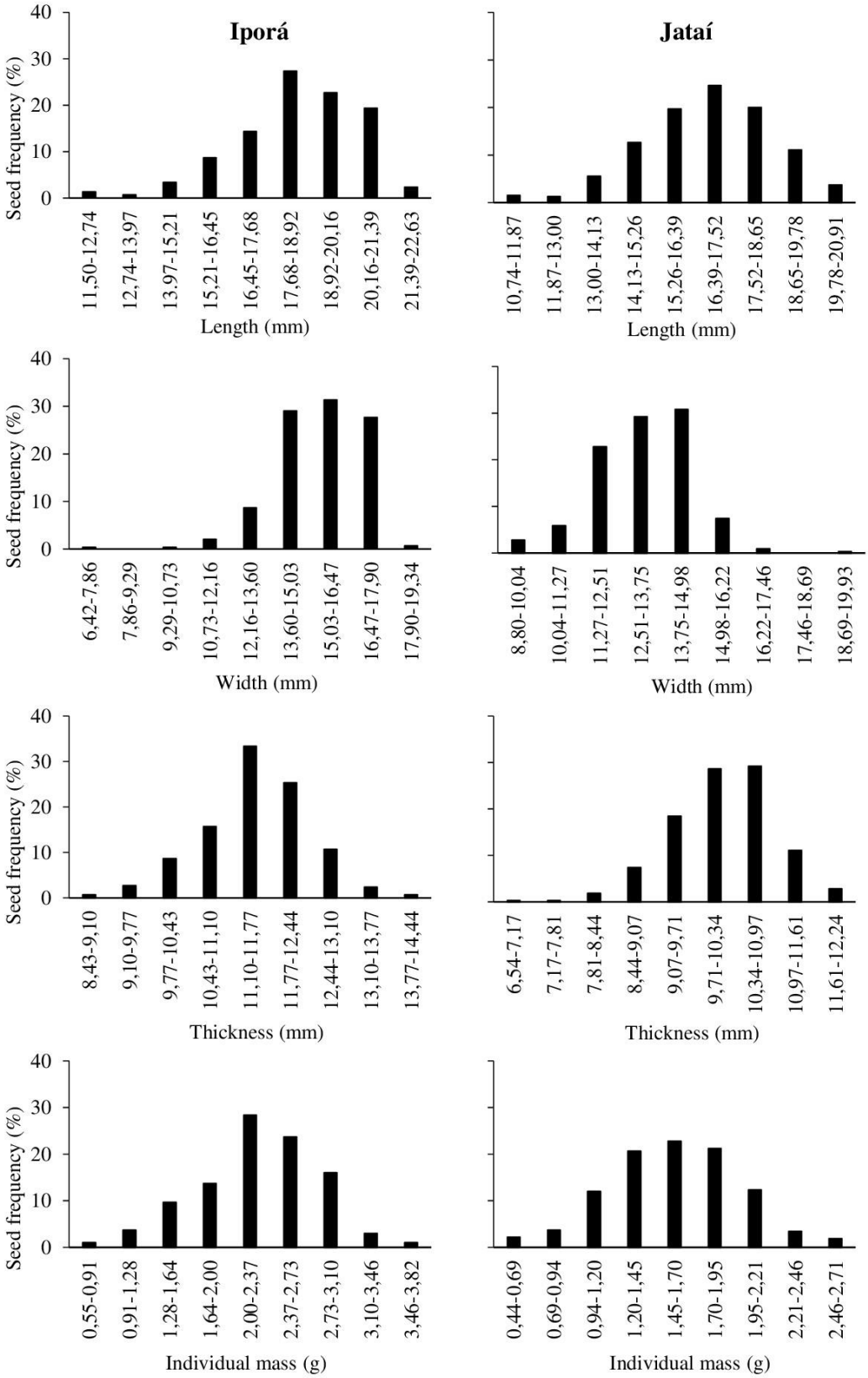

FIGURE 1 - Seed frequency (%) in each class of variables dimension (length, width and thickness – mm) and individual mass (g) of *Brosimum gaudichaudii* Trécul seeds collected from mother trees located in two municipalities in the state of Goiás (Iporá and Jataí).

TABLE 1 - Dimensions (length, width and thickness - in mm) and individual mass (g) of seeds collected in Iporá and Jataí (GO), percentage and emergence speed index (%, ESI), mortality, beginning and end of emergence of *Brosimum gaudichaudii* seedlings.

Variables	Iporá	Jataí	T-test
Seed length (mm)	18.43 ± 0.11*	16.75 ± 0.11	$t = 11.35$; $p = 1.46E^{-27}$
Seed width (mm)	15.19 ± 0.08*	13.21 ± 0.09	$t = 17.12$; $p = 2.00E^{-54}$
Seed thickness (mm)	11.60 ± 0.05*	10.13 ± 0.05	$t = 21.77$; $p = 7.31E^{-79}$
Seed mass (g)	2.25 ± 0.03*	1.57 ± 0.02	$t = 17.75$; $p = 1.20E^{-57}$
Seedling emergence (%)	92^{ns}	81	$p > 0.05$
ESI	19.84^{ns}	17.95	$p > 0.05$
Seedling mortality (%)	10	13	-
Beginning of seedling emergence	9 days	16 days	-
End of seedling emergence	32 days	45 days	-

Mean values ± standard error of the mean. * Significant difference between values of both origins, with p-values lower than 0.05, from the t test.

The emergence percentage of seedlings from *B. gaudichaudii* seeds collected in the two municipalities of Goiás did not differ from each other (Table 1), as well as the emergence speed index (ESI) and the seedling mortality percentage. On the other hand, Ladeia et al. (2012) and Wang et al. (2017) verified the effect of seed origin and size on germination. The high germination percentage allows inferring that seeds of both origins have high quality, despite their different dimensions and individual mass. The fact that seeds collected in Jataí had longer time interval for seedling emergence, in addition to having started emergence seven days after those collected in Iporá, did not affect seedling emergence percentage and speed.

To obtain a certain amount of seedlings in a given period of time, it is necessary to previously know the seedling emergence percentage and speed, in addition to growth and development (BEHLING et al., 2013), which allows knowing their characteristics and limitations. As for ESI, there are authors who have verified the influence of origin on seed quality (SILVA and DANTAS, 2013). The seedling emergence speed can also be influenced by seed size, as observed by Faria et al. (2013) and Queiroz and Dias (2021), where small *B. gaudichaudii* seeds had lower emergence percentage than medium and large ones. The higher the ESI, the greater the seed vigor, which allows inferring about the quality of seeds of both origins under study. However, ESI values for *B. gaudichaudii* seeds in differents origins were insignificant.

As expected, all initial growth variables (height, diameter and number of leaves) increased significantly ($p < 0.001$) over the period under study for seedlings from both origins, except for the chlorophyll index (Figure 2).

Furthermore, height, diameter and number of leaves showed significant difference between seedlings collected in Iporá and Jataí ($p < 0.001$; Figure 2). The initial seedling growth may vary depending on the origin of seeds, which is explained by the effect of climate on seed production, as observed by Navroski et al. (2016). In addition to origin, seed size can also influence seedling height, according to Faria et al. (2013), who, 30 days after sowing, found that large B. *gaudichaudii* seeds produced taller and larger seedlings. Pereira et al., (2017), for example, found statistical difference in width, length and fresh biomass of fruits, number of seeds per fruit and width and length of *Cedrela fissilis* seeds between the different mother trees where fruits and seeds were collected.

The total chlorophyll content of *B. gaudichaudii* leaves in this study did not vary between seedling origins, nor was there any difference between values obtained during initial seedling growth (Figure 2). This was contrary to expectations, as the chlorophyll content of leaves tends to increase during the initial seedling growth, as observed by Marenco et al. (2019). Many factors, both external and internal, can influence chlorophyll biosynthesis, which implies changes in leaf chlorophyll content. Light intensity, for example, affects the chlorophyll concentration, which has been used as a tool to indicate the susceptibility of plants to light intensity (PAVLOVIC et al., 2014).

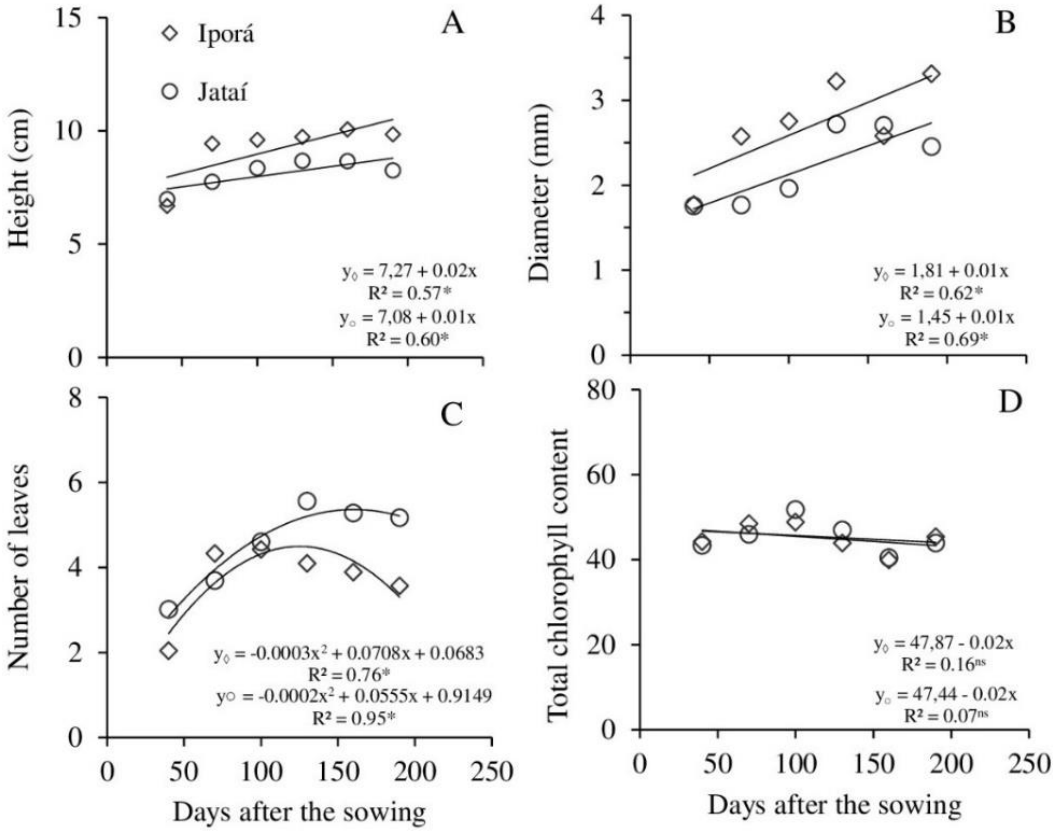

FIGURE 2 - Height (cm), diameter (mm), total chlorophyll content and number of leaves of seedlings determined at 40, 70, 100, 130, 160, and 190 days after the sowing of *Brosimum gaudichaudii* Trécul. seeds collected in two municipalities in the state of Goiás (Iporá and Jataí).

The average dry biomass of seedlings at the end of the experiment (190 DAS) was 4.64 and 3.34 g, respectively, for seedlings collected in Iporá and Jataí, considered statistically similar (p = 0.79). The dry biomass of the different compartments of *B. gaudichaudii* seedlings varied from one another, with root being the one with the highest investment, in seeds of both origins (Figure 3). Over time, it was possible to observe that only the root compartment of seedlings increased, in percentage, their dry biomass (Figure 3). In the first years of life, Cerrado tree species have root system capable of reaching the most humid and deepest soil layers. Only with deep roots, these species could overcome the dry winter season maintaining positive annual carbon and water balance to reach adulthood (SILVA, 2016). Therefore, Cerrado species invest in greater biomass in the root system, so that they can ensure seedling vigor in the dry season.

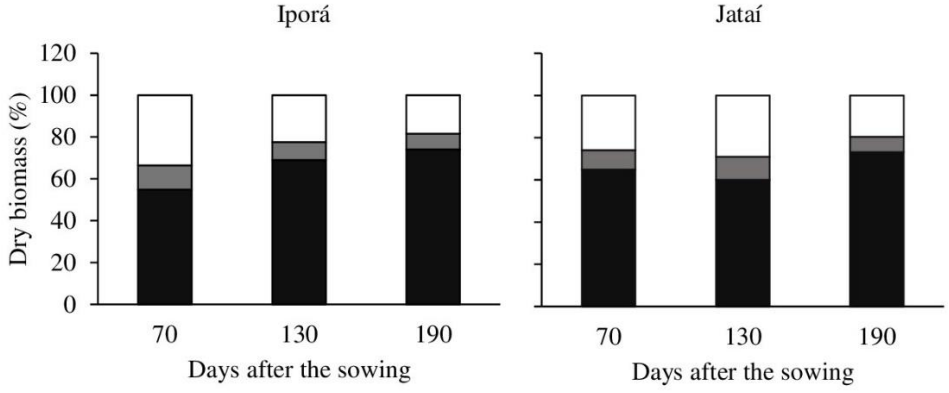

FIGURE 3 - Dry biomass (%) of the different compartments (root, stem and leaf) of *Brosimum gaudichaudii* Trécul. seedlings produced from seeds collected in two locations in the state of Goiás – Iporá (A) and Jataí (B) at 70, 130, and 190 days after sowing.

The Dickson quality index (DQI) for *B. gaudichaudii* seedlings increased over the analyzed period (Figure 4), reaching value of 0.10 (Iporá) and 0.08 (Jataí) at 190 DAS, which were statistically different (p = 0.03). The difference found for the DQI of the different origins probably occurred as a result of the higher diameter and dry biomass values of seedlings produced from seeds collected in Iporá. The DQI has been used as indicator of seedling quality and their development after being planted in the field (ELOY et al., 2013). The higher the DQI, the better the seedling quality standard (AQUINO et al., 2018), and, in forest species, the minimum DQI value would be 0.20. Despite this, in the period under study, seedlings did not reach the expected DQI, mainly due to the slow growth, typical of species or the type of substrate used, or even due to the imbalance between root and shoot biomass, which does not mean that they do not have good quality.

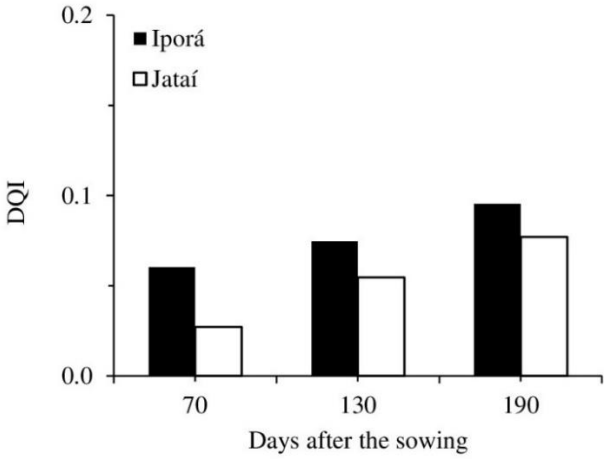

FIGURE 4 - Dickson's Quality Index (DQI) of seedlings produced from *B. gaudichaudii* Trécul. seeds collected in two municipalities in the state of Goiás (Iporá and Jataí) at 70, 130 and 190 days after sowing.

CONCLUSIONS

The seed emergence percentage and speed values and the initial growth of *B. gaudichaudii* seedlings indicate the good quality of seeds and seedlings from the two origins under study. Despite the quality verified for seeds and seedlings from the two origins, seeds collected in Iporá presented larger dimensions than those collected in Jataí, generating seedlings with greater initial growth and higher quality.

REFERENCES

ALMEIDA, J.P.N.; PINHEIRO, C.L.; LESSA, B.F.T.; GOMES, F.M.; FILHO, S.M. Estresse hídrico e massa de sementes na germinação e crescimento de plântulas de *Amburana cearensis* (Allemão) A.C. Smith. **Revista Ciência Agronômica**, v.45, n.4, p.777-787, 2014.

BEHLING, A.; BAMBERG, R. PERRANDO, E.R.; EBLING, A.A.; PELISSARI, A.L. Influência do substrato na germinação e no índice de velocidade de emergência de sementes de *Bauhinia forficata* Link. **Enciclopédia Biosfera**, v.9, n.17, p.17-25, 2013.

CARVALHO, N.M.; NAKAGAWA, J. **Sementes:** ciência, tecnologia e produção. 5a. edição. Jaboticabal: Funep, 2012. 588p.

DEB, P.; SUNDRIYAL, R.C. Effect of seed size on germination and seedlings fitness in four tropical rainforest tree species. **Indian Journal of Forestry**, v.40, n.4, p.313-322, 2017.

ELOY, E.; CARON, B.O.; SCHMIDT, D.; BEHLING, A.; SCHWERS, L.; ELLI, E.F. Avaliação da qualidade de mudas de *Eucalyptus grandis* utilizando parâmetros morfológicos. **Revista Floresta**, v.43, n.3, p.373-384, 2013.

FARIA, R.A.P.G.; COELHO, M.F.B.; FIGUEIREDO, E.; ALBUQUERQUE, M.C.; AZEVEDO, R.A.B. Fenologia de *Brosimum gaudichaudii* Trécul. (Moraceae) no cerrado de Mato Grosso. **Ciência Florestal**, v.25, n.1, p.67-75, 2015.

FARIA, R.A.P.G.; ALBUQUERQUE, M.C.F.; COELHO, M.F.B. Tamanho da semente e sombreamento no desenvolvimento inicial de *Brosimum gaudichaudii* Trécul. **Revista Caatinga**, v.26, n.1, p.9-15, 2013.

FOLAKE, A.B.; OLUSOLA, O.A. Effect of seed size on *Afzelia africana* (Smith) germination. **International Journal of Agriculture, Forestry and Fisheries**, v.8, n.1, p.1-4, 2020.

FONSECA, C.S.; QUEIROZ, E.D.; VENTUROLI, F. **Identificação de espécies florestais na Escola de Agronomia da UFG.** 1ª edição, Goiânia: UFG, 2017. 70p.

GONÇALVES, L.G.V.; ANDRADE, F.R.; MARIMON-JUNIOR, B.H.; SCHOSSLER, T.R.; LENZA, E.; MARIMON, B.S. Biometria de frutos e sementes de mangaba (*Hancornia speciosa* Gomes) em vegetação natural na região leste de Mato Grosso, Brasil. **Revista de Ciências Agrárias**, v.36, n.1, p.31-40, 2013.

IBGE. INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. **Relatório de estação geodésia, Jataí/GO.** 2018. Available at: <http://www.bdg.ibge.gov.br/bdg/pdf/relatorio.asp?L1=93959>. Access in: 31 mai. 2021.

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KUMAR, R.; SHAMET, G.S.; ALAM, N.M.; JANA, C. Influence of growing medium and seed size on germination and seedling growth of *Pinus gerardiana* Wall. **Compost Science and Utilization**, v. 24, n.2, p.98-104, 2016.

LADEIA, E.S.; COELHO, M.F.B.; AZEVEDO, R.A.B.; ALBUQUERQUE, M.C.F. Procedência do fruto e substratos na germinação de sementes de *Pseudobombax longiflorum* (Mart. Et Zucc.) A. Robyns. **Pesquisa Agropecuária Tropical**, v.42, n.2, p.174-180, 2012.

NAVROSKI, M.C.; TONETT, E.L.; MAZZO, M.V.; FRIGOTTO, T.; PEREIRA, M.O.; GALVANI, L.V. Procedência e adubação no crescimento inicial de mudas de cedro. **Pesquisa Florestal Brasileira**, v.36, n.85, p.17-24, 2016.

PAVLOVIC, D.; NIKOLIÉ, B.; DUROVIÉ, H.; ANDELKOVIÉ, A.; MARISAVLJEVIÉ, D.; Chlorophyll as a measure of plant health: Agroecological aspects. **Pesticides and Phytomed**, v.29, n.1, p.21-23, 2014.

PEREIRA, M.O.; NAVROSKI, M.C.; HOFFMANN, P.M.; GRABIAS, J.; BLUM, C.T.; NOGUEIRA, A.C.; ROSA, D.P. Qualidade de sementes e mudas de *Cedrela fissilis* Vell. em função da biometria de frutos e sementes em diferentes procedências, **Revista de Ciências Agroveterinárias**, v.16, n.14, p.376-385, 2017.

QUEIROZ, T.A.F; DIAS, D.P. Efeito do tamanho das sementes sobre a emergência e morfofisiologia de mudas de mama-cadela. **Nativa**, v.9, n. 3, p.260-265, 2021.

R CORE TEAM. **R:** A language and environment for statistical computing. Available at: <https://cran.r-project.org/>. Access in: April 5, 2021.

SCALON, S.P.Q.; NEVES, S.E.M.; MASETO, T.E.; PEREIRA, Z.V. Sensibilidade à dessecação e ao armazenamento em sementes de *Eugenia pyriformis* Cambess. (uvaia). **Revista Brasileira de Fruticultura**, v.34, n.1, p.93-101, 2012.

SILVA, A.F.; RABELO, M.F.R.; ENOQUE, M.M. Diversidade de angiospermas e espécies medicinais de uma área de Cerrado. **Revista Brasileira de Plantas Medicinais**, v.17, n.4, p.1016-1030, 2015.

SILVA, F.F.S.; DANTAS, B.F. Efeito da temperatura na germinação de *Sideroxylon obtusifolium* (Sapotaceae) de diferentes procedências. **Revista Sodebras**, v.8, n.90, p.40-43, 2013.

SILVA, K.B. Qualidade fisiológica de sementes de *Sideroylon obtusifolium* (Roem. & Schult.) Penn. classificadas pelo tamanho. **Revista Brasileira de Biociências**, v.13, n.1, p.1-4, 2015.

SILVA, K.F.; SILVA, L.B.; OLIVEIRA, J.N.; MOTA, E.E.S.; FERNANDES, D. Desenvolvimento inicial de mama-cadela implantada por semeadura direta e mudas. **Brazilian Jornal of Development**, v.6, n.1, p.2159-2168, 2020.

VASQUES, H.S.; BARROS, J.R. Os impactos da apropriação do cerrado sobre os indicadores de precipitação pluvial: o caso do município de Jataí-GO. In: SIMPÓSIO BRASILEIRO DE CLIMATOLOGIA GEOGRÁFICA, 12., 2016. **Anais...** Goiânia. Variabilidade e susceptibilidade climática: implicações ecossistêmicas e sociais. Goiânia: SBCG, 2016.

WANG, T.T.; CHU, G.M.; JIANG, P.; NIU, P.X.; WANG, M. Effects of sand burial and seed size on seed germination, seedling emergence and seedling biomass of *Anabasis aphylla*. **Pakistan Journal of Botany**, v.49, n.2, p.391-396, 2017.