

CHARACTERIZATION OF SEEDS, SEEDLINGS AND INITIAL GROWTH OF *JACARANDA MIMOSIFOLIA* D. DON. (BIGNONIACEAE)¹

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ABSTRACT – This research aimed to characterize the biometry of seeds, the morphology of seedlings and to evaluate the initial growth of blue jacaranda trees (*Jacaranda mimosifolia* D. Don.) in two environments with distinct luminosity. The biometry of 100 de-winged seeds was measured by their length, width and thickness. One hundred seeds were sown into 300 cm³ tubes and seedlings morphology was registered throughout the germination process using digital photographs disposed sequentially according to seedlings age. The initial growth analysis was performed in two environments, full sun and greenhouse, during nine periods, and arranged in a complete randomized design with subplots. The response variables were: number of leaves, plant height, collar diameter, root length, aerial and roots dry weight, and Dickson's Quality Index (*DQI*). Biometry results showed seeds 7.09 - 9.26 mm long, 6.74 - 9.39 mm wide, and 1.11 - 1.89 mm thick. Germination is of hypogeal-phanerocotylar type, with first root arising six days after sown. Plants at full sun presented larger collar diameters, greater root dry weight and higher *DQI* as evaluation periods passed by. In conclusion, the biometry of seeds and the morphology of seedlings of blue jacaranda can be used to recognize this species in the field. Plants at full sun presented better development. Seedlings cultivated at full sun can be destined to recuperate forests and degraded areas just 36 weeks after sowed.

Keywords: Morphobiometry; Types of germination; Seedlings quality.

CARACTERIZAÇÃO DE SEMENTES, PLÂNTULAS E CRESCIMENTO INICIAL DE *JACARANDA MIMOSIFOLIA* D. DON. (BIGNONIACEAE)

RESUMO – Objetivou-se nesta pesquisa fazer a caracterização biométrica das sementes, morfologia das plântulas de *Jacaranda mimosifolia* D. Don. e avaliar o crescimento inicial das mudas em dois ambientes distintos com diferentes níveis de luminosidade. Para a biometria de sementes, utilizou-se 100 sementes sem as partes aladas para a mensuração do comprimento, largura e espessura. Para a morfologia das plântulas, semeou-se 100 sementes em tubetes de 300 cm³, registrando-se os eventos do processo germinativo através de fotos digitais e dispondo-as de forma sequenciada de acordo com a idade das plântulas. A análise de crescimento inicial foi realizada em sol pleno e estufa agrícola durante nove épocas num esquema de parcelas subdivididas, em delineamento inteiramente casualizado. As variáveis respostas foram: número de folhas, altura da planta, diâmetro do coleto, comprimento da raiz, massa seca da parte aérea e raiz, bem como, o índice de qualidade de Dickson (*IQD*). O comprimento das sementes variou de 7,09 a 9,26 mm, a largura de 6,74 a 9,39 mm e a espessura de 1,11 a 1,89 mm. A germinação é do tipo fanerocotiledonar hipógea, com o surgimento da raiz primária ao sexto dia após a semeadura. O jacarandá-mimoso apresentou maiores valores de diâmetro do coleto, massa seca da raiz e *IQD* no transcorrer do tempo em sol pleno. Conclui-se que a caracterização biométrica de sementes e morfológica de plântulas de jacarandá-mimoso possibilita o reconhecimento da espécie em campo. As plantas produzidas em sol pleno apresentam melhor desenvolvimento. Após 36 semanas de desenvolvimento as mudas mantidas em sol pleno podem ser destinadas a recomposição vegetal e recuperação de áreas degradadas.

Palavras-Chave: Morfobiometria; Tipos de germinação; Qualidade de mudas.



1. INTRODUCTION

Bignoniaceae Juss. is a botanical family with approximately 100 genres and 860 species (Fischer et al., 2004), from which the *Jacaranda* genre is widely used on landscaping and recovery of forested areas, e.g. *Jacaranda brasiliiana* (Lam.) Pers., *Jacaranda cuspidifolia* Mart. and *Jacaranda mimosifolia* D. Don. (Costa et al., 2011).

The blue jacaranda (*J. mimosifolia*), known in Brazil as jacarandá-mimoso or carobaguaçu, is an exotic species, native from Argentina, Bolivia and Paraguay, though it can also be found in both tropical and temperate regions (Alves et al., 2010). This tree is used in urban landscaping of both streets and parks due to their leaves delicacy, and also for the abundance and color of their flowers (Souza and Lorenzi, 2005).

The amount of researches related to biometric characterization of seeds, and to seedlings morphology, increased during recent years, as well as the number of studies about the initial growth of arboreal species seedlings in different environments, all due to the increasing interest on using such trees to restore degraded areas, forests, and for landscaping.

Biometric characterization of seeds assists the identification of families, genres and species, it helps to understand dispersion and germination processes, and also to improve seeds processing, storage, and sowing methods (Paoli and Bianconi, 2008; Rego et al., 2010; Diniz et al., 2015). Likewise, studies on seedlings morphology help generating data used to classify germination types and to identify some species structures, enabling to perceive the functionalities of such structures in the ecosystem, and to subsidize programs of conservation and environmental restoration (Cosmo et al., 2017).

Plants growth is influenced by abiotic environmental factors (Mota et al., 2012), and light is one of the most important, since it provides the energy used during photosynthesis, affecting carbohydrates production, dry mass accumulation and biomass increase (Dantas et al., 2009; Lone et al., 2009; Cabanez et al., 2015). Consequently, growth analysis makes it possible to broadly comprehend how plants respond to these factors, being essential to understand how such factors are involved in the physiology of the growing process (Alves et al., 2016).

Despite the environmental, social and economic importance of blue jacaranda, there are still no studies

about its seeds biometry, seedlings morphology and initial growth. Therefore, this research aimed to characterize the morphology of seeds and seedlings of blue jacaranda (*Jacaranda mimosifolia* D. Don.), as well as to evaluate the seedlings initial growth in two environments of distinct luminosity, targeting the use of this species for restoring forests and degraded areas.

2. MATERIAL AND METHODS

The fruits of blue jacaranda were harvested in the Fortaleza metropolitan area, and taken to be processed at the Urban Agriculture Teaching & Research Nucleus (NEPAU), inside the Department of Plant Science at the Agricultural Sciences Center (CCA) from the Federal University of Ceará (UFC).

The biometry of 100 de-winged seeds was characterized by measuring their length, width and thickness with a digital caliper (± 0.01 mm). Histograms, frequency polygons and descriptive statistics were calculated for each of these variables. External aspects of the seeds were also recorded, e.g. color, shape and integument consistency. The weight of 1000 seeds was calculated according to Brasil (2009).

Another 100 seeds were sown into 300 cm³ tubes filled with organic compost and vermiculite (1:1 v/v). These tubes were kept inside an agricultural greenhouse at NEPAU and under irrigation until 18 days after sowing (DAS), when all observations ceased. Morphological events were registered by digital photographs and described using terminologies proposed by Souza (2009). All images were processed using Photoshop software, and the germination process was registered by arranging the photographs according to seedlings age.

To evaluate initial growth, seeds were sown into polyethylene trays containing 162 cells, all filled with a mixture of vermiculite, organic compost and soil (1:1:1 v/v). These trays were kept inside a greenhouse and irrigated on a daily basis. Germination started after 6-7 DAS, and all seedlings presented 6 leaves 23 DAS. At this point, seedlings were replanted in polyethylene bags (11 x 26 cm) filled with soil and organic compost (1:1 v/v) and placed at two environments, full sun and greenhouse, with water being supplied twice a day.

The full sun environment is an open area with no interference to sunlight incidence over all plants. The greenhouse is a metallic structure with an arch

ceiling covered by an UVA plastic filter (0.15 mm width) with an underlying shading screen (50%) covering the whole surface and all sides. Average temperature, relative humidity and luminosity were, respectively, 35.4 °C, 70.1% and 21719.8 lux at full sun, and 33.3 °C, 69.2% and 4368.3 lux at greenhouse.

All factors were arranged in a completely randomized design with sextuplicate subplots containing four plants each, having *environments* as plots and *evaluation periods* (0, 15, 30, 45, 60, 75, 90, 105 e 120 days after replanting – DAR) as subplots. Plant variables were: number of leaves (*NL*), plant height (*PH*), collar diameter (*CD*), root length (*RL*), aerial dry weight (*ADW*), roots dry weight (*RDW*), and Dickson’s Quality Index – *DQI*, calculated by Equation 1 using the aforementioned variables plus plants total dry weight (*TDW*) (Dickson et al., 1960).Eq1

$$DQI = \frac{TDW (g)}{\frac{PH (cm)}{CD (mm)} + \frac{ADW(g)}{RDW (g)}}$$

Data were submitted to an analysis of variance to check effects of isolated factors and their interaction. When the interaction was significant, evaluation periods were unfolded within environments using regressions calculated by the orthogonal polynomials method.

3. RESULTS

Blue jacaranda seeds present cordiform to orbicular shape, with a hyaline wing whit brownish tonalities, and a brown membranous integument. The hilum and the micropyle are inconspicuous.

The seeds were 7.09-9.26 mm long, presenting average, variance and coefficient of variation (CV%), respectively, of 8.12 ±0.51 mm, 0.26 mm² and 6.28%. Lengths frequency distribution was skewed right, with higher frequency of seeds (25%) around 8.33 mm long (Figure 1A). Their width ranged from 6.74 to 9.39 mm, with an 8.00 ± 0.54 mm average, 0.29 mm² variance, and 6.75% CV%. This variable also showed a skewed right histogram, with higher frequency of seeds (29%)

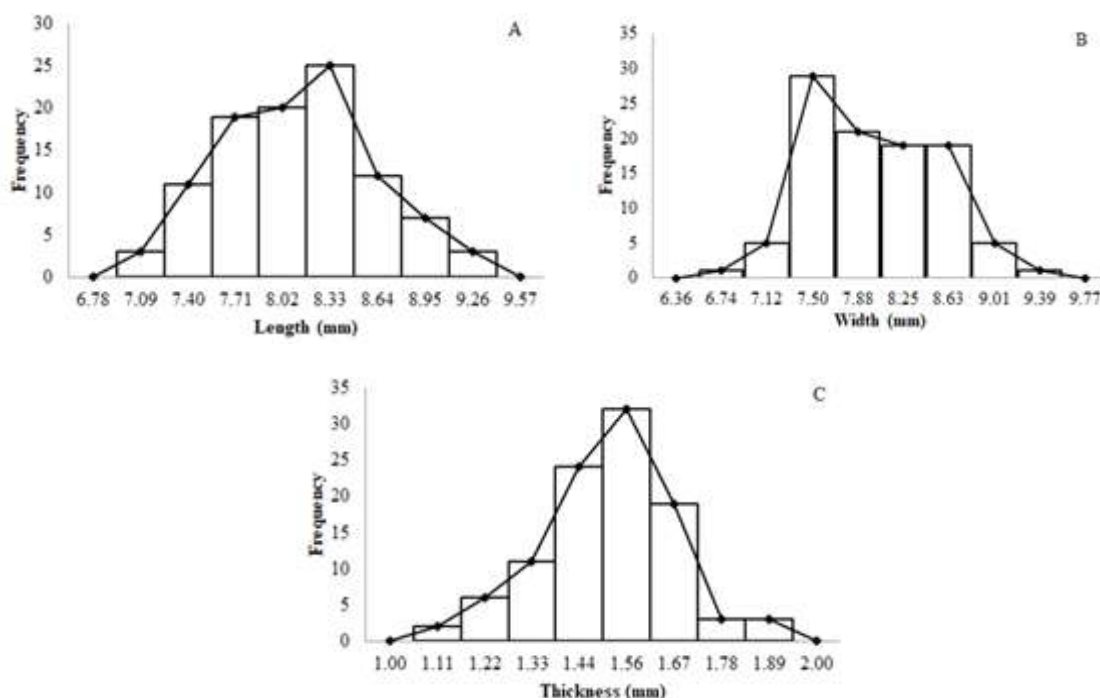


Figure 1 – Histograms and frequency polygons of length (A), width (B) and thickness (C) of 100 seeds of *Jacaranda mimosifolia* D. Dom.

Figura 1 – Histograma e polígono de frequência do comprimento (A), largura (B) e espessura (C) de 100 sementes de *Jacaranda mimosifolia*.

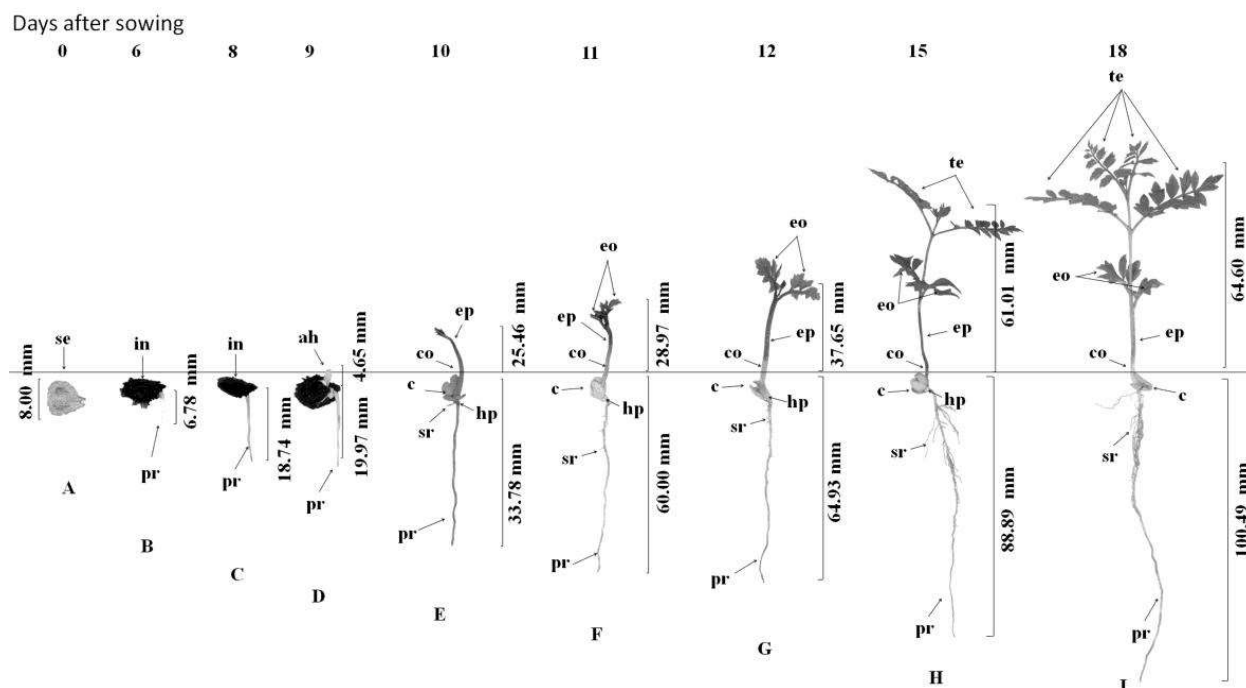


Figure 2 – Morphological aspects of the seedlings and thyrodendro of *Jacaranda mimosifolia* D. Don: A: seed, B – F: developing seedling, G: seedling with a pair of eophylls, H – I: seedling in the phase of the thyrodendro. (ah = apical hook; c = cotyledon; co = collar; eo = eophyll; ep = epicotyl; te = thyrodendro eophyll; hp = hypocotyl; pr = primary root; sr = secondary root; se = seed; in = integument).

Figura 2 – Aspectos morfológicos da plântula e tirodendro de *Jacaranda mimosifolia* D. Don: A: semente, B – F: plântula em desenvolvimento, G: plântula com um par de eofilos, H – I: plântula na fase do tirodendro. (al = alça; c = cotilédone; co = colo; eo = eofilo; ep = epicótilo; et = eofilo do tirodendro; hp = hipocótilo; rp = raiz principal; rs = raiz secundária; se = semente; tg = tegumento).

about 7.50 mm wide (Figure 1B). Their thickness presented amplitude between 1.11 and 1.89 mm, averaging 1.51 ± 0.16 mm, with 0.02 mm^2 variance and 10.60% CV%. This variable was skewed left, with higher frequency of seeds (32%) around 1.56 mm thick (Figure 1C).

The morphological development phases of blue jacaranda seedlings are shown in Figure 2. The de-winged seeds can be seen in Figure 2A. The hypogeal-phanerocotylar germination began with primary root emission 6 DAS (Figure 2B). Axial root was 18.74 mm long 8 DAS, and was cylindrical, glabrous and whitish, becoming light-yellow during growth (Figure 2C). The greenish apical hook emerged 9 DAS, measuring 4.65 mm long (Figure 2D). Integument liberation, and consequent cotyledons unfolding, happened 10 DAS, simultaneously to epicotyl elongation, which was cylindrical, pubescent and greenish. Unfolded cotyledons were opposite, fleshy, obcordate, yellowish, with short petiole (5.96 mm long and 7.13 mm wide). Cotyledons

kept attached to seedlings until the appearance of the first metaphyll, and during this period the secondary whitish roots appeared (Figure 2E). The hypocotyl was too short and not very evident.

The first eophyll pair developed 11 DAS (Figure 2F). The epicotyl is reddish closer to the eophyll, allowing the differentiation between it and the whitish collar (Figure 2F). The first phase of seedlings formation cycle ended 12 DAS, when the first eophyll pair expanded completely, presenting all essential structures in perfect morphological conditions (Figure 2G). The first eophyll of the second phase appeared 15 DAS (Figure 2H). Seedlings presented six eophylls 18 DAS, averaging a height of 64.60 mm, collar diameter of 1.22 mm, and with 100.49 mm long main roots abundant with secondary roots (Figure 2I). The eophylls are pinnately compound leaves with petiole, imparipinnate, pubescent, presenting sessile serrated leaflets, colored green, that are darker in the adaxial face. Leaves present a decussate arrangement,

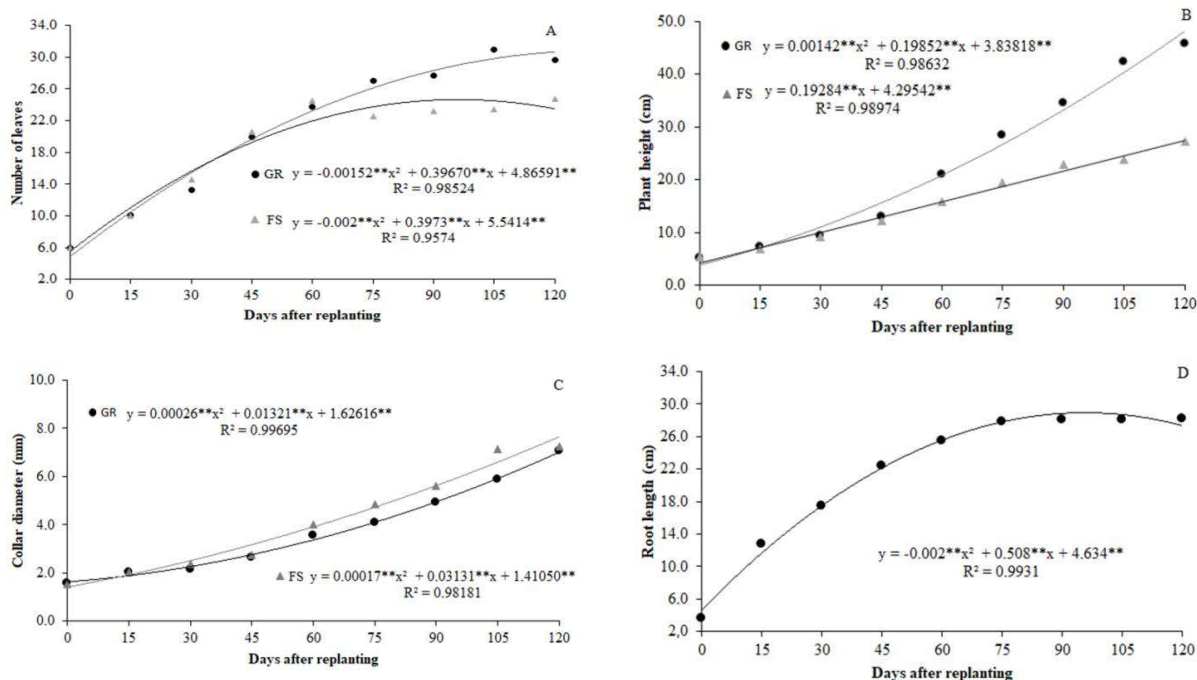


Figure 3 – Number of leaves (A), plant height (B), collar diameter (C) and root length (D) of seedlings of *Jacaranda mimosifolia* D. Don. kept at full sun (FS) and inside a greenhouse (GR), during nine evaluation periods.
Figura 3 – Número de folhas (A), altura da planta (B), diâmetro do coleto (C) e comprimento da raiz (D) de mudas de *Jacaranda mimosifolia* D. Don. sob condições de sol pleno (SP) e estufa agrícola (EA), durante nove períodos de avaliação.

with the first eophyll pair presenting 3-5 leaflets, the second 11, and the third 13 (Figures 2G to 2D).

When observing the initial growth of blue jacaranda, the number of leaves (NL) significantly differed between environments from 75 DAR (performed 23 DAS) and the greenhouse showed the best results (Figure 3A). This environment also presented superior plants height (PH) from 60 DAR (Figure 3B).

Collar diameter (CD) was similar in both environments until 45 DAR, date from which larger values were computed by full sun plants (Figure 3C). This variable presented a quadratic regression with evaluation period in both environments, with coefficients of determination (R^2) higher than 98 % (Figure 3C).

Root length (RL) did not present interaction between environment and evaluation period (Figure 3D). This isolated factor presented a quadratic regression with 99.31% R^2 (Figure 3D). It was noticed a rapid root elongation until 60 DAR, however, changes were non-significant after, with roots reaching 28.18 cm 120 DAR.

Figure 4A shows a quadratic regression of aerial dry weight (ADW) along evaluation periods, with both environments presenting almost maximum R^2 . Seedlings of both environments presented similar accumulation in ADW until 90 DAR. After this period, the best results were observed at greenhouse, which averaged 6.80 g 120 DAR. At 45 DAR, full sun plants presented larger amounts of root dry weight (RDW) (Figure 4B). This tendency was also observed for Dickson's Quality Index (DQI), which averaged 0.73 and 1.33 120 DAR at greenhouse and full sun, respectively (Figure 4C).

4. DISCUSSION

Seeds of blue jacaranda (*Jacaranda mimosifolia*) presented shape similar to *J. decurrens* subsp. *symmetrifoliolata* Farias & Proença (Sangalli et al., 2012). Both species have winged seeds, which may facilitates dispersion by wind at great distances, representing a colonization advantage (Gogosz et al., 2015).

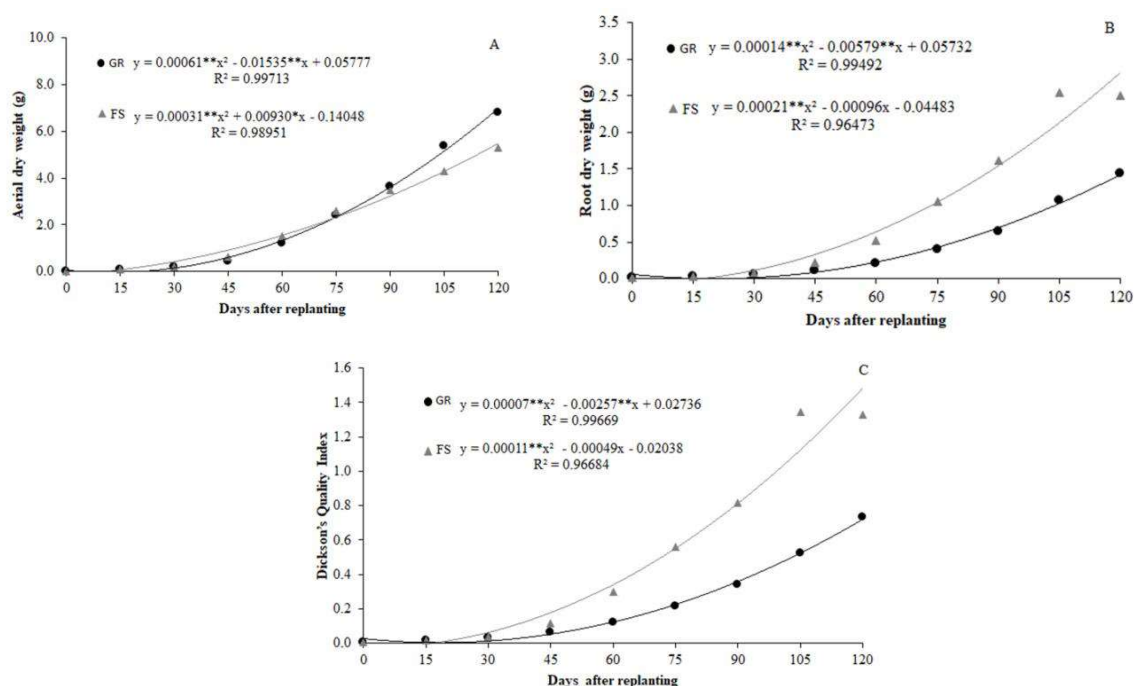


Figure 4 – Aerial dry weight (A), root dry weight (B) and Dickson's Quality Index (C) of seedlings of *Jacaranda mimosifolia* D. Don. kept at full sun (FS) and inside a greenhouse (GR), during nine evaluation periods.

Figura 4 – Massa seca da parte aérea (A), massa seca da raiz (B) e índice de qualidade de Dickson (C) de mudas de *Jacaranda mimosifolia* D. Don. sob condições de sol pleno (SP) e estufa agrícola (EA) durante os nove períodos de avaliação.

However, biometric data and average number of seeds kg^{-1} differ between these congener species. *J. decurrens* subsp. *symmetrifoliolata* seeds are 5.9-13 mm long, 6.0-12.0 mm wide and 0.4-2.2 mm thick, with an average of 31,545 seeds kg^{-1} (Sangalli et al., 2012), which are heavier than those from *J. mimosifolia*. These authors assure that is common to find morphometric variations between undomesticated species, e.g. *J. decurrens* subsp. *symmetrifoliolata*, indicating a high genetic variability within the population. This may be influenced by biotic and abiotic factors during fruits formation and seeds development (Dutra et al., 2017).

Moraes and Alves (2002) affirm that seed size is an important factor, since larger seeds boost the chances of having a successful germination, and increase growth and seedling survival, also producing seedlings that are more vigorous and competitive.

Another feature that deserves attention is the germination type, which in the case of *J. mimosifolia* was hypogea-phanerocotylar. This differs from both

J. copaia (Aubl.) D. Don. subsp. *spectabilis* (Mart. ex A. DC) Gentry (Gurgel et al., 2006; Abensur et al., 2007) and *J. ulei* Bureau and K. Schum. (Silveira et al., 2013), which present epigeous-phanerocotylar germination. *J. mimosifolia* also presented fleshy cotyledons, being the same observed for *J. copaia* (Gurgel et al., 2006).

Radicle protrusion happened 6 DAS for *J. mimosifolia*, while *J. copaia* took 11 DAS (Abensur et al., 2007). Leaves morphological analysis revealed mutual elements amongst congener species, e.g. *J. copaia* (Gurgel et al., 2006), *J. brasiliiana* (Lam.) Pers. and *J. cuspidifolia* Mart. (Costa et al., 2011).

The axial root system presented faster development than aerial shoots, which may be considered as an ecological advantage that provides a better use of substrate resources.

J. mimosifolia presented larger number of leaves and higher average plant height inside the greenhouse.

Similar results were found for *J. puberula* Cham. (Almeida et al., 2005a). This pattern is explained by plants capacity of growing fast when shadowed, constituting an important adaptation mechanism for this species as a strategy to escape low luminosity conditions (Almeida et al., 2005b; Pacheco et al., 2013).

Full sun environment significantly influenced *J. mimosifolia* collar diameter, likewise results found for *Tabebuia aurea* (Silva Manso) Benth. & Hook. f. ex S. Moore (Oliveira and Perez, 2012). The higher radiation of this environment provides a larger production of photassimilates, which accumulates inside plants stalk (Siebeneichler et al., 2008; Ferreira et al., 2016). Câmara and Endres (2008) sustain that this variable is a strong quality indicator for seedlings, since larger collars improve plants equilibrium and provides a better development to aerial shoots.

There were no differences between root lengths in the two environments along evaluation periods. This was probably due to physical impediment caused by the size of the recipients used for seedlings production, which was only 26 cm long (Vallone et al., 2010; Antoniazzi et al., 2013).

Aerial dry weight presented better results inside greenhouse, since plants in this environment were taller. However, full sun presented larger values of root dry weight. Probably, luminosity intensity favored photosynthesis, which directed more photassimilates to the root system (Freitas et al., 2012). The same authors believe that seedlings with well-developed roots have more chances of surviving in the field, since seedlings with longer aerial shoots have more chances of tipping, altering the quality pattern.

Dickson's Quality Index (*DQI*) stood out for full sun seedlings. *DQI* includes important characteristics that interfere on plants survival and seedlings quality (Bonamigo et al., 2016), since it takes into consideration biomass distribution and robustness, pondering several important parameters (Melo and Cunha, 2008).

5. CONCLUSIONS

The characterization of seeds biometry and morphology of seedlings of blue jacaranda (*Jacaranda mimosifolia* D. Don.) make it possible to recognize this species in the field, since its morphological characters are homogeneous. These information permit to plan laboratorial activities, to improve seeds processing and to identify this plant during its juvenile phase.

Plants cultivated at full sun presented better development and higher vigor, and this environment is the most recommended to the production of seedlings of this species.

Seedlings produced at full sun can be destined to recuperate forests and degraded areas just 36 weeks after sowing.

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