GERMINATION AND MORPHOLOGY OF SEEDS AND SEEDLINGS OF *Parkia gigantocarpa* FABACEAE: MIMOSOIDAE

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Abstract

Parkia gigantocarpa is a valuable timber tree, and due to its rapid growth and great survival can be used to enrich forest clearings. The aims of this study was describe main morphological characters of seeds and seedlings, and to evaluate germination and initial growth of the species at six temperatures. The seed shape varies from elliptical, oblong or ovoid with bone consistency surface, smooth, glossy black color and presence of pleurogram. Average dimensions were 21.25 mm (length), 10.43 mm (width), and 6.15 mm (thickness). The embryo type is linear axial, with fleshy cotyledons, convex planes and dominant. The germination is epigeous phanerocotyledonary with fleshy cotyledons, and occurs between the second and fifth days after sowing. The fully developed seedling stage was reached on the fifteenth day after sowing. Temperatures of 30 and 35 C provided higher germination rates in less time and with higher root biomass allocation.
Keywords: Amazon; biometrics; germination temperature; fava-atanã; forest seeds.

Resumo

Germinação e morfologia de sementes e plântulas de Parkia gigantocarpa Fabaceae: Mimosoidae. Parkia gigantocarpa é uma árvore de interesse madeireiro, indicada para o enriquecimento de clareiras devido seu rápido crescimento. Os objetivos deste trabalho foram descrever os principais caracteres morfológicos de sementes e plântulas, e avaliar a germinação de sementes e desenvolvimento inicial da espécie em seis temperaturas. As sementes apresentam formato que varia de elíptica, ovóide ou oblonga com superfície de consistência óssea, lisa, brilhosa de coloração negra e presença de pleurograma, com dimensões médias de 21,25 mm de comprimento, 10,43 mm de largura, e 6,15 mm de espessura. O embrião é do tipo axial linear, com cotilédones crassos, plano convexos e dominantes. A germinação é epígea fanerocotiledonar com cotilédones carnosos, e ocorre entre o segundo e quinto dias após semeadura, sendo que o estágio de plântula completamente formada é alcançado no décimo quinto dia após a semeadura. As temperaturas de 30 e 35 ºC proporcionaram elevadas taxas de germinação em menor tempo e com maior alocação de biomassa radicular.
Palavras-chave: Amazônia; biometria; temperatura para germinação; fava-atanã; sementes florestais.

INTRODUCTION

Due to high deforestation that took place in the last decades, especially in ecosystem with great biodiversity like tropical forests (LAURANCE, 1999; RODRIGUES *et al*., 2009), many studies arose aiming to increase knowledge of native forest species and production of their seedlings, to be used in ecological restoration programs (SANCHEZ-CORONADO *et al.*, 2007); BRANCALION *et al*., 2011).

Diversity of available seedlings in native forest species nurseries is generally insufficient, because of the difficulty to obtain seedlings or even for lack of knowledge on physiology and germination technology (VIANI; RODRIGUES, 2007). Besides plantation of native species plantlets coming from nurseries, another alternative is recuperation of plantlets or transposition of seed banks and plantlets coming from ecosystem near the area under restoration. These techniques may provide increased biodiversity of native species which are generally not produced in nurseries (VIANI; RODRIGUES, 2007); RODRIGUES *et al*., 2010); PAULA *et al*., 2013).

Thus, knowledge on biology of seeds and seedlings becomes essential to conduct ecological restoration programs, both in knowledge of the germination process to obtain seedlings and in knowledge of the morphological character of propagation material located in the seed bank and seedlings.

Morphological studies on seeds and seedlings have been developed with the aim to provide information to be used in botanical identification of native species, also facilitating individuation of the species in field and in the seed bank (ARAÚJO-NETO *et al.*, 2002; COSMO *et al.*, 2010; ALMEIDA JR. *et al.*, 2010). They may also be useful in characterization of seed dormancy related to morphology, to interpretation of germination tests and determine storage methods (DONADIO; DEMATTÊ, 2000; RAMOS; FERRAZ, 2008; PAIVA SOBRINHO; SIQUEIRA, 2008).

Studies on seed germination are essential, because germination is a complex process, involving physiological factors like cell metabolism and environmental conditions like humidity, temperature, oxygen and light (Carvalho; Nakagawa, 2012). Each species reacts uniquely to the different factors, like temperature for example, which affects individually all the germination processes, acting mainly on water soaking velocity and on all metabolic reactions of the process, thus affecting total germination and velocity of germination (BASKIN; BASKIN, 1998).

Knowledge of morphological characters of seeds and seedlings, and germination of tropical species is scarce; mainly considering biodiversity of Brazilian ecosystems, like for example the amazon biome (CAMARGO *et al.*, 2008; SOUZA, 2009). Few data are available in literature on germination and morphological characters of seeds and seedlings of the amazon species *Parkia gigantocarpa* Ducke, (CARVALHO, 2010; OLIVEIRA *et al.*, 2012).

The species *Parkia gigantocarpa*, commonly known as fava-barriguda, fava-atanã or visgueiro, occurs in dry land forests of the Brazilian Amazon, reaching up to 60 meters height and 1.5 meters in diameter, considered a commercially valuable species, with lightwood and good for plywood production (Paula; Alves, 1997; CARVALHO, 2010). Besides, it is indicated for enrichment of forest clearings and reforestation, due to its rapid growth and high survival rate (VIDAL *et al.*, 2002; Gomes *et al.*, 2010).

Considering the ecological and economical importance of this species, the aim of this work was to describe the main morphological characters of seeds and seedlings, and to evaluate germination and initial development of *P. gigantocarpa* in six different temperatures.

MATERIAL AND METHODS

Collection, processing and storage

Seeds of *P.gigantocarpa* were manually collected from mature fruits of twelve stock plants in a low impact forest management area developed by the Tropical Forest Foundation during the month of July 2009, in the municipality of Paragominas, Pará, Brazil. After collection, seeds were conditioned in plastic bags and transported to the Laboratory of Research of Environmental Systems and Biodiversity, in Campo Grande, Mato Grosso do Sul. In the laboratory, screening of seeds took place, eliminating the malformed and damaged by insects. After that, water content was assessed, following the method of the hothouse at 105±3°C (BRASIL, 2009), during 24 hours, and results were expressed in percentage. After screening, seeds were stored in plastic bags and conditioned in a refrigerator at 15 °C until beginning of the experiments.

Morphological aspects of seeds

External and internal morphological characteristics of seeds were observed with a stereomicroscope (Stemi DRC, Carl Zeiss). Assessed external characteristics of seeds were color, shape, consistence, texture, position of heel and micropyle. To observe internal characteristics, ten seeds were submitted to mechanical scarifying with sandpaper n° 80 on one side and on the opposite side of heel (OLIVEIRA et al., 2012) and immersed in distilled water for 24 hours (CAMARA et al., 2008). Internal characteristics observed were type of embryo, cotyledons, embryonal axis and plumule. Works of Barroso *et al.* (1999), Camara *et al.* (2008), Ramos and Ferraz (2008) and Nogueira *et al*. (2010) were used as reference for the morphological description of seeds.

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For biometrical determination, 60 seeds randomly chosen were used to be individually measured: length, width and thickness were determined using a digital caliper with 0.01 mm precision. Length was measured from base to top, while width and thickness were taken in the middle line of seeds. Biometrical data were submitted to descriptive statistical analysis with the software Bioestat 5.0, obtaining minimum and maximum values, arithmetic mean, standard deviation and coefficient of variation for each variable.

Morphological aspects from germination to seedling

Thirty seeds were randomly chosen to morphologically describe the germination process and seedlings, overcoming their tegumentary dormancy using a n° 80 sandpaper until their cotyledon was slightly exposed (OLIVEIRA *et al.*, 2012). After that, seeds were disinfected by immersion in sodium hypochlorite (2%) for a minute, and then rinsed in distilled water.

Seeds were left to germinate in transparent boxes (11 x 11 x 3.5 cm) on vermiculite bed, in a germination chamber (B.O.D., Eletrolab®) regulated at 30 ± 2°C, with twelve hours of fluorescent white light photoperiod. After 3 days they were transplanted into plastic bags (20 x 10 cm), filled with plantimax commercial substrate. Plastic bags were maintained in laboratory on a bench where sunlight was regularly available, with minimum and maximum temperature respectively of 23 and 26 °C.

Observations continued for 15 days after sowing, determining how long the primary root protrusion took to appear and the time for complete formation of the seedling, with vegetative characteristics of root, hypocotyl, epicotyl, cotyledon and eophyll described and registered. Terminology used to describe the germination process and morphological characters of seedlings was based on Oliveira (1993), Gonçalves and Lorenzi (2007), Ramos and Ferraz (2008) and Nogueira *et al*. (2010). The adopted concept of seedling is referred to the phase extending from the end of complete seed germination until complete expansion of the first leaf (eophyll) (SOUZA, 2009).

Germination of seeds in different temperatures

To overcome tegumentary dormancy, in this case, a chemical scarifying method was used by immersion of seeds in sulfuric acid (H_2SO_4 98%) for 20 minutes, by putting them in a Becker and adding sulfuric acid until covering all seeds. After the planned immersion time was over, seeds were put on a metallic sieve and rinsed with running water for about 10 minutes, to wash acid away (OLIVEIRA *et al.*, 2012).

To evaluate the effect of temperature on germination, four constant temperatures were tested (20, 25, 30 and 35°C) and two alternate temperatures (20-30 and 25-35 °C). All treatments were applied with 12 hours of white light photoperiod (fluorescent 20W lamps, approximately 60 $\mu mol.m^{-2}.s^{-1}$) in germination chambers (Eletrolab®). Tests were performed in transparent plastic boxes (11 x 11 x 3.5 cm), over two germitest paper sheets, previously treated with Rovral fungicide at 0.1% (OLIVEIRA *et al.*, 2011). A completely randomized experimental design was applied, with six treatments and four replications of 25 seeds per treatment.

Germinated seeds were counted daily, starting from first day after installation. Germination was assumed as completed when the primary root reached 2 mm minimum length. Percentage of germination and final percentage of normal seedlings were assessed, just as Mean Germination Time (MGT), relative frequency and synchronization index of germination (LABOURIAU, 1983). Seedlings were considered normal when at the end of the experiment (11 days) showed well developed basic structures, complete and proportional, with long and thin primary roots, long hypocotyl and epicotyl and first leaves into expansion process (BRASIL, 2009).

Data of germination percentage and formation of normal seedlings were transformed in Asin $(x/100)^{1/2}$. However, data are presented in table in the original form. All data went through normality test (Kolmogorov-Smirnov α=0.05) and homogeneity of variances test (Bartlett α=0.05). After that, they were submitted to analysis of variance followed by the test of Tukey ($p<0.05$) (SANTANA; RANAL, 2004).

RESULTS AND DISCUSSION

Humidity degree

Seeds of *P. gigantocarpa* presented 3.4% water content. This low value, associated to impermeability of tegument as reported by Oliveira *et al*. (2012), may be advantageous characteristics for storing and longevity of the species (ROBERTS, 1973; CARVALHO *et al.*, 2006); however, specific studies are necessary to determine the physiological behavior of seeds in storage conditions.

Morphological aspects of seeds

Seeds of *P. gigantocarpa* present variable shape, like elliptical, ovoid or elongated, with the apex more rounded than the base (Figure 1-A). The testa has bone consistence when dehydrated, and coriaceous when hydrated. Hilum is circular and visible to the naked eye, however micropyle is inconspicuous, and both are located in the basal region (Figure 1-B). Surface is glabrous, smooth and brilliant with black color. Pleurogram, appearing with inverted U-shape, open in the basal region, covers 90% of the seed length (Figure 1-B).

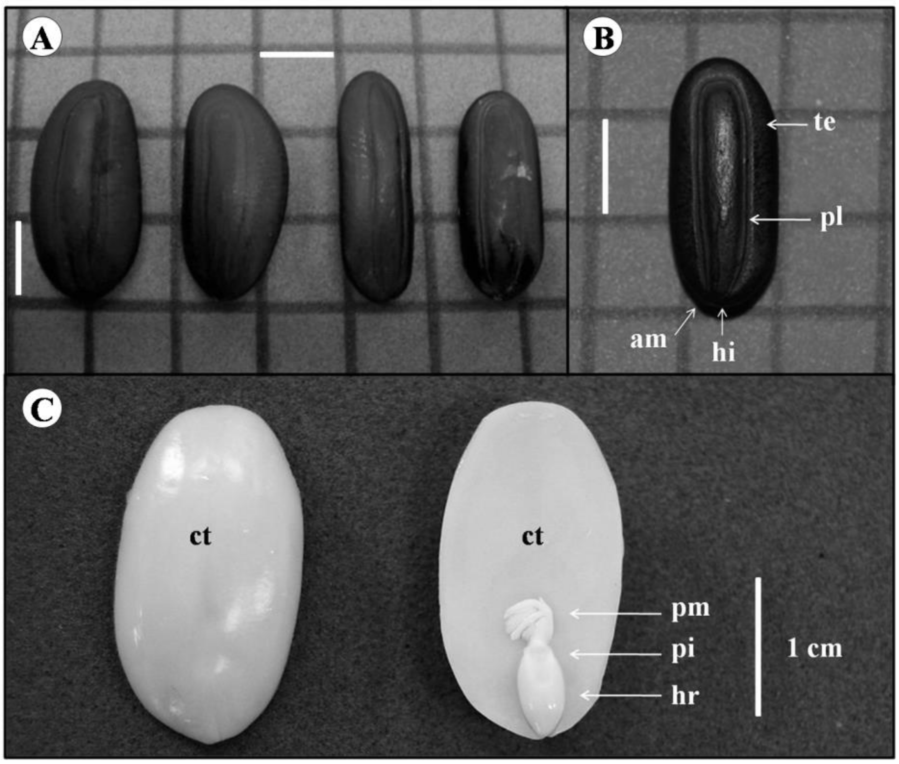

Figura 1. Semente de *Parkia gigantocarpa*. A e B – aspecto externo das sementes; C – embrião. (am: área micropilar; ct: cotilédone; hr: eixo hipocótilo-radícula; hi: hilo; pi: ponto de inserção; pl: pleurograma; pm: plúmula; te: testa). Barras: 1 cm.

Figure 1. Seeds of *Parkia gigantocarpa*. A and B – external aspect of seeds; C – embryo. (am: micropylar area; ct: cotyledon; hr: hypocotyl-radicle axis; hi: hilum; pi: insertion point; pl: pleurogram; pm: plumule; te: testa). Scale: 1 cm.

According to Barroso *et al.* (1999), pleurogram is a lateral mark on surface of certain seeds, originated by an interruption in the palisade of the exotesta or by differences in the external layer of the testa. According to what reported by Araújo-Neto *et al.* (2002), in the Faboideae family there is no pleurogram; however, this structure is present in around 67% to 70% of Mimosoideae genera studied and in 9% to 14% of Caesalpinioideae. Melo and Varela (2006) found absence of pleurogram in seeds of *Dinizia excelsa* Ducke and presence of pleurogram in seeds of de *Cedrelinga catenaeformis* Ducke. In the same way, seeds of *Acacia polyphilla* DC. also presented this structure (ARAÚJO-NETO et al., 2002); all the mentioned species belong to the Fabaceae family, Mimosoideae sub-family.

Embryo is linear-axial type, with crass, straight, convex and dominant cotyledons, and in the base there is a slot, where the point of insertion of cotyledons in the embryonal axis is located (Figure 1-

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C). The hypocotyl-rootlet axis is straight, and a well-developed plumule is observable in its superior extremity, with differentiated leaf primordium with same color as the hypocotyl-rootlet axis (Figure 1-C).

Dimensions of seeds were from 14.92 to 26.8 mm length, 7.85 to 12.87 mm width and 3.27 to 7.77 mm thickness, with means respectively of 21.25 mm, 10.43 mm and 6.15 mm (Table 1). Carvalho (2010) reported lengths around 18-25 mm and widths around 10-13 mm for seeds of the same species, partially similar results as the ones of this study. Size of seeds among *Parkia* species is variable, for example, considering mean length of seeds, it can be 46.37 mm (*P. multijuga* Benth.), 22.0 mm (*P. decussata* Ducke and *P. oppositifolia* Spruce), 16.56 mm (*P. discolor* Spruce ex Benth.), and 10.1 mm (*P. pendula* (Willd.) Benth. ex Walp.) (MOREIRA; MOREIRA, 1996; ROSSETO *et al.*, 2009; MELO, 2013; ROCHA *et al.*, 2014).

Table 1. Seeds dimensions (mm) of *Parkia gigantocarpa*.
Tabela 1. Dimensões (mm) de sementes de *Parkia gigantocarpa*.

	Minimum	**Mean**	**Maximum**	**Standard deviation**	**Coefficient of variation**
Length	14.92	21.25	26.8	3.33	15.69
Width	7.85	10.43	12.87	1.23	11.8
Thickness	3.27	6.15	7.77	1.07	17.54

Morphological aspects from germination to seedling

Germination was epigeal phanerocotylar, starting from day two to five after sowing. Primary root is axial with positive geotropism, with 1.5 to 2 cm length in the third day after sowing, color is white-yellowish, pearly, it is cylindrical, smooth surfaced, with conic protection and evident red-pinkish hypocotyl (Figure 2-A). Seven days after sowing appears the hypocotyl, which is epigeous and reddish, characterized by a thickening of the axis delimiting the root portion, which is yellowish thin and cylindrical (Figure 2-B). Cotyledons were opposite, fleshy, persistent, pink-yellowish, with an inverted V-shaped slot in the base and parallel linear wrinkles, vertically inserted in the hypocotyl (Figure 2-B, C). Cotyledons remained on the seedling until the end of the observation period. After seven days from sowing, appears the epicotyl, thin, cylindrical, and presence of secondary roots is observed (Figure 2-C).

In the subfamily of mimosoideae, the epigeous germination with foliaceous cotyledons is predominant; however, there is occurrence of fleshy cotyledons in a small number of species (POLHILL *et al.*, 1981; OLIVEIRA, 1999). As previously described, seedlings of *P. gigantocarpa* are epigeous with fleshy cotyledons. Fleshy cotyledons have already been described in species of the same genus like *P. discolor* and *P. oppositifolia* and epigeous germination was reported in *P. decussata*, *P. pendula*, *P. discolor* and *P. oppositifolia* (MOREIRA; MOREIRA, 1996). However, in the species *P. multijuga*, germination was hypogeal cryptocotylar (ROCHA et al., 2014).

Eophyll was composed, bipinnate, with two pairs of opposite stipules and 8-10 pairs of also opposite leaflets, light green and completely expanded fifteen days after sowing (Figure 2-D; 3-A). Leaflets were membranous, with asymmetrical base, continuous margin, slightly sharp apexes and with the midrib in evidence (Figure 3-B). Small stipules appear at the apex of the rachis of all leaflets and another bigger stipule is in the apex of the rachis (Figure 3-C).

In the rachis, between leaflets, glands were noticed, with emission of sweet liquid. Carvalho (2010) reported the presence of glands in the rachis and apical portion of pinnae in adult leaves of this species and, according to the author, glands has the purpose to attract ants, who protect the plant against herbivores. Starting from the tenth day after sowing, it was possible to notice the apical gem in the insertion of the petiole of the eophyll, light green, and two laminar stipules at the base of the gem (Figure 3-D).

Therefore, the completely formed seedling condition was considered reached fifteen days after sowing, with all the characteristics previously described. Abnormal seedlings presented long hypocotyl and atrophied primary root, deteriorated cotyledons, developed aerial part and atrophy of the hypocotyl-rootlet, besides separation of cotyledons with breakage of the embryonal axis before the third day after germination.

Germination of seeds

There was no significant effect of temperatures on the final percentage of germination of *P.gigantocarpa* seeds *(F=1.130, P=0.380)*, which presented good germination performances in all temperatures, showing germination percentages equal and/or bigger than 79% (Table 2). Temperatures between 20 and 35°C are the ones generally offering better germination conditions in most of the tropical species (LARCHER, 2003).

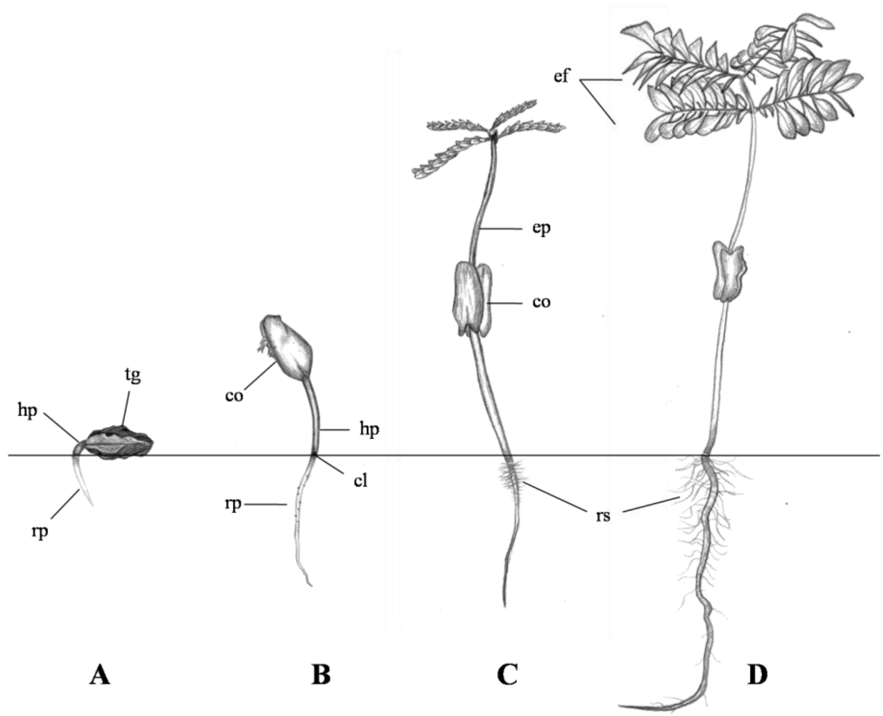

Figure 2. Morphological aspects of germination and seedling formation of *Parkia gigantocarpa*. A: seed with primary root (3 days); B: seedling with 7 days; C: seedling with 10 days; D: seedling with 15 days. (co: cotyledon; cl: colon; ef: eophyll; ep: epicotyl; hp: hypocotyl; rp: primary root; rs: secondary root; tg: tegument). Illustration: Junior Braga de Carvalho.

Figura 2. Aspectos morfológicos da germinação e formação da plântula de *Parkia gigantocarpa*. A: semente com raiz primária (3 dias); B: plântula com 7 dias; C: plântula com 10 dias; D: plântula com 15 dias. (co: cotilédone; cl: colo; ef: eofilo; ep: epicótilo; hp: hipocótilo; rp: raiz primária; rs: raízes secundárias; tg: tegumento). Ilustração: Junior Braga de Carvalho.

In seeds of *P. pendula*, temperatures between 20 and 35 °C also were adequate to germination, with mean percentages above 80% (ROSSETO *et al.*, 2009). However, in seeds of *P. platycephala* Benth, temperature significantly affected the percentage of germination, reaching 15, 37 and 53% respectively under constant temperatures of 20, 25 and 30 °C (NASCIMENTO *et al.*, 2003).

Temperatures significantly affected the mean germination time (MGT) *(F=33.11, P=0.00).* Seeds germinated in less time at constant temperatures of 30 and 35 °C; on the other hand, germination process was slower at constant temperature of 20 °C and in the alternate temperatures of 20-30 °C (Table 2). Similar results, where temperature only has effect on mean germination time, or on other parameters like germination strength, have already been reported in other species (ZUCARELLI *et al.,* 2010).

Temperature has direct effect on velocity of germination, because it affects water absorption and biochemical reactions, which tend to increase together with increasing temperatures (Marcos Filho, 2005; Bewley *et al*., 2013), which could justify the MGT reduction as temperature increases (from 20 to 35°C constant temperatures).

Considering the relative frequency of germination, at the temperature of 20 °C germination began four days after sowing, reaching its peak seven days after beginning of the experiment. At the temperatures of 25, 30 and 20-30 °C, germination began two days after sowing and peaks occurred respectively six, five and seven days after sowing. At temperatures of 35 and 25-35 °C, germination process began the first day, respectively with peaks at fifth and seventh day after sowing (Figure 4).

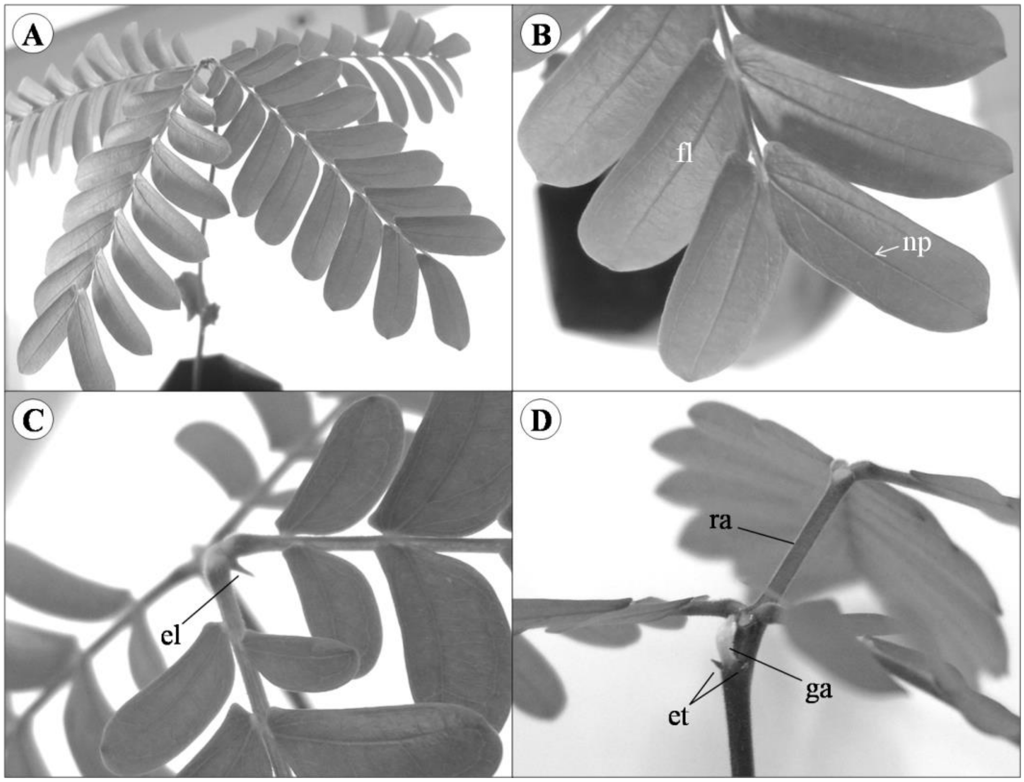

Figure 3. Seedling of *Parkia gigantocarpa* fifteen days after sowing. A – general appearance of eophyll; B, C and D – details of the seedling and eophyll. (el: stipule at the apex of the rachis; et: stipules; fl: leaflet; ga: apical bud; np: leaflet midrib; ra: raquis).

Figura 3. Plântula de *Parkia gigantocarpa* quinze dias após a semeadura. A – aspecto geral do eofilo; B, C e D – detalhes da plântula e do eofilo. (el: estipélula no ápice da raque, et: estípulas, fl: foliólulo, ga: gema apical, np: nervura principal do foliólulo, ra: raque).

Under alternate temperatures, relative frequency was slightly more heterogeneous, suggesting loss of synchronization (LABOURIAU, 1983); however, in all temperatures, frequencies were practically identical (Figure 4). The temperature of 35 °C presented the lowest mean of germination index; however the only significant difference appeared for temperatures of 20-30 °C *($F=3.59$, $p=0.02$)* (Table 2).

For some species, the greatest synchronization of germination occurs under optimal temperatures (ROSSATTO; KOLB, 2010), a strategy related to a rapid colonization of the environment. On the other hand, loss of synchronization under not-optimal temperatures may increase chances of at least some seeds germinate in favorable conditions to develop seedlings, because this means that germination will have a temporal distribution (FERREIRA; BORGHETTI, 2004).

It not possible to address this behavior to seeds of *P. gigantocarpa* in this study. Despite seeds germinated more rapidly at temperatures of 30 and 35 °C, there were no big variations between treatments in the germination index, due to great germination percentage and strength of seeds, which reached germination peak around seven days after sowing, independently on temperature.

Constant temperatures of 25, 30 and 35 °C and alternate 25-35 °C presented the greatest percentage of normal seedlings. However, results were statistically equivalent at all the tested temperatures *($F=1.55$, $p=0.22$)*. On the other hand, building of dry biomass was bigger at the constant temperatures between 25 to 35 °C and at the alternate temperatures of 25-35 °C *($F=36.11$, $p=0.00$)* (Table 2).

The lower biomass accumulation at temperatures of 20 and 20-30 °C is probably related to delay in the germination process (>MGT) in these conditions. However, allied to this factor, lower temperatures may induce lower metabolic rates, as consequence of slower carbohydrates translocation and respiration rates, resulting in less biomass (TAIZ; ZEIGER, 2004).

Table 2. Mean germination (PG), mean germination time (TMG) and germination synchronization index (U) of seeds; normal seedlings (PN) and dry mass of the primary root (MSR) of *Parkia gigantocarpa* at different temperatures.

Tabela 2. Germinação média (PG), tempo médio de germinação (TMG) e índice de sincronização de germinação (U) de sementes; plântulas normais (PN) e massa seca da raiz primária (MSR) de *Parkia gigantocarpa* em diferentes temperaturas.

Temperature (ºC)	**PG (%)**	**TMG (dias)**	**U (bits)**	**PN (%)**	**MSR (g)**
20	79±13.2 a	7.3±0.39 d	2.15±0.16 ab	59±10.5 a	0.055±0.002 c
25	88±8.6 a	6.4±0.43 bc	2.07±0.37 ab	73±11.4 a	0.125±0.012 a
30	90±5.1 a	4.9±0.15 a	2.36±0.24 ab	71±14.3 a	0.123±0.010 a
35	86±5.1 a	4.9±0.44 a	2.01±0.20 a	67±6.0 a	0.109±0.010 ab
20-30	81±6.8 a	6.8±0.32 cd	2.59±0.24 b	58±7.6 a	0.104±0.011 b
25-35	91±7.3 a	6.0±0.59 b	2.47±0.35 ab	69±3.8 a	0.118±0.015 ab

Mean ± standard deviation followed by the same letter are not statistically different by the test of Tuckey ($p<0.05$).

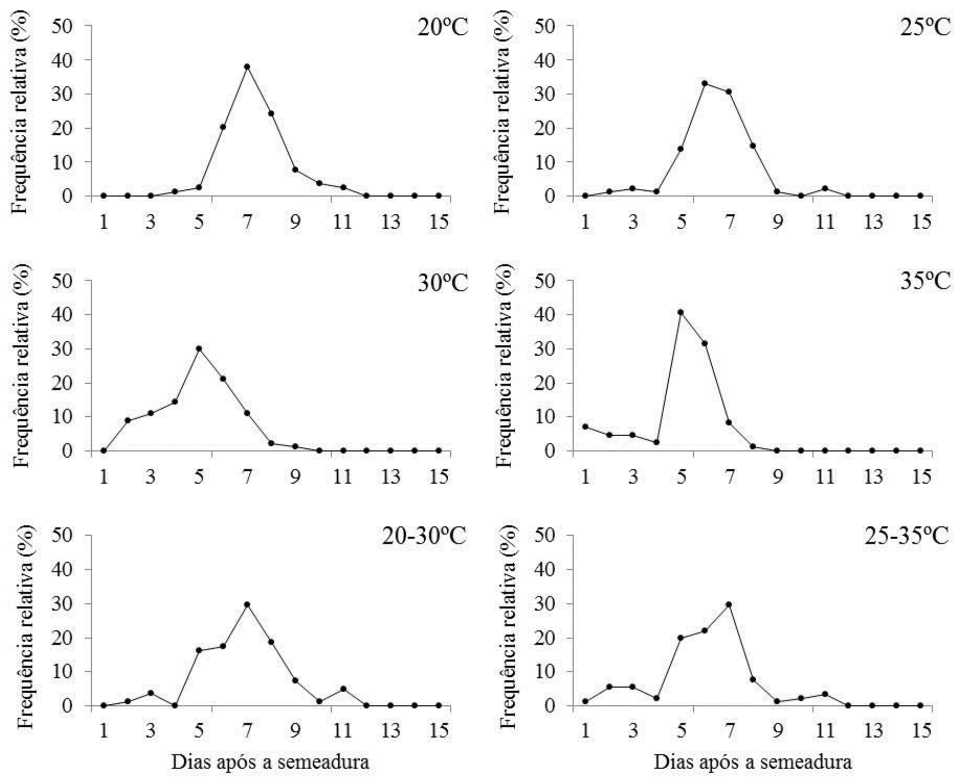

Figura 4. Frequência relativa da germinação de sementes de *Parkia gigantocarpa* nas temperaturas constantes de 20, 25, 30 e 35ºC e temperaturas alternadas de 20-30 e 25-35ºC.

Figure 4. Germination relative frequency of *Parkia gigantocarpa* seeds in constant temperatures of 20, 25, 30 and 35ºC and alternating temperatures of 20-30 and 25-35ºC.

Temperatures of 30 and 35 °C may be optimal for germination of *P. gigantocarpa* seeds, because resulted in high germination rates, lower mean germination time and high biomass accumulation in primary roots. These results are in accordance with observations of Schmidt (2000) and Rosseto *et al.* (2009), who reported that temperatures above 20 °C are generally the more indicated for forest species, mainly in the amazon region, where average temperature over the year stays around 24 to 26 °C. Furthermore, Brancalion *et al*. (2010) found relation between optimal germination temperature and biome where species occurred, being the most frequent optimal temperature for species of the Amazon biome equal to 30 °C.

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CONCLUSIONS

- Remembering that some morphological characters are different from the ones reported for other species of the same family, morphological characters of seeds and seedlings of *P. gigantocarpa* can be used to identify the species in field.
- Once seeds are scarified, they present rapid and uniform germination, with completely formed seedlings 15 days after sowing. Temperatures of 30 and 35 °C allowed high germination rates in less time and with greater root biomass accumulation.

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