

SEED MORPHOBIOMETRY AND GERMINATION OF *Sesbania punicea* (Cav.) Benth. AND *Sesbania virgata* (Cav.) Pers.

Manoela Mendes Duarte¹; Jaçanan Eloísa de Freitas Milani²; Thiago Wendling Goncalves de Oliveira¹; Christopher Thomas Blum¹; Antonio Carlos Nogueira¹

¹ Universidade Federal do Paraná, Programa de Pós-Graduação em Engenharia Florestal, Curitiba, Paraná, Brasil - manu-florestal@hotmail.com; thiagowendling@yahoo.com.br; ctblum.ufpr@gmail.com; nogueira@ufpr.br

² Universidade Federal de Mato Grosso, Departamento de Engenharia Florestal, Cuiabá, Mato Grosso, Brasil - jacanan.milani@gmail.com;

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Resumo

Morfobiometria de sementes e germinação de sesbania punicea (Cav.) Benth. e Sesbania virgata (Cav.) pers. Pertencentes a família Fabaceae, *Sesbania punicea* e *S. virgata* se caracterizam pelo elevado potencial ecológico para sua utilização na recuperação de áreas degradadas. O presente estudo teve por objetivo descrever as características físicas, morfobiométricas das sementes, as fases da germinação e o desenvolvimento inicial das plântulas de *S. punicea* e *S. virgata*, bem como o comportamento germinativo das sementes em diferentes temperaturas e substratos. Para a caracterização física das sementes foi determinado o peso de mil sementes, número de sementes por quilo, biomassa seca de mil sementes e o grau de umidade. Para avaliar o efeito do substrato e temperatura na germinação, conduziu-se o experimento sob um delineamento inteiramente casualizado, adotando-se um esquema fatorial 3 x 3, sendo três substratos (areia, vermiculita e papel mata-borrão) e três temperaturas (20, 25 e 30 °C). Foram avaliados: porcentagem de germinação, índice de velocidade de germinação, tempo médio de germinação e índice de sincronização. *S. punicea* apresentou 13.243 e *S. virgata* 14.414 sementes por quilograma, com grau de umidade de 14,5 e 7,9 %, respectivamente. As duas espécies apresentam morfobiometria e desenvolvimento de plântulas semelhantes. Para *S. punicea* o substrato papel mata-borrão e a temperatura de 25 °C foram mais eficientes para a germinação. Para *S. virgata* todos os tratamentos se mostraram efetivos para a germinação.

Palavras-chave: espécies nativas; recuperação de áreas degradadas; IVG; Fabaceae.

Abstract

Belonging to the family Fabaceae, *Sesbania punicea* and *S. virgata* are characterized by their ecological potential in the recovery of degraded areas. The present study aimed to describe the physical, morphobiometric characteristics of seeds, the germination phases and the initial development of *S. punicea* and *S. virgata* seedlings, as well as the germination behavior of seeds at different temperatures and substrates. For the physical characterization of seeds, the weight of one thousand seeds, number of seeds per kilogram, dry biomass of one thousand seeds and the moisture content were determined. To evaluate the effect of substrate and temperature on germination, the experiment was conducted in a completely randomized design, using a 3 x 3 factorial scheme, three substrates (sand, vermiculite and blotting paper) and three temperatures (20, 25 and 30 °C). The following factors were evaluated: germination percentage, germination speed index, mean germination time and synchronization index. *S. punicea* presented 13,243 seeds and *S. virgata* presented 14,414 seeds per kilogram, with moisture content of 14.5 and 7.9 %, respectively. Both species present similar morphobiometry and seedling development. For *S. punicea*, the blotting paper substrate and the temperature of 25 °C were most efficient for germination. For *S. virgata*, all treatments were effective for germination.

Key words: native species; recovery of degraded areas; GSI; Fabaceae.

INTRODUCTION

Fabaceae presents countless species with great economic and ecological potential. In an ecological context, this family is used to recover degraded areas, as many species affect nitrogen-fixing bacteria, allowing them to maintain adequate levels in the soil, which helps in the establishment and development of plants (FLORENTINO; MOREIRA, 2009).

Sesbania punicea (Cav.) Benth. and *Sesbania virgata* (Cav.) Pers. are legumes of the subfamily Papilionoideae, characterized as bushes and occur naturally in the Southern, Southeastern, Midwestern and Northeastern regions of Brazil. In general, they are found in riverine vegetation, and are associated with the initial stages of ecological succession (POTOMATI; BUCKERIDGE, 2002).

These species are highly tolerant to environments with low oxygenation, showing their potential and ability to restore riparian forests (ALLEN; ALLEN, 1981). Studies developed with the genus *Sesbania* indicated

that *S. virgata* presented important results regarding carbon immobilization, due to its rapid growth and fast and efficient fixation of large amounts of carbon, being a feature of interest for the processes of carbon sequestration, ecological succession and restoration (BUCKERIDGE; MORTARI; MACHADO, 2007).

Despite the ecological potential of *Sesbania* species, further studies addressing the morphological description of seeds, seedlings and their germination characteristics are still needed. Thus, knowledge about morphological characteristics of seeds and the germination and development stages of young plants provides information that can help identify species and in studies about natural regeneration and recovery of degraded areas (HALISKI *et al.*, 2013). The germination test is the most widely used method for determining germination potential, since it determines the viability of seeds under previously established conditions (OLIVEIRA *et al.*, 2008), making inferences about the potential seedling production and their use in the field.

According to the Rios *et al.* (2016), biometric studies of fruits and seeds are developed to complement morphological studies, which help determine the ecological aspects of species, and obtain subsidies for studies about dispersal, establishment and development of seedlings in native forests. Furthermore, biometric characters differentiate species within the same genus, identify genetic variability within a population of the same species, and analyze the relationships between this variability and environmental factors (GONÇALVES *et al.*, 2013).

Temperature and substrate are basic components of laboratory germination tests and, in general, seeds have variable performance when subjected to different conditions of these factors (MONDO *et al.*, 2008). Due to this variation in seed physiological response, it is important and advisable to study the influence of temperature and substrates on the germination of forest species, which provides input for further analyses and studies (GUEDES *et al.*, 2009).

Therefore, the present study aimed to describe the physical morphobiometric characteristics of seeds, the germination phases and initial development of *S. punicia* and *S. virgate* seedlings, as well as study the germinative behavior of seeds submitted to different temperatures and substrates.

MATERIALS AND METHODS

Physical analysis of seeds and morphological characterization of seeds, seedlings and germination phases

Fruits were collected from matrix trees located in a remnant known as "Capão do Cifloma", located at at *Campus Jardim Botânico* of the Universidade Federal do Paraná, urban perimeter of Curitiba-PR. After collecting fruits, the seeds were manually removed, packaged in polyethylene containers and kept in a cold chamber (5 ± 3 °C and 55% relative humidity) until experiments were carried out. All analyses were performed at the Laboratório de Sementes Florestais do Departamento de Ciências Florestais da Universidade Federal do Paraná, in Curitiba, Paraná.

For physical characterization of seeds, the weight of one thousand seeds, the number of seeds per kilo, and the moisture degree of seeds were determined, adopting the methodology described in the Rules for Seed Analysis (BRASIL, 2009). The weight of a thousand seeds was obtained from eight subsamples of 100 seeds each, weighed on a precision scale (0.001 g) and the number of seeds per kilo was calculated from the weight of 1,000 seeds. The moisture degree was obtained from two ~5g samples, dried in a forced ventilation oven at 105 ± 3 °C, for 24 hours. The dry biomass of 1,000 seeds was calculated based on the moisture degree and the weight of 1,000 seeds.

For biometric characterization, 50 seeds were randomly taken from the total sample. Length, width and thickness were measured with a precision caliper, and the length was measured from the base to the apex, while the width and thickness were measured from the median line of seeds. For the morphological characterization of germination and seedling phases, 50 seeds were used, which were scarified and sown in plastic gerbox boxes (11x11x3.5 cm) with blotting paper substrate, kept in Biochemical Oxygen Demand (B.O.D.) chamber at a constant temperature of 25°C and a photoperiod of 24 hours. Evaluations were performed every day after the first seed germinated and were considered seedlings when protophylus were fully formed.

The seed morphology of both species was described by characterizing the external and internal aspects. The following external factors were observed: coloration, texture, integument consistency, shape, edge, hilum and micropyle position. To study the internal morphology, the seeds were placed in hot water (approximately 95°C) and left to hydrate for approximately 30 minutes and, from cross-sectional and longitudinal sections, the following

characteristics were observed and described: endosperm type and color; type, position and shape of the embryo; shape and consistency of cotyledons; and the position of the hypocotyl-radicle axis.

At all stages from germination to seedling formation, the type of germination, radicle and root, hypocotyl, epicotyl and cotyledon were described and presented. The observations to describe the morphology of seeds and seedlings were done visually and with a stereo microscope (Olympus SZ40), from well-developed and representative material of each phase and presented as digital photographs (Digital camera Sony DSC-S750).

Influence of substrate and temperature on germination

To evaluate the effect of substrate and temperature on germination, this experiment was conducted using a completely randomized design, adopting a 3 x 3 factorial scheme, with three substrates (sand, vermiculite and blotting paper) and three temperatures (20, 25 and 30°C). Five replicates of 35 seeds were used for each treatment, which were sown in the substrates, placed in gerbox boxes sterilized with 70% alcohol and put in B.O.D. chamber, under constant white light. Seed dormancy was overcome by mechanical scarification (manual with sandpaper) at the top and opposite to the embryo axis.

The sand was standardized in a 0.8 mm mesh sieve, washed and oven sterilized at 200° C for two hours, using 100 grams for each gerbox, moistened with 35 ml of distilled water (60% retention capacity). For the vermiculite substrate (medium granulometry), 20 grams of substrate were used in each gerbox with 70 ml of water. For the paper substrate, blotting paper moistened with 7 ml of distilled water was used. Whenever necessary, water was added in all substrates.

The germination criterion used was primary root protrusion with a length equal to or greater than 2 mm. After the first germinated seed, evaluations were performed daily until germination stabilized for three consecutive days. Germination percentage, germination speed index (GSI) proposed by Maguire (1962), mean germination time (MTG) proposed by Laboriau (1983) and synchronization index were calculated.

The data was submitted to the Bartlett test to verify homogeneity of variances. Next, an analysis of variance (ANOVA) was performed at 95% probability and for comparison of treatment mean the Tukey test was performed.

RESULTS

Physical analysis and morphological characterization of seeds, seedlings and germination phases

The physical and biometric characteristics of the seeds of both species studied are described in Table 1. Both species had similar values of length, width, thickness, weight and dry biomass of 1,000 seeds, but the moisture degree of *S. punicea* was twice as high as that of *S. virgata*.

Tabela 1. Características físicas e biométricas das sementes de *Sesbania punicea* e *Sesbania virgata*.

Table 1. Physical and biometric characteristics of *Sesbania punicea* and *Sesbania virgata* seeds.

Determinations	<i>Sesbania punicea</i>			<i>Sesbania virgata</i>		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Seed length (mm)	6.10	6.9 ± 0.40	8.04	5.03	6.5 ± 0.62	7.84
Seed width (mm)	3.93	4.2 ± 0.14	4.52	3.77	4.3 ± 0.27	4.95
Seed thickness (mm)	2.97	3.4 ± 0.17	3.61	2.82	3.2 ± 0.24	4.43
Weight of 1,000 seeds (g)		75.5			69.4	
Number of seeds per kilo		13.243			14.414	
Moisture degree (%)		14.5			7.9	
Dry biomass of 1,000 seeds (g)		64.5			63.9	

The mean values of length were 6.9 ± 0.40 and 6.5 ± 0.62 mm, width: 4.2 ± 0.14 and 4.3 ± 0.27 mm and thickness: 3.4 ± 0.17 and 3.2 ± 0.24 for *S. punicea* and *S. virgate*, respectively. According to deviation values, variation of all characteristics was higher for *S. virgata*. The external and internal morphology of the seeds of both species is shown in Figure 1.

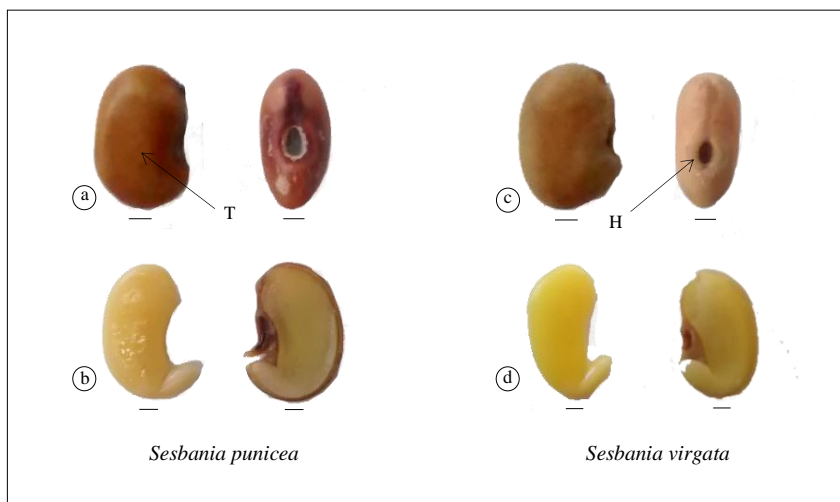


Figura 1. Morfologia externa e interna das sementes de *Sesbania punicea* e *Sesbania virgata*. Aspecto externo, demonstrando tegumento (T) e o hilo (H) (a, c); Corte transversal das sementes (b, d); Embrião (b, d). Barra = 0,1 cm.

Figure 1. External and internal morphology of *Sesbania punicea* and *Sesbania virgate* seeds. External aspect, showing tegument (T) and hilum (H) (a, c); Cross section of seeds (b, d); Embryo (b, f). Bar = 0.1 cm.

Externally, the seeds of *S. punicea* have a smooth, hard, waterproof and dark brown tegument. The hilum has an ovoid shape, dark brown, with central fissure, and the hilar region is noticeably larger than that of *S. virgata*. The micropyle was not observed and the raphe is presented as a line, coming out of the hilum and ending shortly before the seed base with a higher region, presenting a darker color than the rest of the seed.

In the internal morphology of *S. punicea* seeds, the inner part of the tegument has a spongy consistency, with thickness approximately 1/3 the size of the endosperm and voluminous in the region of the hilum. The seed is albuminous, that is, the endosperm is a very clear, cream color that is almost transparent and has a gelatinous consistency (seeds hydrated in boiling water). The endosperm envelopes the entire embryo, presenting a thinner layer at the edges of cotyledons. The embryo is axial curved, continuous and cotyledonary. The cotyledon are cream colored, thick and equal, with edges that are slightly folded towards the inside of the embryo, and short and inflected hypocotyl-radicle axis (Figure 1).

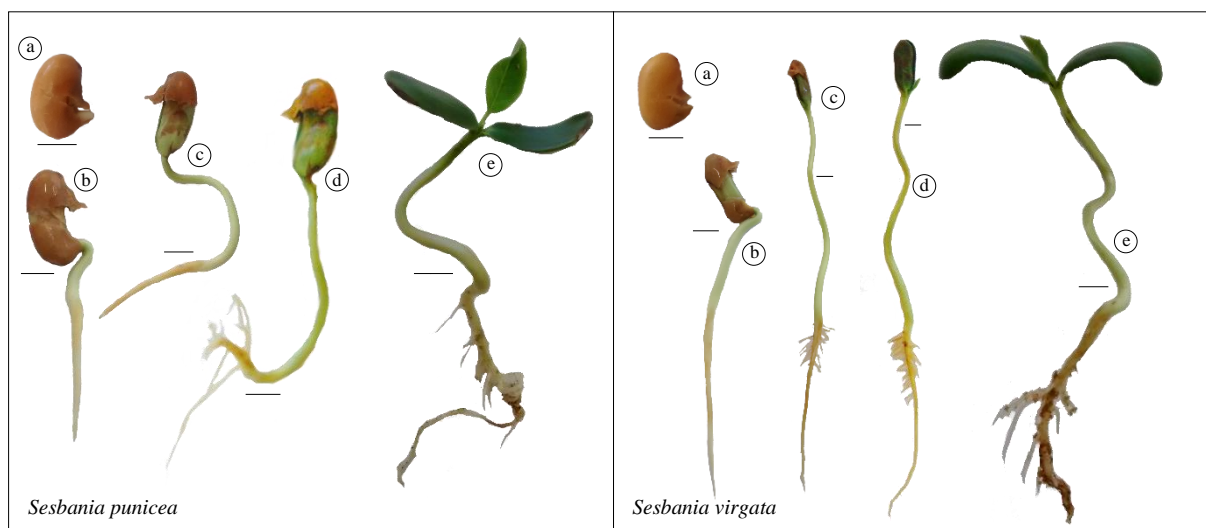


Figura 2. Morfologia, desenvolvimento e fases da germinação de *Sesbania punicea* e *Sesbania virgata*. *S. punicea*: início da germinação, quarto, sétimo, oitavo e 13º dia (a, b, c, d, e, respectivamente). *S. virgata*: início da germinação, quarto, sétimo, nono e 13º dia (a, b, c, d, e, respectivamente). Barra = 1 cm.

Figure 2. Morphology, development and germination stages of *Sesbania punicea* and *Sesbania virgata*. *S. punicea*: beginning of germination, fourth, seventh, eighth and thirteenth day (a, b, c, d, e, respectively). *S. virgata*: beginning of germination, fourth, seventh, ninth and thirteenth day (a, b, c, d, e, respectively). Bar = 1 cm.

Externally the seeds of *S. virgata* have a hard, smooth, waterproof and light brown tegument. The hilum is located laterally, in the middle portion of the seed, with an ovoid shape, dark brown color and central fissure. The micropyle is circular with reduced size that is almost imperceptible to the naked eye. A short raphe can be seen externally, coming out of the hilum to the base of the seed, ending in a higher region and presenting a slightly darker color.

Regarding the internal tegument, the characteristics of the endosperm, embryo and cotyledon, there were no significant morphological differences between the two species, and the seeds of *S. virgata* were morphology equal to *S. punicea* (Figure 1).

As for the characterization of germination, both species are similar, and for *S. punicea*, germination began after the 3rd day of sowing, with elevation of the hypocotyl and radicle expansion extending until the 13th day, while the germination of *S. virgata* began on the 2nd day and extended until the 9th day. The two species present phanerocotyledonary germination, since the cotyledons emerged from the seed tegument and expanded. The phases of germination and seedling development are presented in Figure 2.

The seedling morphology is also similar for the species, with a long hypocotyl compared to the epicotyl, cream-colored at the base and greenish towards the apex. The cotyledons are foliate, opposites, membranous, dark green, with full and rounded margins at the apex (Figure 2). Seedling development occurred quickly and homogeneously, however, seedlings of *S. virgata* developed and grew faster when compared to those of *S. punicea* (Figure 2).

Influence of different substrates and temperatures on germination

The results of *S. punicea* indicated that for the germination percentage (G), germination speed index (GSI) and synchronization index (E) there were no significant interactions between temperature and substrate, however, there was a significant difference between treatments according to the Tukey test. For mean germination time (MGT), the interaction was significant (Table 2).

For *S. virgate*, there was no statistical difference between the substrates and temperatures for germination percentage. For germination speed index, the interaction was not significant, but the results showed significant differences between temperatures and substrates. The synchronization index showed a significant difference at 95% probability for evaluated temperatures only. For mean germination time, the interaction between substrate and temperature was significant (Table 2).

Tabela 2. Análise de variância para porcentagem de germinação (G), índice de velocidade de germinação (IVG), índice de sincronização (E) e tempo médio de germinação (TMG) de sementes de *Sesbania punicea* e *Sesbania virgata*.

Table 2. Variance analysis for percentage of germination (G), germination speed index (GSI), synchronization index (E) and mean germination time (MGT) of *Sesbania punicea* and *Sesbania virgata* seeds.

Species	S.V.	D.F.	Mean Square			
			G	GSI	E	MGT
<i>Sesbania punicea</i>	Substrate	2	568.89 *	5.55 *	0.79 **	9.97 **
	Temperature	2	411.61 *	31.00 **	3.16 **	36.53 **
	Interaction	4	281.81 ns	3.02 ns	0.19 ns	0.87 *
	Mean	-	62.15	5.19	1.75	4.85
	C.V. (%)	-	17.64	24.73	15.87	11.34
<i>Sesbania virgata</i>	Substrate	2	6.53 ns	3.24 **	0.15 ns	0.78 **
	Temperature	2	28.30 ns	22.80 **	0.78 **	5.18 **
	Interaction	4	38.09 ns	0.50 ns	0.13 ns	0.29 *
	Mean	-	94.28	8.53	1.36	4.07
	C.V. (%)	-	4.92	8.52	21.93	8.07

S.V.: Source Variation; C.V. (%): Variation coefficient; D.F.: Degrees of freedom; ** Significant at 1% probability level ($p < 0.01$); * Significant at a 5% probability level ($0.01 < p < 0.05$); ns: Not significant ($p > 0.05$).

Among the substrates tested with *S. punicea*, the blotting paper differed statistically from the vermiculite, presenting the highest germination percentage. Among the temperatures, the 25 °C treatment was more efficient for germination of the species, with a statistically higher mean than the 30 °C treatment (Table 3).

Tabela 3. Médias para porcentagem de germinação (G), índice de velocidade de germinação (IVG), índice de sincronização (E) e tempo médio de germinação (TMG) de sementes de *Sesbania punicea* submetidos a diferentes substratos e temperaturas.

Table 3. Percentage of germination (G), germination speed index (GSI), synchronization index (E) and mean germination time (MGT) of *Sesbania punicea* seeds submitted to different substrates and temperatures.

Substrate	TEMPERATURE °C			
	20	25	30	Mean
G				
Sand	58.86	72.57	52.00	61.14 ab
Vermiculite	52.00	58.29	59.43	56.57 b
Paper	75.43	71.43	59.43	68.76 a
Mean	62.10 ab	67.43 a	56.95 b	
GSI				
Sand	3.18	6.77	5.97	5.31 ab
Vermiculite	3.68	6.35	7.19	5.74 a
Paper	3.75	4.73	5.14	4.54 b
Mean	3.54 b	5.95 a	6.10 a	
E				
Sand	2.25	1.77	1.52	1.85 a
Vermiculite	2.33	1.83	1.65	1.93 a
Paper	2.14	1.55	0.81	1.50 b
Mean	2.24 a	1.71 b	1.32 c	
MGT				
Sand	6.94 a A	4.01 b B	3.52 ab B	4.82
Vermiculite	5.46 b A	3.55 b B	3.13 b B	4.05
Paper	7.38 a A	5.54 a B	4.11 a C	5.68
Mean	6.59	4.37	3.59	

Mean followed by the same lowercase letter in the column and capitalized letter in the row do not differ by the Tukey test at 5% probability.

Regarding the GSI, the vermiculite substrate was more efficient, with a statistically higher germination speed than the blotting paper. Among the temperatures, the 20 °C treatment presented the lowest GSI and was statistically lower than the temperatures of 25 °C and 30 °C.

For interpretation of the means of synchronization index, it is important to highlight that the lower the value, the more synchronized germination is in relation to time. Thus, the blotting paper substrate was more efficient at synchronizing the germination of *S. punicea* and statistically superior to the other substrates. For temperatures, the 30°C treatment proved to be the best at synchronizing germination (Table 3).

The best combinations for mean germination time of *S. punicea* are the temperatures of 25 °C and 30 °C, combined with sand or vermiculite substrates, as they were statistically superior to the other combinations, since the germination time was shorter when the observed value was lower (Table 3).

For germination percentage of *S. virgata*, no statistical differences were observed between the substrates and temperatures tested, and for all treatments the mean germination was above 90%. For the GSI, the sand substrate promotes faster germination and, among the temperatures, 30°C is most efficient at accelerating the germination process (Table 4).

Tabela 4. Médias para porcentagem de germinação (G), índice de velocidade de germinação (IVG), índice de sincronização (E) e tempo médio de germinação (TMG) de sementes de *Sesbania virgata* submetidos a diferentes substratos e temperaturas.

Table 4. Percentage of germination (G), germination speed index (GSI), synchronization index (E) and mean germination time (MGT) of *Sesbania virgata* seeds submitted to different substrates and temperatures.

SUBSTRATE	TEMPERATURE °C			
	20	25	30	Mean
G				
Sand	91.43	92.57	97.71	93.90 a
Vermiculite	95.43	94.29	92.00	93.90 a
Paper	94.86	92.57	97.71	95.05 a
Mean	93.90 a	93.14 a	95.81 a	
GSI				
Sand	7.63	9.41	9.94	8.99 a
Vermiculite	6.99	8.91	9.79	8.56 ab
Paper	7.04	7.90	9.25	8.06 b
Mean	7.22 c	8.74 b	9.66 a	
E				
Sand	1.60	1.26	1.22	1.35 a
Vermiculite	1.75	1.32	1.31	1.46 a
Paper	1.44	1.45	0.90	1.26 a
Mean	1.60 a	1.34 ab	1.14 b	
MGT				
Sand	4.36 b A	3.58 b B	3.60 a B	3.85
Vermiculite	5.01 a A	3.82 ab B	3.42 a B	4.08
Paper	4.84 ab A	4.27 a B	3.80 a B	4.30
Mean	4.74	3.89	3.61	

Mean followed by the same lowercase letter in the column and capitalized letter in the row do not differ by the Tukey test at 5% probability.

There were statistical differences between temperatures for the synchronization index, where 30°C presented the best synchronization and was superior to the treatment with 20°C. Regarding the MGT, there was a significant interaction between the treatments and the most efficient combination of 25°C with sand substrate presented the lowest germination times for *S. virgata* seeds (Table 4).

DISCUSSION

Understanding biometric characteristics and germination is an important component for the recovery of ecosystems, since seeds are the propagules most often used for such purposes. Among the variables analyzed in the present study, the biometric characteristics of both species were quite similar, however, there was differentiation in some physical characteristics, as in the number of seeds per kilo and in the weight of 1,000 seeds. Since the seed dimensions are similar, physical differences may be due to the water content at the time of analysis, which can be explained by changes in temperature and relative humidity of the air, causing constant adjustments in water content of the stored seeds and even resulting in differences between samples of the same species (CARVALHO; NAKAGAWA, 2012). For *S. virgata*, the observed biometric values were similar to those described by Araújo *et al.* (2004).

The morphological characteristics of seeds and development after germination are important characteristics that help increase knowledge about the autoecology of species, especially when it proposes natural regeneration of environments. *S. punicea* and *S. virgata* present morphological characteristics of pioneer species, such as small and light seeds that persist in the seed bank of the soil (TWEEDLE *et al.*, 2003), as well as phanerocotyledonous, epigeal seedlings with foliaceous cotyledons, as described by Gogosz *et al.* (2015). The characteristics related to cotyledons provide advantages for competition and establishment in environments with high luminosity rates, since the rapid process of raising and opening of cotyledons favors the initial development of seedlings from the photosynthetic rate (RESSEL *et al.*, 2004). During the germination process, the cotyledons

in both species are free from the tegument, and are above the soil surface, being important characteristics for the morphological classification of the seedlings (BATTILANI *et al.*, 2011).

Regarding the germination test, *S. virgata* presented a higher percentage of mean germination than *S. punicea*. Among the factors that support this difference, one can infer about aspects of overcoming dormancy, and *S. punicea* could possibly be more sensitive to the mechanical scarification of seeds, as all stages and treatments were applied equally and simultaneously to both species. In the study developed by Araújo *et al.* (2004), *S. virgata* showed mean germination of 52% with the use of commercial substrate.

In the present work, optimum germination temperatures for *S. punicea* were 20 °C and 25 °C, and all evaluated temperatures were favorable for the germination process of *S. virgata*. When compiling several studies about ecological aspects related to optimum temperature for germination of 272 Brazilian tree species, Brancalion *et al.* (2010) concluded that 25°C can be considered the most favorable temperature for seed germination for most Atlantic forest species, followed by a temperature of 30°C.

According to Marcos Filho (2015), each species presents an optimum temperature in which seeds will express the most efficient combination between germination speed and percentage of final germination, since temperature directly influences these characteristics. Therefore, this variable is extremely important for detecting climatic adaptations and niche amplitude (JIMENEZ-ALFARO *et al.*, 2016), resulting in the number of seeds that will become seedlings and that may survive (SIMONS, 2009).

The most suitable substrate is one that provides the best moisture retention, aeration for seeds and lowest degree of infection by pathogens, allowing for the highest germination percentages and speeds (MIRANDA *et al.*, 2012). Despite being from the same genus, the two species presented different performances regarding the substrates tested. For *S. punicea* seeds, the most efficient substrate was the blotting paper, which presented a higher germination percentage and shorter synchronization time. However, the most suitable substrate for the germination for *S. virgata* was vermiculite, which presented higher values compared to most of the variables evaluated in the experiment, favoring the uniformity and germination potential of the species.

The ample amount of information in the literature shows that seeds of forest species have distinct requirements of substrates used for germination (BOCCHESI *et al.*, 2008). Such fact demonstrates the need for studies that aim to better understand the silviculture of each species, which can affect their maximum vigor and subsidize and assist in the production of seedlings used in forest restoration programs.

In degraded landscapes, where the dispersion processes are interrupted or habitats are isolated, the germination characteristics are just as important as information about dispersal types for the composition of plant communities. For restoration techniques, such as seed bank transposition or natural regeneration, it is essential that germination and seedling development characteristics are considered, since their descendants need to germinate and establish in an environment to ensure the recruitment of subsequent generations.

Thus, given the high germination rate and vigor of the seeds of both species, allied with their possible use in the recovery of ecosystems, the results of this work are indispensable for the success, use and understanding of the silviculture and ecology of native species.

CONCLUSION

- The morphological and biometric characteristics described in this work are relevant for taxonomic identification, as well as for the autoecology of the species, favoring both their silvicultural and ecological uses.
- For *S. punicea*, the blotting paper substrate and the temperature of 25 °C proved to be most efficient for germination. For *S. virgata*, all treatments proved to be effective for the germination of the species.

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