



Acta Scientiarum. Biological Sciences

ISSN: 1679-9283

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Universidade Estadual de Maringá
Brasil

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Acta Scientiarum. Biological Sciences, vol. 33, núm. 1, 2011, pp. 113-118
Universidade Estadual de Maringá
.png, Brasil

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Effect of temperature and substrate on germination of *Peltophorum dubium* (Sprengel) Taubert seeds

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ABSTRACT. *Peltophorum dubium* (Spreng.) Taub. is a species belonging to the family Fabaceae, and is known popularly as golden shower tree. Its wood has multiple uses in reforestation programs and as an ornamental tree, and is also considered an endangered species, requiring studies that assist in its preservation. The present work was conducted with the objective of determine the ideal substrate type and temperature to perform germination and vigor tests with *P. dubium* seeds. The experiment was carried out at the Seed Analysis Laboratory (Centro de Ciências Agrárias, Universidade Federal Paraíba, Areia, Paraíba, Brazil), in a completely randomized design. The treatments were distributed in a 4 x 6 factorial scheme; temperatures (constant temperatures of 25, 30 and 35°C; and alternate temperatures of 20-30°C) and substrate (paper towel, over blotting paper, in sand, in vermiculite, Bioplant® and Plantmax®) on four replications of 25 seeds. The following parameters were analyzed: germination percentage, germination speed index, first germination count, length and dry mass of seedlings. The constant temperature of 30°C and 20-30°C alternate, and the substrates into sand and paper towel can be recommended for germination and vigor tests of *P. dubium* seeds. The temperature of 25°C should not be used in germination and vigor tests of *P. dubium* seeds in any of the tested substrates.

Key words: golden shower tree, forest seeds, vigor, seed analysis.

RESUMO. Efeito da temperatura e do substrato na germinação de sementes de *Peltophorum dubium* (Sprengel) Taubert. *Peltophorum dubium* (Spreng.) Taub. é uma espécie pertencente à família Fabaceae, conhecida popularmente como canafístula. A espécie pode ser utilizada como ornamental e sua madeira tem múltiplos usos em programas de reflorestamento, é também considerada uma espécie em extinção, fazendo-se necessários estudos que auxiliem em sua preservação. Este trabalho teve como objetivo recomendar o substrato e a temperatura ideais para condução de testes de germinação e vigor para sementes desta espécie. O experimento foi realizado no Laboratório de Análise de Sementes (Centro de Ciências Agrárias, Universidade Federal Paraíba, Areia, Paraíba, Brasil), em delineamento inteiramente ao acaso, com os tratamentos distribuídos em esquema fatorial 4 x 6 (temperaturas constantes de 25, 30 e, 35°C e alternada de 20-30°C e os substratos: papel toalha, sobre papel mata-borrão, entre areia, entre vermiculita, Bioplant® e Plantmax®), distribuídas em quatro repetições de 25 sementes. Foram analisadas as seguintes características: germinação, índice de velocidade de germinação, primeira contagem de germinação, comprimento e massa seca de plântulas. Recomendam-se para condução dos testes de germinação e vigor das sementes de *P. dubium* os substratos entre areia ou papel toalha, na temperatura constante de 30°C e alternada 20-30°C. A temperatura de 25°C não deve ser utilizada para testes de germinação e vigor de sementes de *P. dubium*, em quaisquer dos substratos utilizados.

Palavras-chave: canafístula, sementes florestais, vigor, análises de sementes.

Introduction

Peltophorum dubium (Spreng.) Taub., popularly known as golden shower tree, is an arboreal species belonging to the Fabaceae family (LORENZI, 2002). Its wood is moderately heavy, hard and of long durability. It is considered promising as it presents substantial economic value, due to the quality of its

wood (MATTEI; D'AVILA, 2002). Its growth is fast, which enables its classification as a species capable of artificial regeneration (CARVALHO, 1994); hence it is commonly found colonizing grasslands, filling glades and borders of forests, and is also used to compose assorted reforestation of degraded and permanent preservation areas (DONADIO; DEMATTÊ, 2000).

Seed analysis of forest species has gained the attention of the scientific community, aiming for the acquisition of information concerning the ideal conditions for seed germination of many species. Analysis is performed by means of a set of procedures approved by Rules for Seed Analysis (BRASIL, 2009) and aims to evaluate the quality regarding batch composition and germinative capacity for sowing purposes.

Temperature and substrate are basic components to carry out germination tests (STOCKMAN et al., 2007). Since the physiological response of seeds is unequal under different temperatures and substrates, it is recommendable to study the influence of these components on the germination of each species of interest, providing subsidies for the analysis of these seeds (GUEDES et al., 2009).

Substrate directly influences germination, due to its structure, aeration, water retention capacity, pathogen infestation grade, among other factors, and may favor or impair seed germination. It constitutes the physical support in which seeds are placed, and its function is to maintain proper conditions for the germination and development of seedlings (FIGLIOLIA et al., 1993). Therefore, the substrate choice must be done according to the seed requirements related to its form and size (BRASIL, 1999).

For the seeds of many forest species, several different substrates have been tested in germination trials, such as charcoal, vermiculite, rag, paper towel, filter paper, blotting paper, vegetal soil-sand, among others (ANDRADE et al., 1999). Substrates Plantmax® and Bioplant® have shown good acceptance for germination tests of some species, especially due to its physical-chemical characteristics, such as the presence of organic matter, sufficient amount of ionic charges, porosity and satisfactory moisture retention.

Temperature exerts a strong influence on germination speed and uniformity, and is related to the biochemical processes (CARVALHO; NAKAGAWA, 2000). One can observe that seeds may have unequal behaviors under different temperatures, and there is no optimal and uniform germination temperature for every species. In general, temperature is considered optimal when maximum germination is observed, at minimum time. The temperature range between 20°C and 30°C has been regarded as adequate for the germination of seeds of many subtropical and tropical species, since these are temperatures ordinarily found in their native regions, at the time of natural germination (ANDRADE et al., 2000).

Santos and Aguiar (2000) obtained the best germination results for seeds of *Sebastiania*

commersoniana (Baill.) Smith and Downs at the temperature range of 20-30°C and with the substrate on sand. For seeds of *Mimosa caesalpiniiifolia* Benth., the temperature of 25°C was presented as the most adequate for the conduction of germination and vigor tests, independently of the substrate used (ALVES et al., 2002). Paper towel substrate is recommended for the physiological quality evaluation of *Crataeva tapia* L. seeds (GONÇALVES et al., 2007). The temperature of 30°C and paper as substrate, in the shape of a roll, provided the ideal conditions for the germination of seeds of *Peltophorum dubium* (Sprengel) Taubert (OLIVEIRA et al., 2008). The germination test for seeds of *Parapiptadenia rigida* (Benth.) Brenan must be performed at the temperature of 25°C, using vermiculite as substrate (MONDO et al., 2008). The substrate roll of paper, at the temperature of 30°C is more suitable for the conduction of germination and vigor tests in seeds of *Cereus jamacaru* DC. (GUEDES et al., 2009). And for the germination of seeds of *Amburana cearensis* (Allemão), A.C. Smith recommended a temperature of 35°C (GUEDES et al., 2010).

The current study aimed to evaluate the effect of temperature systems and different substrates on the germination of seeds and initial development of seedlings of *Peltophorum dubium*.

Material and methods

The experiment was carried out at the Laboratory of Seed Analysis, belonging to the Center of Agrarian Sciences, Federal University of Paraíba, Areia, Paraíba State Brazil. Seeds of *Peltophorum dubium* were used, manually collected from 10 mother plants at the beginning of the dehiscence process, in the city of Areia, Paraíba, State Brazil. After collection, seeds were manually conditioned and kept in the shade, for natural drying, during five days. Before the start of the germination process, dormancy was overcome using sulfuric acid for 10 minutes, according to the recommendation of Piroli et al. (2005). Seeds were treated with the fungicide Captan, at the ratio of 240 g per 100,000 g of seeds, and next, submitted to the following tests:

Germination test

The germination test was performed in substrates paper towel (organized in the shape of rolls), on blotting paper, burial in sand, burial in vermiculite, Plantmax® and Bioplant®, at the constant temperatures of 25, 30 and 35°C and alternated temperatures of 20-30°C, in four

replications with 235 seeds, sown in gerbox, with dimensions of 0.11 x 0.11 x 0.03 m in germination chamber (B.O.D. type), under 8 hours photoperiod. Substrates were moistened with distilled water, according recommendation of Brasil (2009), and the substrates paper towel and blotting paper were moistened with distilled water with the amount equivalent to 2.5 times its dry weight. Counts were performed daily, from the 5th to the 10th day after sowing, considering the number of seedlings with cotyledon exposure.

First count of germination

Corresponding to the accumulated percentage of seedlings with cotyledon exposure up to the 5th day after test application.

Speed of germination index (SGI)

Performed along with the germination test, where, the number of seedlings with cotyledon exposure was daily reckon, and calculated according to the formula described by Maguire (1962), in which:

$$GSI = \frac{G_1}{N} + \frac{G_2}{N_2} + \dots + \frac{G_n}{N_n}$$

with:

G_1 , G_2 and G_n = number of normal seedlings found at the first, second and last count; N_1 , N_2 and N_n = number of days from sowing at the first, second and last count.

Seedlings length

At the end of the germination test, normal seedlings (from root to shoot) of each replicate were measured with a graded ruler in centimeters, and results were expressed in cm seedling⁻¹.

Dry mass of seedlings

Same seedlings used for the previous evaluation were placed in paper bags and taken to oven adjusted for 65°C, remaining until reaching constant weight, and next, seedlings were weighed in analytical balance with precision of 0.001 g.

Statistical design

Completely randomized statistical design, with treatments distributed in a 4 x 6 factorial arrangement (four temperatures and six substrates), with four replications of 25 seeds each, with data submitted to analysis of variance, and means compared by the Scott-Knott test at 5% probability.

Results and discussion

Percentage means of germination of seeds of *P. dubium* are presented in Table 1, where significant interactions between substrate and temperature were found. It was observed that the highest germination percentage were obtained in the substrate burial in sand in every temperatures used, followed by the substrates burial in vermiculite and paper towel at the temperature of 30°C; and paper towel at the temperature of 35°C and 20-30°C. In the substrate on paper, no germination was verified, probably due to the lack of contact with the seeds, which reduces the proper moistening for germination.

Table 1. Germination (%) of *Peltophorum dubium* (Spreng.) Taub., seeds under different temperatures and substrates.

Substrates	Temperatures (°C)			
	25	30	35	20-30
Burial in sand	87 a A	93 a A	91 a A	94 a A
Burial in vermiculite	80 a B	96 a A	49 c C	84 b B
Burial in Bioplant®	37 c B	61 b A	57 c A	51 d A
Burial in Plantmax®	52 b B	56 b B	72 b A	60 c B
Blotting Paper	0 d A	0 c A	0 d A	0 c A
Paper towel	81 a B	91 a A	87 a A	92 a A

Means followed by same letter in the column and capital in the same row do not differ at 5% probability by Scott-Knott test.

In Table 1, different responses regarding the interactions between substrates and temperatures were recorded. Figliolia et al. (1993) report that the significant interaction between temperature and substrate may be explained by the capacity of water retention and the amount of light the substrate allows to reach the seed, being responsible for different responses of seeds at the same temperature, as occurred with *P. dubium* seeds in this experiment.

Results obtained with this experiment corroborate those obtained with seeds of *Myracrodruon urundeuva* Fr. All. (PACHECO et al., 2006), *Apeiba tibourbou* Aubl. (PACHECO et al., 2007), *Bixa orellana* L. (LIMA et al., 2007), *Jatropha curcas* L. (MARTINS et al., 2008), *Peltophorum dubium* (Sprengel) Taubert (OLIVEIRA et al., 2008) and *Dypsis decaryi* (Jum.) Beentje & J. Dransf. (LUZ et al., 2008), where significant interactions between substrates and temperature occurred. Also, results are different from those by Andrade et al. (1999) with seeds of *Euterpe edulis* Mart., those of Lima et al. (2006) with seeds of *Caesalpinia ferrea* Mart. ex. Tul., those of Pivetta et al. (2008) with seeds of *Archontophoenix cunninghamii* H. Wendl. & Drude and those of Rodrigues et al. (2008) with seeds of *Prunus selowii* Koehne, where no significant interaction between substrates and temperatures occurred.

Concerning the temperatures for *P. dubium* germination, the results obtained in this experiment contradict those found by Oliveira et al. (2008), the best germinating results were obtained for the Lins batch, at the temperature of 25°C, with the substrates on sand and on paper; at the temperature of 20-30°C, with the substrate on sand, and at the temperature of 30°C, with the substrate on sand and paper roll. This discrepancy may be explained by the seeds' source, since germination differences might be associated with the species ecological characteristics.

Andrade et al. (2006) established the temperatures of 25°C and 20-30°C, using the substrates on vermiculite and paper roll for the germination of *Dalbergia nigra* (Vell.) Fr. All. ex Benth. seeds, and, hence, did not recommend the substrate on blotting paper. Associations of on paper or burial in vermiculite, with temperature of 30°C were those that provided greater germination in seeds of *Mimosa caesalpiniaefolia* Benth. (NOVEMBRE et al., 2007). For the seeds of *Bixa orellana* L., germination was impaired when sown in the substrate Plantmax®, at the temperature of 20-30°C (LIMA et al., 2007).

Data regarding vigor, determined by the first germination count are presented in Table 2, in which significant interaction were found between temperature and substrates. The highest germination percentage were obtained for *P. dubium* seeds sowed in the substrates paper towel, at temperatures 30, 35 and 20-30°C. By analyzing the isolated effects of substrates on temperatures, it was verified that the highest percentages of seedlings in the first germination count were found for the substrates burial in sand and burial in vermiculite, at the temperature of 30°C.

Table 2. First germination count (%) of *Peltophorum dubium* (Spreng.) Taub., seeds under different temperatures and substrates.

Substrates	Temperature (°C)			
	25	30	35	20-30
Burial in sand	29 a C	83 b A	23 b C	41 b B
Burial in vermiculite	20 b B	32 c A	3 c C	5 c C
Burial in Bioplant®	14 b A	0 d B	0 c B	1 c B
Burial in Plantmax®	20 b A	0 d C	2 c C	10 c B
Blotting Paper	0 c A	0 d A	0 c A	0 c A
Paper towel	27 a B	92 a A	86 a A	88 a A

Means followed by same letter in the column and capital in the same row do not differ at 5% probability by Scott-Knott test.

Pacheco et al. (2007) verified that the first germination count of *Apeiba tibourbou* Aubl. seeds did not present significant difference in germination. In contrast, Ferreira et al. (2008) observed that temperatures of 25, 30 and 35°C and the substrate burial in vermiculite provided the highest

germination percentages for *Eruca sativa* Mill. seeds, at the first count. The combination that promoted the greatest number of seedling at the first count for *Peltophorum dubium* (Sprengel) Taubert (OLIVEIRA et al., 2008) and *Cereus jamacaru* DC. (GUEDES et al., 2009) seeds was the utilization of the temperature of 30°C and the substrate paper towel, disposed in rolls.

Results concerning the germination speed index (GSI) of *P. dubium* seeds submitted to different substrates and temperatures are presented in Table 3, in which is possible to verify that the greatest indexes occurred for the interactions between the substrate paper towel and temperatures of 30, 35 and 20-30°C, and burial in sand and at the temperature of 30°C. There were no interactions between treatments, for the temperature of 25°C, and hence, it is not favorable for this species germination. Therefore, one can assume that the most elevated temperatures might proportionated a greater metabolic activity, accelerating and uniformizing the germinative process, which is in accordance to Carvalho and Nakagawa (2000), who reported that the higher the temperature, respecting a threshold, the faster and more uniform the germination will be.

Table 3. Speed of germination index (SGI) of *Peltophorum dubium* (Spreng.) Taub., seeds under different temperatures and substrates.

Substrates	Temperatures (°C)			
	25	30	35	20-30
Burial in sand	4.26 a C	5.69 a A	4.36 b C	5.42 b B
Burial in vermiculite	3.90 b C	5.07 b A	2.19 d D	4.40 c B
Burial in Bioplant®	1.36 d D	2.32 c A	1.85 e B	1.62 d C
Burial in Plantmax®	2.56 c B	2.01 d C	2.83 c A	1.99 d D
Blotting Paper	0.00 e A	0.00 e A	0.00 f A	0.00 e A
Paper towel	3.99 b B	5.73 a A	5.56 a A	5.61 a A

Means followed by same letter in the column and capital in the same row do not differ at 5% probability by Scott-Knott test.

Substrates burial in sand and on sand, at the temperatures of 25 and 27°C provided the highest GSI for seeds of *Myracrodruon urundeuva* Fr. All. (PACHECO et al., 2006). The substrate blotting paper promoted the highest GSI for seeds of *Apeiba tibourbou* Aubl. (PACHECO et al., 2007). For *Mimosa caesalpiniaefolia* Benth. seeds, 30°C is the most suitable temperature to increase the germination speed, by distributing seeds on blotting paper or in burial in vermiculite (NOVEMBRE et al., 2007). Pivetta et al. (2008) mentioned the temperatures of 25 and 30°C, along with the substrate vermiculite as the medium and the conditions responsible for the highest GSI for seeds of *Archontophoenix cunninghamii* H. Wendl. & Drude.

Averages concerning seedling length are presented in Table 4. The greatest lengths of seedling of *P. dubium* seeds were obtained by the interaction of temperatures 20-30°C with the substrate burial in sand. When considering the isolated effects, it was observed that the highest lengths of seedlings might be obtained if seed are sowed in the substrate sand, independent of the temperature applied, as well as the substrates Bioplant® and Plantmax® at the temperature of 30°C.

Table 4. Length (cm) of *Peltophorum dubium* (Spreng.) Taub. seedlings under different temperatures and substrates.

Substrates	Temperature (°C)			
	25	30	35	20-30
Burial in sand	10.92 a B	10.32 a C	9.55 a D	11.91 a A
Burial in vermiculite	9.40 b A	9.63 b A	6.32 c B	10.08 b A
Burial in Bioplant®	5.55 c B	10.10 a A	6.53 c B	6.03 d B
Burial in Plantmax®	8.51 c B	10.43 a A	7.78 b B	8.14 c B
Blotting Paper	0.00 f A	0.00 c A	0.00 e A	0.00 e A
Paper towel	7.55 d B	9.35 b A	4.28 d C	7.98 c B

Means followed by same letter in the column and capital on the line do not differ at 5% probability by Scott - Knott.

For *Myracrodruon urundeuva* Fr. All., the best primary root development occurred when seedlings were submitted to substrates burial in sand and on sand, at the temperature of 27°C and burial in sand at the temperature of 20-35°C (PACHECO et al., 2006), whilst Iossi et al. (2003) did not recommend the use of vermiculite for the conduction of length tests for *Phoenix roebelenii* O'Brien seedlings, since the lowest results were obtained. Kissmann et al. (2007) verified that the greatest length of shoots of seedlings of *Adenanthera pavonina* L. was obtained with seeds submitted to temperatures of 20-30°C, 25°C and 30°C, independently of the substrate (paper towel and on paper). The length of *Cereus jamacaru* DC. seedlings was greater in temperatures of 25 and 30°C, using the substrate paper roll; the smallest lengths were found when using the substrate on paper, in the temperatures 20-30 and 30°C (GUEDES et al., 2009).

In the evaluation of dry mass content of *P. dubium* seedlings no significant interactions between different temperatures and substrates were observed.

Conclusion

For the germination and vigor of *P. dubium* seeds, we recommend the substrates burial in sand or paper towel, disposed in rolls, in the temperatures of 20-30 and 30°C.

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Received on May 25, 2009.

Accepted on August 14, 2009.

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