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Cardinal temperatures for the germination of *Chorisia speciosa* A. St.-Hil.. and parameters of the accelerated aging test for determination of vigor

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Abstract

Chorisia speciosa A. St.-Hil., popularly known as paineira, barriguda, paineira-branca and paineira-rosa, belongs to the Bombacaceae family, being used to fill mattresses, pillows and cushions. The trees can be used in the construction of boats, boxes and mainly in the recovery of degraded areas. Among the most important tests of vigor, temperature is a factor that can directly interfere with germination and seedling growth. The accelerated aging might be emphasized as the most suitable to estimate seed vigor. The experiment was conducted in a laboratory of the Federal University of Alagoas/UFAL, aiming to determine the cardinal temperatures and to study the influence of accelerated aging on the germination and seed vigor of *C. speciosa*. The seeds were submitted to temperatures of 20 ºC, 30 ºC, 35 ºC and 40 ºC in paper roll substrate. For the accelerated aging test, temperatures of 41 and 45 ºC were tested during the periods of 24, 48, 72 and 96 hours. The variables analyzed were: first germination count, germination, germination speed index (IVG), dry mass and seedling length. The results showed that temperature of 30 ºC can be indicated as optimum for the germination of the species, since it provided the best values for the evaluated characteristics. Accelerated aging after 24 hours affected the physiological quality of *C. speciosa* seeds, promoting a reduction in viability and vigor.

Keywords: Bombacaceae, Ecological, Forest seeds, Seed analysis.
Abbreviations: BOD_Biochemical Oxygen Demand; IVG_Index of speed of germination; UFAL_Federal University of Alagoas.

Introduction

The paineira (*Chorisia speciosa* A. St.-Hil.) Bombacaceae family is a deciduous plant, characteristic of broadleaf forest Semideciduous in the states of Rio de Janeiro, Minas Gerais, Goiás, São Paulo, Mato Grosso do Sul and northern Paraná (Lorenzi, 2002). It also occurs in Bahia, Espírito Santo, Paraíba, Federal District, Santa Catarina and Rio Grande do Sul (Carvalho, 2003). It has great ecological importance, being included in the list of rare or endangered species in Brazil.

It is a large tropical tree and robust trunk with thickening near the base that reach 30 meters in height. It is extremely ornamental when in full bloom, which lends itself admirably to the landscaping of large gardens and squares (Carvalho, 2003).

C. speciosa also occurs in countries such as Argentina and Paraguay (Carvalho, 1994). This species is known by the names of barriguda, paina-de-seda, paineira-branca, paineira-rosa, árvore-de-paina and árvore-de-lã.

It is used in filling mattresses, pillows, cushions and the construction of boats. It has rapid growth in the initial phase and long life cycle. The flowers are hermaphrodite, the fruits are capsule shaped and the seeds are wrapped in hair (paina), which help in dispersion by the wind. Each tree produces on average 300 to 700 fruits, with approximately 120 to 200 seeds (Carvalho, 1994).

The seeds are dispersed by wind (anemocoria), reaching distances greater than 160 m, and the pollination is done by animals (Lorenzi, 1992; Carvalho, 1994). It flowers between the months of December and April. The maturation of the fruits occurs during the months of August and September with the tree totally without foliage.

In reforestation and restoration of degraded areas, plant species with capabilities such as rapid growth, protection and enrichment of the soil, sheltering fauna, restoration of the landscape and re-establishment of water regime in the soil are desirable (Lorenzi, 2016). *C. speciosa* can be used for this purpose.

The germination process involves a series of metabolic activities, where a sequence of chemical reactions occurs with specific temperature requirements, since they depend on the activity of specific enzymatic systems (Marcos Filho, 2015).

Temperature variations affect the speed, percentage and uniformity of germination. The germination process can be affected by a series of intrinsic and extrinsic conditions, such as humidity, temperature, light and oxygen. However, all are essential for the process to be carried out normally. The absence of one of them can prevent the germination of the seed (Popinigis, 1985; Carvalho and Nakagawa, 2012). Among the environmental conditions that affect the germination process, temperature can be considered the most relevant.

More vigorous seeds have the ability to produce normal seedlings, presenting faster and higher germination after being submitted to the accelerated aging test, while those with low vigor showed low viability (Guedes et al., 2009). As a relatively easy test in the laboratory, the accelerated aging test has been used to determine the vigor of several species, and may present limitations for some species (Rodo et al., 2000).

It is of great importance to obtain the knowledge of the factors that influence seed germination, especially for forest species, allowing a more precise understanding of the mechanisms that regulate seed longevity in the soil and the establishment of plants under natural conditions. Based on this, the objective of the research was to determine the cardinal temperatures and to study the influence of accelerated aging on the germination and seed vigor of *C. speciosa*.

Results and Discussion

Germination in different temperatures

For the results concerning the first germination count (Figure 1), the temperature of 30 ºC provided the best result, obtaining a germination of 65%. For most species, the optimum temperature range is between 20 ºC and 30 ºC (Marcos Filho, 2015). Lascher (2000) extended this range even to 35 ºC.

The seeds of *C. speciosa* showed lower vigor when submitted to a temperature of 20 ºC. These results are explained by the fact that lower temperatures decrease the metabolic activity of the seeds, delaying the germination process speed, as reported by Sousa et al. (2008).

The seeds of *C. speciosa* germinated at different temperatures, which allowed their colonization in a greater diversity of habitats, facilitating their dispersion. The vigor of the seeds varied according to the temperatures tested.

It was verified that the seeds submitted to the temperature of 30 ºC and 35 ºC presented higher germination percentages, obtaining respectively 80% and 71% (Figure 2). These data demonstrate the range of temperatures in which germination of the seeds of this species can occur. This provides greater capacity of establishing the seedlings in the field, enabling them to withstand the adverse conditions of the environment.

The optimal temperature for seed germination is directly associated with the ecological characteristics of the species (Probert, 1992). Figliolia et al. (1993) stated that the water retention capacity and the amount of light that the substrate allows to reach the seed can be responsible for different seed responses at the same temperature. Guedes et al. (2010) tested the temperature of 35 ºC, and this was indicated for the conduction of germination and vigor tests with *Amburana cearensis* (Allemão) A.C. Smith seeds, regardless of the substrate used. The responses of seeds to temperature for germination are different between species.

In the index of germination speed (Fig 3), the highest index was observed (3.621), when the temperature of 30 ºC was used. According to Gonçalves et al. (2007) the paper roll substrate, the same as that used in the present research, is also recommended for the evaluation of the physiological quality of seeds of *Crataeva tapia* L.

Ferreira et al. (2004) state that the germination speed is a good index to evaluate the occupation of a species in a given environment, since the rapid germination is characteristic of species whose strategy is to settle in the environment as quickly as possible taking advantage of favorable environmental conditions.

An important factor to consider is the temperature and substrate interaction, since the water retention capacity of the substrate can be responsible for different responses obtained up to the same temperature (Figliolia et al., 1993).

The seed germination speed may be influenced by the different water retention capacities between substrates. This probably influences the seed imbibition rate and, consequently, the average germination time.

The lowest germination speed index (0.424) was obtained at temperature of 20 ºC. Probably, the lower temperature may be responsible for the reduction in the seed germination index of *C. speciosa*.

The maximum value of 0.0836g was obtained for dry mass of the primary root (Figure 4) when the temperature of 30 ºC was used. Ramos et al. (2004) reported that the aerial and root dry mass evaluations are of great importance in the evaluation of the development of the plants, ensuring the establishment of the seedlings in the field.

It was verified that the most vigorous seedlings (dry mass of aerial part of 0.286g) (Figure 5) were obtained from seeds at the temperature regime of 30 ºC. Alves et al. (2002) used the dry mass to conclude that the temperature of 25 ºC was more adequate to conduct the test of germination and vigor of seeds of *Mimosa caesalpiniaefolia.*

We analyzed the initial development of the seedlings by measuring length of the primary root (Figure 6) and noticed that the best result (4,772 cm) can be reached at a temperature of 30 ºC. In *Parkia pendula* the seedling and primary root lengths were measured and the temperature of 25 ºC was the most adequate for the germination test of this species (Rosseto et al., 2009). The length of the primary root of *C. speciosa* seedlings was influenced by the temperatures studied, presenting the smallest lengths at the temperature of 20 ºC.

For the shoot length of the seedlings (Figure 7), the highest value (5.7685 cm) was obtained at a temperature of 35 ºC, differing from the results that were found in Figure 6 for the length of the primary seedling root of *C. speciosa*. Along with the germination test, the determination of the seedling length is important, because seeds may present high percentage of germination and low average length of seedlings, as well as low percentage of germination, but with high average length of seedlings (Rosseto et al., 2009).

Accelerated aging in different periods

Figure 8 shows the results of the evaluation of the physiological quality of the seeds of *C. speciosa* by the first count and germination test. There was a significant decrease

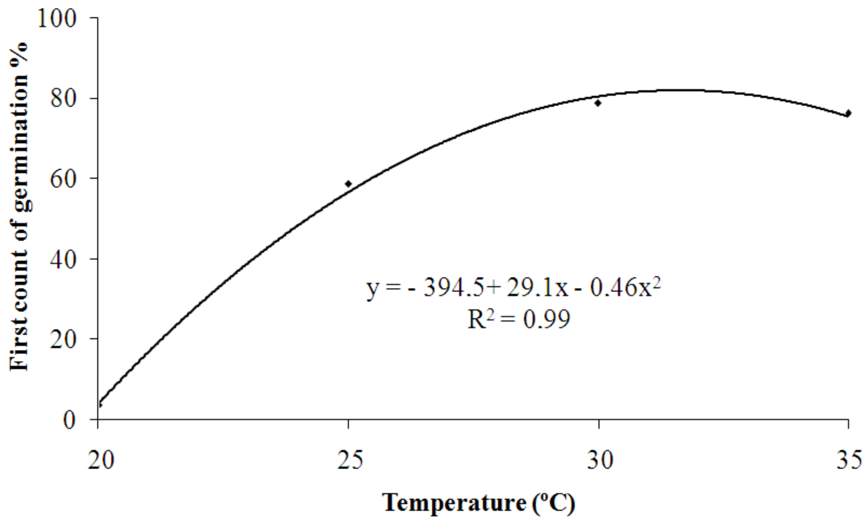

Fig 1. First seed germination count of *Chorisia speciosa* A. St.-Hil. subjected to different temperatures.

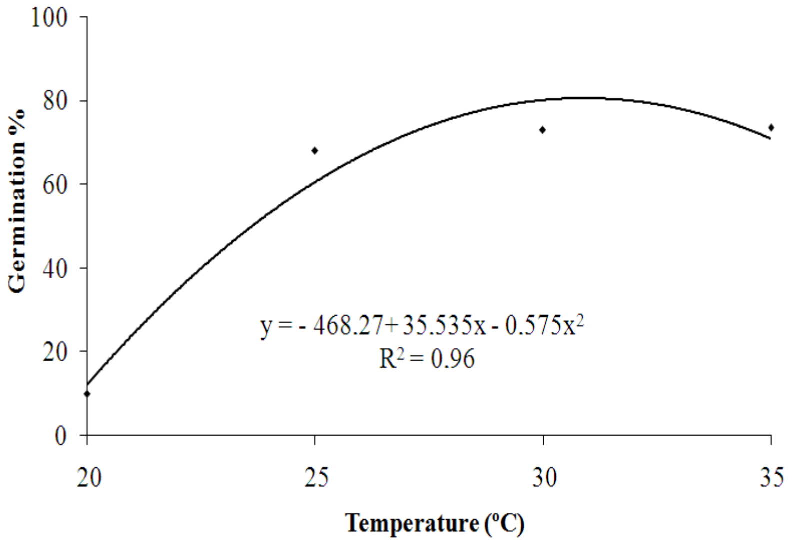

Fig 2. Germination of *Chorisia speciosa* A. St.-Hil seeds at different temperatures.

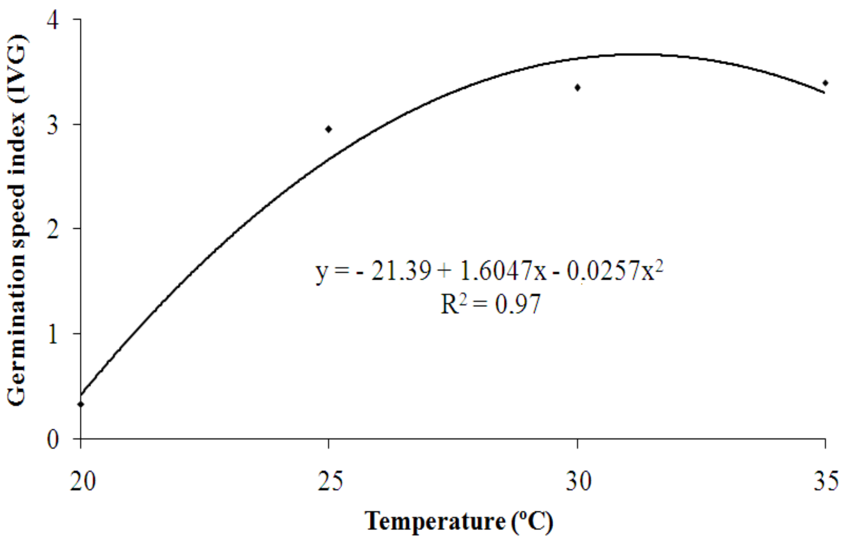

Fig 3. Seed germination rate index of *Chorisia speciosa* A. St.-Hil.. subjected to different temperatures

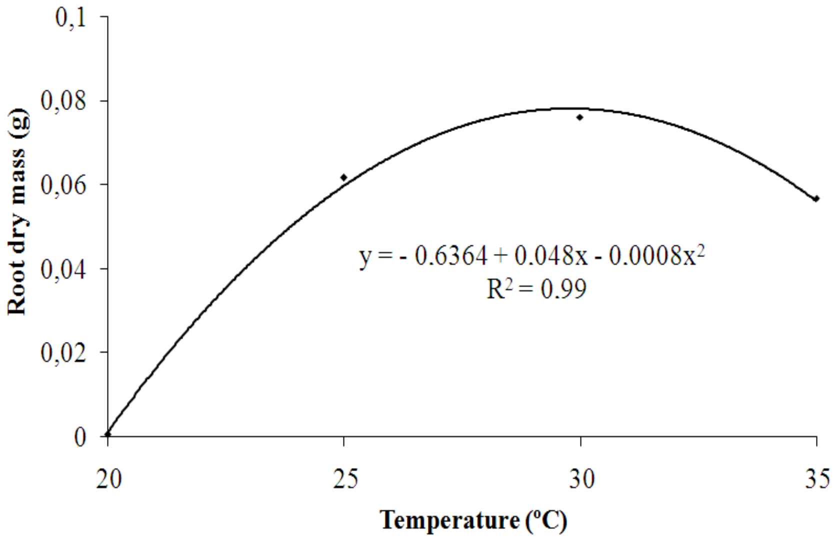

Fig 4. Dry mass of seedlings of *Chorisia speciosa* A. St.-Hil. from seeds subjected to different temperatures.

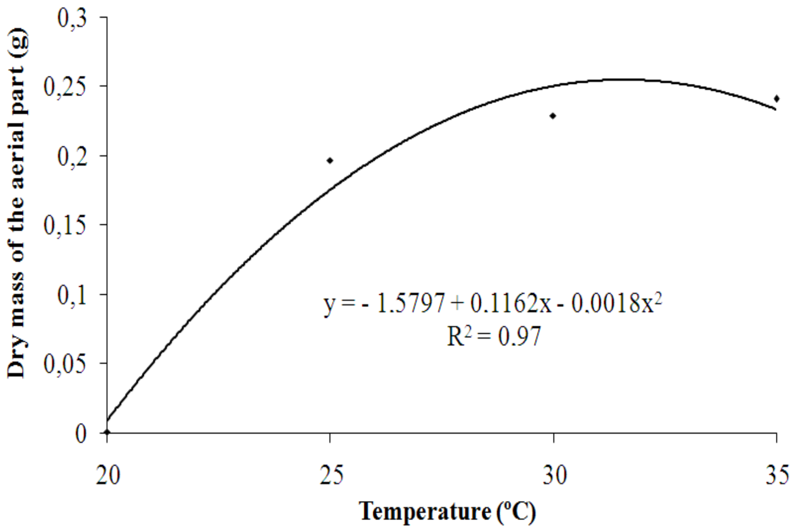

Fig 5. Dry mass of the aerial part *Chorisia speciosa* A. St.-Hil. seedlings from seeds subjected to different temperatures.

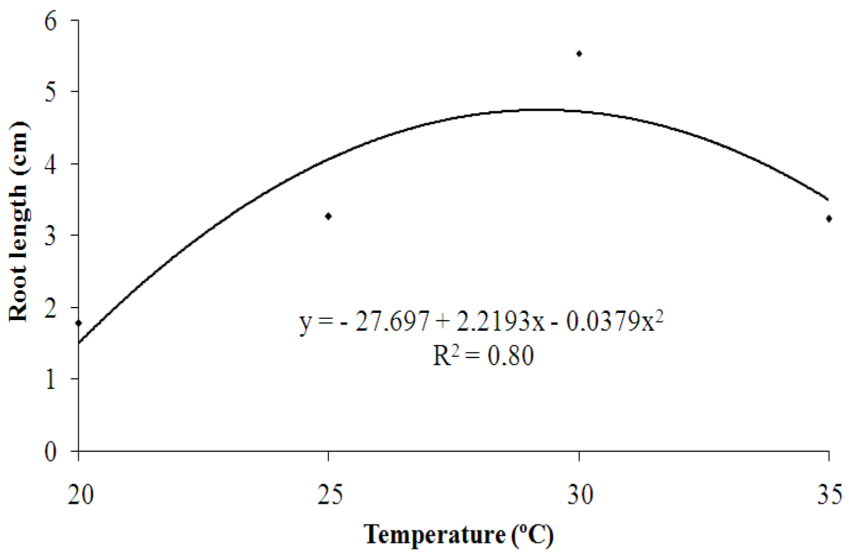

Fig 6. Root length of seedlings of de *Chorisia speciosa* A. St.-Hil.from seeds subjected to different temperatures.

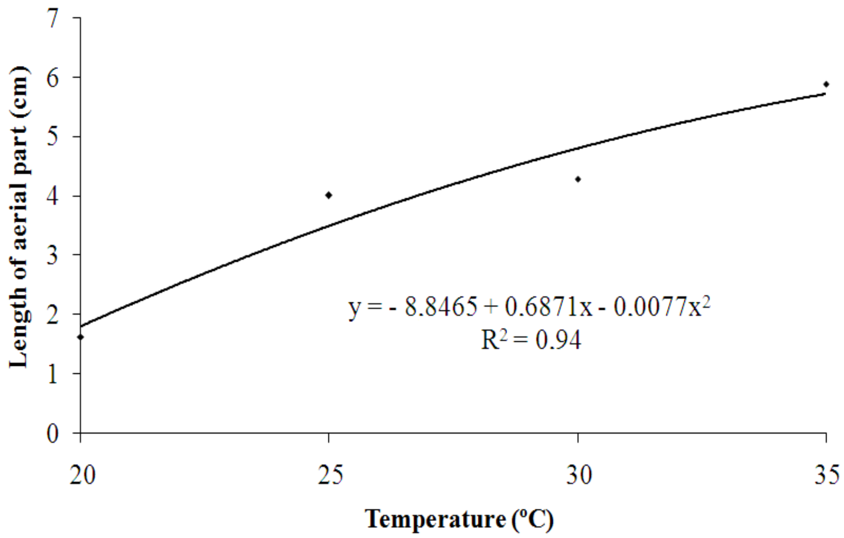

Fig 7. Length of aerial part of seedlings of *Chorisia speciosa* A. St.-Hil. from seeds subjected to different temperatures.

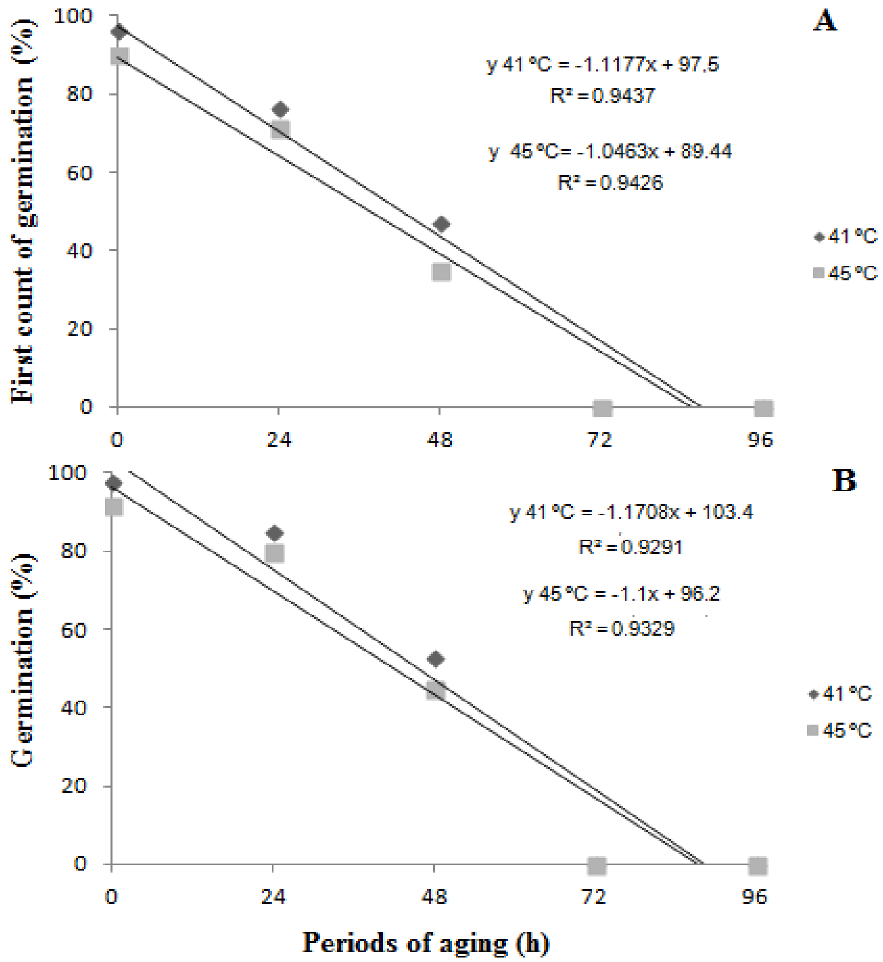

Fig 8. First count (%) (A) and germination (%) (B) of *Chorisia speciosa* A. St.-Hil., Seeds before and after accelerated aging.

in the percentage of normal seedlings as the seeds were aged. However, when the seeds were submitted to temperatures of 41 and 45 ºC, no significant differences were observed after 24 hours, compared to the control (0 hour). However, these were superior to the others, indicating a drastic reduction of the physiological quality of seeds from 48 hours of aging. Probably, this reduction is associated with the seed deterioration process, when submitted to high temperature and high humidity conditions. Similar results were verified for seeds of *Dalbergia nigra* (Guedes et al., 2011) and *Erythrina velutina* (Guedes et al., 2009).

High temperatures in the aging test promoted more drastic effects on germination than the prolongation of the period of exposure to aging (Tomes et al., 1988). Similar results were observed by Borges et al. (1990) studying seeds of *Cedrela fissilis* L.. Lima et al. (2006) studied seeds of *Ocimum gratissimum* L.. and Fanti and Perez (1999) seeds of *Adenanthera pavonina.* All these authors reported similar results.

Seed aging causes metabolic changes during the germination process, including respiratory metabolism and altered membrane structure (Marcos Filho, 2015), synthesis of proteins, nucleic acids and DNA metabolism (Vázquez et al., 1991), delaying the germination process, lowering embryo growth and susceptibility to environmental stresses and eventually leading to loss of viability.

Materials and Methods

Plant materials

The experiment was conducted in a laboratory belonging to the Federal University of Alagoas. The seeds of the *C. speciosa* were collected in parent trees in the rural area of Rio Largo-AL in the period between November and December 2016.

C. speciosa seeds were disinfected with a 2% sodium hypochlorite solution (12.5 mL sodium hypochlorite and 487.5 mL distilled water) for five minutes, then washed in running water for four minutes, followed by washing with distilled water for one minute.

Germination

The paper rolls with the seeds were placed in a *Biochemical Demand Oxigen* (B.O.D) chamber at constant temperatures of 20 ºC, 25 ºC, 30 ºC and 35ºC, with photoperiod of 8 hours. The germination criterion adopted was root length equal to or greater than 0.25 cm.

Accelerated aging

For each treatment, 25 seeds per replicate were used, which were uniformly distributed to form a single layer on the metal screen surface suspended inside the plastic box (internal compartment) containing 40 mL (Guareschi et al., 2015) of distilled water and obtaining approximately 100% relative humidity of the air, at the temperature of 41 and 45 ºC, according to the Gerbox method (Tilmann and Mello, 2006). The treatments were composed of different exposure times to the stress conditions: 0, 24, 48, 72 and 96 hours.

Variables analyzed:

Germination: The test was set up with four replicates of twenty five seeds per treatment, containing as substrate paper roll. The paper was previously moistened with water corresponding to 2.5 times the weight of the dried paper and kept in a vertical chamber germinator type B.O.D., regulated at 20 ºC, 25 ºC, 30 ºC and 35 ºC. Counts were performed from the fifth (first count) to the fifteenth (last count) of the test facility. The normal seedlings of each replicate were counted and a mean of the subsamples was then recorded and the results were expressed as percentage of normal seedlings.

First germination count: was carried out with the germination test, when the normal seedlings were counted soon after their germination on the 4th day after sowing, and the data were expressed as percentage.

Index of speed of germination (IVG): daily counts of normal seedlings were performed for 15 days, and the index was calculated according to the formula presented by Maguire (1962).

Length of seedlings: at the end of the germination test, the normal seedlings of each replicate were measured with a ruler graduated in centimeters, the results being expressed in cm per seedling $^{-1}$.

Dry mass of seedlings: after the last germination test count, the seedlings were submitted to the oven regulated at 80 ºC for 24 hours and after that, they were weighed in an analytical balance with an accuracy of 0.001 g (Nakagawa, 1999).

Experimental design used: A completely randomized experimental design (DIC) was used, with 4 replicates of 25 seeds each. The results were submitted to analysis of variance and analyzed in the form of polynomial regression. The analyses were performed using the SISVAR software 5.6 (Ferreira, 2011).

Conclusion

C. speciosa seeds are capable of germinating under different temperatures. In laboratory conditions the temperature of 30 ºC was higher, and it could be indicated for tests of germination and vigor. Accelerated aging after 24 hours affected the physiological quality of *C. speciosa* seeds, promoting a reduction in viability and vigor.

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