

Effect of Temperature and Storage on Seed Germination of *Archontophoenix alexandrae* H. Wendl. & Drude (Arecaceae)

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Abstract—This work had as goal to verify the temperature's effect on the germination of seeds. The experiments were carried out at the laboratory of Seeds Analysis of Horticultural Plants of the Department of Plant Production, at the University of Agrarian and Veterinary Sciences, UNESP, Campus Jaboticabal, SP, Brazil. The experimental design was interely randomized in factorial scheme being six temperature conditions (25°C, 30°C, 35°C, alternate of 20-30°C, 25-35°C with photoperiod of 12 hours and environment temperature) with 4 repetitions of 25 diaspores (seed with adherent endocarp). The fruits were collected from matrices localized at Jaboticabal, and were pulped (removal of mesocarp and exocarp). The diaspores were dried at shade and their water content was determined were placed in plastic boxes (gerbox type) containing vermiculite. Diaspores that emitted the germinative intumescence were daily counted until stabilization of germination. The germination percentage and the Speed of Germination Index were calculated.

Index Terms: palm, sexual propagation

I. INTRODUCTION

The species *Archontophoenix alexandrae* (F. Muell) H. Wendl. & Drude, commonly known in Brazil as seafórtia and royal palm-australian originated in Australia. Widely used in parks and gardens, it is also grown for palm heart production. (LORENZI et al., 2004).

Several palm trees have commercially available palmetto, but until 1998, only those of the genus *Euterpe*, mainly *E. edulis* and *E. oleraceae*, predominated in this basically extractive activity. As promising alternatives, first came the pupunha, *Bactris gasipaes* and later the Australian royal palm, *Archontophoenix* spp. which produces palmetto of the noble type, with a quality and flavor pattern still superior to that of the palms of the genus *Euterpe* (BOVI, 1998).

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The commercial propagation is done almost exclusively by seeds, although these have low percentage of germination, being considered slow, ununiform and quite variable among the species (PIVETTA et al., 2007).

According to Bewley and Black (1985), the temperature influences both the final percentage of germination and the speed of germination. Seeds are able to germinate under a given temperature range, defined for each species, with a maximum and minimum temperature, above and below which germination does not occur.

Although most palm trees are of tropical origin, the seeds of which usually germinate naturally at higher temperatures, several results on the temperatures that provide the highest percentage of germination have been found for different species, such as 35 °C for *Thrinax parviflora* (PIVETTA et al. (PIVETTA et al., 2005), 25 and 30 °C for *Phoenix roebelenii* (IOSSI et al., 2003), 25 °C for *Rhapis excelsa* (AGUIAR et al., 2005), 30 and 35 °C for *Syagrus romanzoffiana* 2005b); alternating temperatures of 25-35 °C for *Roystonea borinquena* (BUENO et al., 2013) or a wide range as 20, 25 and 30 °C and alternating at 20/30 °C or 25/35 °C for *Archontophoenix cunninghamiana* (LUZ et al., 2017).

Pivetta et al. (2007), citing several authors, commented that palm seeds have a typical behavior of recalcitrant seeds, that is, they do not tolerate desiccation until certain degrees of humidity considered relatively high, which, considered as lethal to the seed, vary with the species.

The water content is a limiting factor for the behavior of recalcitrant seeds during storage (MARTINS et al., 1999); For *Archontophoenix alexandrae*, water contents lower than 31.5% significantly reduced the germination rate and the total germination loss was verified in seeds with 15.1% moisture (Martins et al., 2003). Seeds of *Carpentaria acuminata* and *Phoenix canariensis* tolerated drying at 5% and 8% seed moisture, respectively. On the other hand, seeds of *Dypsis decaryi* and *Ptychosperma elegans* were sensitive to dehydration even at high moisture contents, 20% and 27% of seed moisture, respectively (BATISTA et al., 2016).

The conservation of seeds during storage with high water contents, close to those at the harvest stage, favored the attack of microorganisms and germination within the packages of seeds of *Archontophoenix cunninghamii* (LUZ and PIVETTA, 2010).

The germination of *A. cunninghamii* seeds stored under different conditions in polyethylene and cold chamber packaging, Luz and Pivetta (2010) concluded that the storage of seeds of this species for 11 months causes a reduction in germination percentage of less than 50% of germination.

Also, studying the conservation of *Archontophoenix alexandrae* seeds, with an initial water

content of 33%, stored under uncontrolled conditions and in a chamber at 20 °C (UR = 70 to 82%), Castelani et al. (2001) verified that the storage in the chamber at 20°C was more efficient, maintaining around 40% of germination after 240 days of storage.

There is not much information in the literature on temporary storage, that is, how long the seeds remain viable after harvest without the pretense of storing them.

Pivetta et al. (2005a) found that the seeds of *Thrinax parviflora* germinated more slowly when sown soon after harvest and more quickly when placed to germinate 6 and 7 days later; the seeds stored for ten days presented 92% of germination with maximum germination values (94% for both) 4 and 5 days after harvest. The germination percentage at harvest (68%) was lower than that obtained after storage, showing that the seeds, when harvested, probably had not yet reached the point of physiological maturity.

In order to elucidate some aspects related to the production of seedlings of *Archontophoenix alexandrae*, this work had as objectives, to study the effect of temperature and temporary storage on seed germination.

II. MATERIAL AND METHODS

The fruits of *Archontophoenix alexandrae* were collected from existing specimens in the Faculty of Agrarian and Veterinary Sciences - UNESP, Jaboticabal. The experiment was conducted at the Seed Analysis Laboratory of the Plant Production Department.

The bunches were harvested when it was observed that the fruits began to detach from the bunch and with the red coloration. The experimental design was completely randomized. The effect of 6 temperature conditions (constant temperatures of 25 °C, 30 °C, 35 °C and alternates of 20-30 °C and 25-35 °C and laboratory environment conditions) was studied. The effect of temporary storage for 4 weeks, that is, 5 treatments: sowing soon after harvest and 1 to 4 weeks after. For each, 4 replicates of 25 seeds each were used.

After harvest, the pericarp and mesocarp of the fruits were removed by hand rubbing against a sieve and the diaspores consisting of endocarp and seed, rinsed in running water and dried in the shade. After this process, 2 samples with 20 seeds each were taken to determine the water content of the seeds. The greenhouse method was used at 105°C for 24 hours (BRASIL, 2009).

Biometric data of the diaspores (seeds with the attached endocarp) were recorded in a sample of 100 units. Measurements of length and width were taken with the aid of a digital caliper and recorded the weight of one thousand diaspores and number of diaspores per kg.

In order to install the experiments that studied the effect of temperature and temporary storage, the diaspores were packed in plastic boxes (gerbox type), containing fine vermiculite, previously moistened, maintaining the substrate in its field capacity, using distilled water with 0,2% of nystatin to avoid contamination by fungi, and later placed in germination chambers.

For the study of the effect of temperature, the chambers were regulated according to the treatment and for the study of temporary storage, the diaspores were placed in conditions of laboratory environment. Maximum and minimum temperatures were recorded daily. The mean maximum temperature in the period was 28 °C and the mean minimum temperature was 25 °C.

In the alternating temperature regime, the luminous period corresponded to the highest temperature, using a 12-hour photoperiod under white light provided by eight 20W fluorescent lamps.

For storage the diaspores were packed in plastic bags under laboratory environment conditions. Each week, 140 diaspores were separated, 40 of which were used to determine the water content of the seeds by the oven method at 105 °C (+ -3 °C) for 24 hours (BRASIL, 2009).

The germination count was performed daily, from the date of installation of the experiment until germination stabilization, using germination as the criterion for germination.

To determine the percentage of germination, the formula proposed in the Rules for Seed Analysis was used (BRASIL, 2009). The IVG was calculated using the formula proposed by Maguire (1962).

The percentage germination data were transformed into $\arcsin(x/100)^{1/2}$. Statistical analysis was performed and the means of the temperature effect study were compared by the Skott-Knott test at 1% probability. For the study of the effect of the temporary storage, the polynomial regression analysis was performed to verify the behavior of the variables over the 4 weeks.

III. RESULTS AND DISCUSSION

According to the results observed between the temperatures tested (Table 1), the highest percentages of germination occurred at temperatures of 25 °C, 20-30 °C and in laboratory environment conditions (25-28 °C). This result is similar to that observed by Aguiar et al. (2005), who found better temperature responses of 25 °C for *Raphis excelsa*. Also, Iossi et al. (2003) observed high percentages of seed germination of *Phoenix roebelenii* at constant temperature of 25 °C (along with 30 °C). Better results were obtained by Bueno et al. (2013) for *Roystonea borinquena* at an alternating temperature of 25-35 °C, a condition similar to that registered under laboratory environment conditions and which also presented significantly higher averages.

However, the lowest percentage of *A. alexandrae* seed germination obtained in this study occurred at a temperature of 35 °C; as compared to *Thrinax parviflora* (PIVETTA et al., 2005a) and *Roystonea borinquena* (BUENO et al., 2013).

Also related to the germination speed, Table 1 shows that seed germination was faster at temperatures of 30 °C, 35 °C, 20-30 °C and 25-35 °C; already in conditions of laboratory environment and 25°C, the seeds germinated more slowly.

In general analysis, the temperature that provided the highest percentage and the germination speed was the alternating temperature of 20-30 °C.

The results concerning the percentage of germination and the Rate of Germination of seeds of *A. alexandrae* stored for 4 weeks after harvest are presented in Table 2.

It was observed that there was no regression adjustment for percentage of germination, that is, the percentage of germination of the seeds shortly after harvest, one, two, three and four weeks after it was similar.

There was a positive linear regression adjustment for the rate of germination (Table 2 and Figure 1), that is, the seeds germinated faster after storage.

Similarly, Pivetta et al. (2005a) found that *Thrinax parviflora* seeds germinated more slowly when sown soon after harvest and more rapidly when sowed to germinate 6 and 7 days later; the seeds stored for ten days presented 92% of germination

with maximum germination values (94% for both) 4 and 5 days after harvest. The percentage of germination at harvest (68%) was lower than that obtained after storage, showing that the seeds of *T. parviflora* harvested had not yet reached the point of physiological maturity, in which the seed reaches maximum germination power and maximum vigor.

In many species, the seeds do not have all their germinative power soon after harvest; in this case, because of the dormancy that is established during maturation. In order for the seeds to germinate to their full potential, a period of storage is required. This period is variable with the species and variety (POPINIGIS, 1977).

Thus, storage for 30 days was beneficial for *A. alexandrae* seeds that maintained high percentages and germinated more rapidly.

The water content is a very important factor for seeds considered recalcitrant as is the case of *Archontophoenix alexandrae* already defined by MARTINS et al. (2003) and STRINGHETA et al. (2004).

MARTINS et al. (2003) verified that water contents lower than 31.5% significantly reduced the germination rate in *A. alexandrae* seeds and the total germination loss was verified in seeds with 15.1% moisture content.

Analyzing the contents found in this study, that is, 38.72%, 35.31%, 35.00%, 34.07%, 33.80% respectively at harvest, 1, 2, 3 and 4 weeks after storage was found to be always above the value considered critical by Martins et al. (2003).

IV. CONCLUSION

It was concluded that the germination rates were 20-30 °C (94%), 25 °C (92%) and ambient (88%) for the various temperatures studied, and the germination was faster at temperatures of 30 °C, 35 °C, 20-30 °C and 25-35 °C. The germination percentage of freshly harvested seeds was similar to those stored for 1, 2, 3 or 4 weeks, but the germination speed increased during storage.

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Table 1. Means and means squares of germination percentage and speed of germination index (SGI) of *Archontophoenix alexandrae* seeds submitted to 6 different temperatures. Jaboticabal, SP.

Cause of variation	G	Germinação (%) ¹	IVG ²
L			
Temperature	5	163,03**	0,33**
Residue	18	15,5	0,07
CV (%)		5,76	14,10
Averages			
25 °C		73,83 ¹ (92,24) ² a	1,67 b
30 °C		64,98 (82,11) b	1,84 a
35 °C		58,30 (72,39) c	1,86 a
20-30 °C		76,02 (94,16) a	2,09 a
25-35 °C		67,54 (85,40) b	2,21 a
Room temperature		69,73 (88,00) a	1,41 b

¹Data transformed into arc sin (x/100)^{1/2}

² Unprocessed data

Means followed by the same letter in the column do not differ from each other by the Skott-Knott test at 1% probability.

Table 2. Percentage and speed of germination index (SGI) of *Archontophoenix alexandrae* seeds submitted to storage. Jaboticabal, SP.

Cause of variation	GL	Germination (%) ¹	SGI ²
Storage period	4	33,0442 NS	1,3063 **
Residue	15	19,1374	0,0655
CV(%)		6,71	12,76
Average Overall		65,20	2,0170
Linear Regression	1	34,3566 NS	4,3310 **
Quadratic Regression	1	22,0943 NS	0,0026 NS
Cubic Regression	1	50,1873 NS	0,1972NS

NS not significant

** significant at 1% probability

* significant at 5% probability

¹Data transformed into arc sin (x/100)^{1/2}

²Unprocessed data

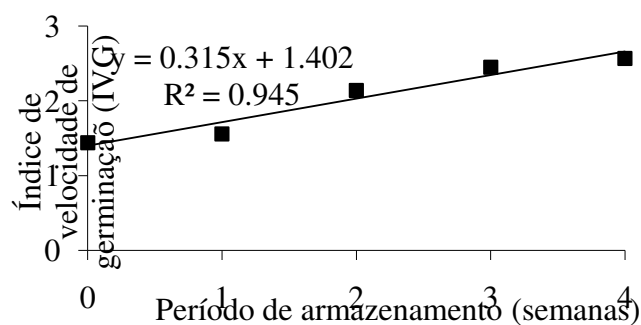


Figure 1. Regression curve between the storage periods and the seed germination velocity indexes of *Archontophoenix alexandrae*.