Biometry of fruits and seeds, dormancy and substrates in seeds germination of *Dypsis lutescens*[1]

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ABSTRACT

Areca palm (*Dypsis lutescens*) is an ornamental palm largely used in landscape which propagate occur by seeds germination. However, the biometry and the endogenous and exogenous factors than can limit propagation of this plant are poorly known. Thus, this study aimed to characterize the biometric fruits and seeds of areca palm and to evaluate the seed germination after the dormancy breaking treatments in different substrates. For this, the biometric analysis of length, diameter and weight were recorded; the description of internal and external morphology of fruit and seed were also studied. The treatments to improvement of seed germination were control (T1); immersion of seeds in water a solution of 500 mg L^{-1} GA_3 (T2), mechanical scarification with sandpaper (T3) and combination of mechanical scarification followed of immersion in 500 mg L^{-1} GA_3 (T4). The seeds were sown in containers containing sand, coir dust or vermiculite in all possible combinations. The areca palm fruits and seeds are both, elliptical shape and the weight of fruits and seeds is 1.70 g and 1.04 g, respectively. There is positive correlation between fruit weight and length and diameter of the fruit and just like the diameter has a positive correlation with the diameter of the seed. The mechanical scarification improve the seed germination. The Coir dust is the most appropriate substrate to seed germination of areca palm. The seed germination of Areca palm is hypogeal and the protrusion of the haustorium was observed at 59 days after sowing and the plantlets is fully grown at 153 after sowing.

Keywords: Areca Palm, *Dypsis lutescens*, seedling, morphology.

RESUMO

Biometria de frutos e sementes, dormência e substratos na germinação de sementes de germinação *Dypsis lutescens*

Palmeira areca (*Dypsis lutescens*) é uma palmeira ornamental amplamente utilizada no paisagismo que se propaga principalmente por sementes. No entanto, a biometria e os fatores endógenos e exógenos que podem limitar a propagação desta planta são pouco conhecidos. Assim, este trabalho teve como objetivo caracterizar a biometria de frutos e sementes de palmeira areca e avaliar a germinação de sementes após tratamentos de superação de dormência e em diferentes substratos. Para isso, as análises biométricas de comprimento, diâmetro e peso foram registradas; a descrição da morfologia externa e interna de frutos e sementes também foram estudados. Os tratamentos para superação de dormência foram: controle (T1), imersão das sementes em solução de 500 mg L^{-1} de GA_3 (T2), escarificação mecânica com lixa (T3) e combinação de escarificação mecânica após imersão em 500 mg L^{-1} de GA_3 (T4). Para cada tratamento de superação de dormência foram testados areia, pó de coco ou vermiculita. Os frutos e sementes de palmeira areca são elípticos o peso dos frutos e sementes são de 1,70 g e 1,0 4 g respectivamente. Há correlação positiva entre o peso do fruto e comprimento e diâmetro do fruto assim como o diâmetro do fruto também tem correlação positiva com o diâmetro da semente. A escarificação mecânica melhora a germinação das sementes. O pó de coco é o substrato mais apropriado para a germinação das sementes de palmeira areca. A germinação de sementes de palmeira areca é hipógea e o aparecimento do haustório germinativo foi observado em 59 dias após a semeadura. E as plântulas estão completamente crescidas aos 153 após a semeadura.

Palavras chaves: *Dypsis lutescens*, plântulas, dormência.

1. INTRODUCTION

Dypsis lutescens (H.Wendl.) Beentje & J. Dransf., known as Areca Palm, Golden Cane palm or Butterfly Palm is a member of the family Arecaceae, native to Madagascar (KUMAR et al., 2012). These palms are used in landscape or as planted pot in residential interior design.

Areca palm can be propagated vegetatively by division of clumps, however the propagation by seeds is the most used by producers (LORENZI et al., 2010). Therefore, it is important to know the characteristics of fruits and seeds to know the time of fruit harvest. The post seminal morphology is also important in the differentiation of plant species and to understand the dynamic establishment of natural populations. Although these studies are important, few reports address the biometrics and morphology of fruits and seeds of areca palms (MOURA et al., 2010).

The biometry and morphology of fruits and seedlings of the ornamental palms is efficiently used to differentiate the species such as *Phoenix roebelenii* O'Brien, *Caryota mitis* Lour, and *Livistona chinensis* (Jack.) R. Br. *ex*. Mart. and *Butia capitata* (Mart.) Beccari (MOURA et al., 2010; PÊGO et al., 2013). This information can be also used to estimate storage and make possible the treatment to improvement germination of seeds.

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The substrates requirements to seed germination vary according to specie. One of the main factors that affecting the growth of areca palm is the physical and chemical proprieties of substrate (KLOCK-MOORE and BROSCHAT, 2001). Thus, a suitable substrate must contain the physical and chemical proprieties that enable rapid seed germination and seedling emergence. Another factor that may contribute to the increased percentage of seed germination is the treatments for overcome seed dormancy.

The physical scarification and the use of gibberellin are two methods commonly used in the treatment of seeds palms. Piotto (1993) observed that the physical scarification of seeds of *Trachycarpus fortunei* (Hookes) Wendl was not effective in increasing the percentage of germination but it caused the reduction of 21 days of germination time and greater uniformity compared to seeds control. Therefore, the responses from palm seed germination vary according to species, for exemple, to germination of *Rhapis excelsa* (Thunberg) Henry ex. Rehder is recommended to use any scarification or application of growth regulators (LUZ et al., 2008). However, the immersion of *Acrocomia aculeata* (Jacq.) Lodd. ex. Mart. (macaw palm) seeds in 2,000 or 5000 mg L^{-1} GA_3 and the removal of the opercular tegument result in increased germination (OLIVEIRA et al., 2013)

Although the areca palm has been widely used in landscape, there are few studies on the morphological characterization of seeds and fruits, and seed treatment (PEGO et al., 2013). This search is important because there is no report on the limitation of physical or physiological dormancy on Areca palm seed germination. Thus, this study aimed to characterize the biometric fruits and seeds of areca palm and to evaluate the seed germination after different pre-germination treatment and substrates.

2. MATERIAL AND METHODS

Fully ripe fruit, showing the yellow color, were collected in Viçosa City, State of Minas Gerais (20º 45' Latitude South, 42º 55' Longitude West and altitude of 689,7m) of plants grown in Floriculture Sector of the Department of Plant Science of Federal University of Viçosa.

The biometric analyses of length and diameter of fruits or seeds were carried out with the help of a graduated caliper; the fresh weight (fruits or seeds) was achieved in a 0.0001 g precision scale and the moisture content, by the oven method at 105±2 °C, according to Brasil (2009). The biometric data were obtained from 50 replications of fruit and seeds and subjected to quantitative analysis. For morphological description was observed the form, color, presence of hairiness and brightness of the fruits; externally, it was observed the presence and location of the perianth and stigma. The external morphology of the seeds was described, highlighting the position of the raphe, hilum and operculum. Internally, the type of endosperm and position of the embryo and endocarp were observed. The post-seminal morphology of seedlings obtained from indicted seeds after germination as previously ddescripted, were also described using the same method descripted to seed germination of indicted seeds.

The seeds used in the germination test were obtained from mature fruits presenting yellow coloration. Seeds were separated from fruits pulp by friction on steel mesh sieve under water. The pre-germination treatments were: control – intact seeds (T1), intact seeds soaked in 500 mg L^{-1} GA_3 solution (T2), physically scarified seeds with sandpaper (T3) and physically scarified seeds after immersion in 500 mg L^{-1} GA_3 solution (T4). Three substrates for germination test were also tested: sand, coconut dust and vermiculite whose physical and chemical proprieties are showed in table 1. The physical and chemical proprieties were obtained according methods to EMBRAPA (1997). The incubation was in a greenhouse. The evaluation of germination was weekly recorded until the germination process stabilized at 168 days after sowing.

Table 1. Wet density (WD), dry density (DS), water retention capacity (WRC) (water (g)/substrate (g)), pH and electrical conductivity (EC) of substrates used in the experiment.

Substrates	WD (Kg m^{-3})	DS (Kg m^{-3})	WRC	pH	EC (mS cm^{-1})
Sand	1413.5	1382.4	1.2	6.7	0.11
Vermiculite	145.3	136.2	4.5	6.5	0.10
Coconut dust	179.9	90.4	7.2	5.6	0.39

For seeds germination the experimental design used was completely randomized with four replicates of 50 seeds in a factorial scheme (3x4) (substrate x pre-germinative treatment). After the analyses of variances, means were compared by the Tukey test at 5% probability using the statistical software Sisvar 4.3 (FERREIRA, 2011).

To seedling morphological description pictures are taken and recorded the morphology of the seed and seedlings of Areca palm seedless detailing events relationship to opercular tegument opening, development of haustorium, roots, leaf sheath, leaflet and the respective days to each event.

3. RESULTS AND DISCUSSION

Fully ripe fruit of areca palm presented average dimensions of 1.69 cm of length, 1.25 cm of diameter and 1.70 g of weight (Table 2). The seeds presented 1.54 cm of length, 1.04 cm of diameter and 1.04 g of weight and the pulp of fruits was in average 1.56 cm of thickness. Similarly, to the fruits, the seeds were longer than the diameter.

Table 2. Biometric characteristics of areca palm fruits and seeds.

	FRUIT			SEEDS			PULP
	Length (cm)	Diameter (cm)	Weigth (g)	Length (cm)	Diameter (cm)	Weigth (g)	Thickness (cm)
Average	1.69	1.25	1.70	1.54	0.94	1.04	1.56
Maximum	1.82	1.37	2.03	1.64	1.07	8.80	1.96
Minimum	1.53	1.14	1.25	1.34	0.80	0.69	1.09
SD*	0.69	0.46	0.16	0.54	0.67	1.13	0.20
CV**	0.17	0.13	0.13	0.14	0.22	1,11	0.16

*SD = Standard deviation; CV** = coefficient of variation

These characteristics were similar to fruits of *L. chinensis* that presented weight of 2.15 g, length of 1.92 cm and diameter of 1.58 cm, while seeds weighed 1.07 g, observing the length of 1.38 cm and diameter of 1.04 cm (PÊGO et al., 2013). Goudel et al. (2013) reported that *Syagrus romanzoffiana* palm presents variation in fruit, pulp and seed mass, which can be explored for breeding projects and should be considered in the formation of seed lots that are more homogeneous.

There was a positive correlation between fruit weight and length and diameter of the fruit (Table 3). The diameter also has a positive correlation with the diameter of the seed. However, the thickness of spares is negatively correlated with the diameter of the seed. Thus, with increasing the size of seeds the pulp thickness of the fruits is lower.

Table 3. Simple correlation coefficients (r) between the variables analyzed, fruit length (FL), fresh fruit weight (PF), fruit diameter (FD), seed length (SL), seed diameter (SD) fresh seed weight (WS) and pulp thickness (PT) of areca palm.

VARIÁVEIS	FD	FW	SL	SD	SW	PT
FL	0.55^{*}	0.66^{*}	0.52^{*}	0.48^{*}	-0.05^{ns}	-0.17^{ns}
FD	-	0.83^{*}	0.39^{*}	0.82^{*}	0.04^{ns}	-0.23^{ns}
FW	-	-	0.37^{*}	0.68^{*}	0.01^{ns}	-0.19^{ns}
SL	-	-	-	0.42^{*}	-0.04^{ns}	-0.26^{ns}
SD	-	-	-	-	0.17^{ns}	-0.74^{*}
SW	-	-	-	-	-	-0.27^{ns}
PT	-	-	-	-	-	-

*Significative at 5% of probability.

The polar diameter of fruit of Jeriva palm (*Syagrus romanzoffiana*) showed a significant positive linear correlation with fruit mass, pulp mass, seed mass and polar diameter of the seed (GOUDEL et al., 2013). Pedron et al. (2004) observed that Buriti palm (*Butia capitata* (Mart.) Becc.) weight and size of fruits and seeds had high positive linear correlation between them with the following values: weight and fruit size (r^2 = 0.95); seeds weight and size (r^2 = 0.94); fruit weight and seeds (r^2 = 0.95); fruit size and seeds (r^2 = 0.87). These authors reported that these values correlation indicate the possibility of performing the collection larger fruits with the aim of selecting larger endocarps in an attempt to obtain better performance in the germination process.

The mature fruits of areca palm are elliptical, glabrous and brilliant yellow color (Figure 1A); they are connected to the rachis by yellow perianth (Figure 1B). The seeds are covered by the fibers poorly adhering (Figure 1C). The seeds are formed by hard albuminous endosperm, which with a depression near to operculum and depression on area near to hilum (Figure 1D).The undifferentiated embryo is immediately below the operculum, with 1,5 mm of length and the endosperm were compact of white color (Figure 1E).

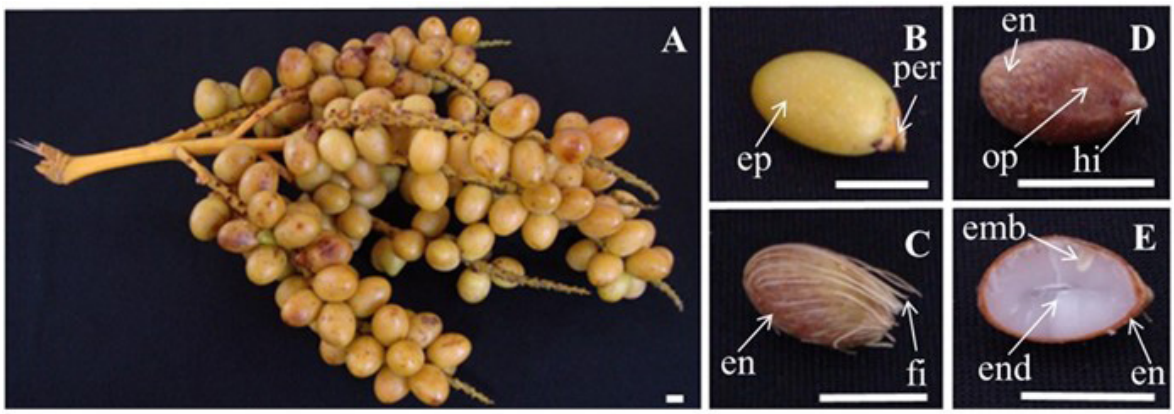

Figure 1. Morphology of fruits and seeds of areca palm. A) Rachis with fruits; B) Fruit; C) Fibers loosened but still attached on endocarp; D) Seeds cleaned; E) Sectioned seed. ep- epicarp; per- perianth; fi- fibres; en- endocarp; hi- hilum; op- operculum, end- endosperm; emb- embryo. Bars: 1 cm.

The biometric characteristics and the morphology descriptions of fruits and seeds of the ornamental palms are important information for plant identification, differentiation of species, and storage and germination of seeds of ornamental palms (PÊGO et al., 2013). The characteristics observed on areca seeds are similar the observed by (PÉREZ, 2009) in Loulu palm (*Prichardia remota*) seeds may possess a relatively thick endocarp and testa. A germination lid, or operculum, may be observed on the test for mesocarp of some plants. The small, usually cylindrical embryo is found under the operculum.

There was no significative interation between the factors substrate and pre-germinative treatment of seeds (Table 4). In average, the mechanical scarification enable highest seed germination of 31% compared to control of 25%. Thus, appears that the limitation of seeds germination more strongly associated to mechanical resistance of hard endocarp than hormonal, because the gibberellin did not improve germination.

Table 4. Percentage of Areca palm of seed germination under pre-germinative treatment sow in vermiculite, coir dust coconut and sand as substrate.

	Substrate			
Pre-germinative treatment	**Vermiculite**	**Coconut dust**	**Sand**	**Average**
Control	22.0	28.0	25.5	25.2 B*
Mechanical scarification	24.5	38.5	35.5	32.1 A
Inctact seeds + GA_3	30.0	32.0	32.5	31.5 AB
Mechanical scarification + GA_3	31.8	38.5	35,0	35.1 A
Average	27.0 b	34.3 a	32.1 ab	

*Means followed by same capital letters in columns and lowercase letters on lines do not differ significantly ($p<0.05$; Tukey's test).

Pivetta et al. (2005) observed that the Aricuri palm *Syagrus schizophylla* seeds scarification improved the germination from 17.5 to 42.0%. Ornamental palm have different requirements to seeds germination. For example, *Thrinax morrisii* seeds exhibit exogenous dormancy which is entirely imposed by the hard seed coat, whereas the *Sabal palmetto* seeds exhibit both, exogenous and physiological dormancy, for the reported that to *Thrinax* is necessary seed scarification and to sabal the combination of scarification and soaking in 500 mg L^{-1} gibberellin to improvement of germination (DEWIR et al., 2011).

One of the factors affecting the germination and young areca palms establishment palm is the characteristic of the substrate. Seeds sown in coconut dust substrate was higher germination than those sown in vermiculite, but germination of seeds in sand substrate did not differ significantly from the other substrates. Possibly the lower density combined with the higher water retention capacity of coconut dust favored seed germination of areca palm (Table 1).

The selected substrates for palm seeds germination is many important because the physical proprieties as structure, porosity, water retention capacity and degree of infestation of pathogens may vary according to the type of material; this way substrate as vermiculite sand and coconut fiber, used at early stage of growth and development of ornamental palms (BARBOSA and LOPES, 2007). Beckmann-Cavalcante et al. (2012) recommended the substrates sand, vermiculite and coir dust to seed germination of palms *Euterpe edulis* and *Euterpe oleraceae* and reported that all of similarly efficient.

The seed germination of Areca palm is hypogeal, while development is initiated from an undifferentiated mass of cells in the observed at 47 days after sowing by opening of opercular tegument (Figure 2A).

Figure 2. Morphology of the seed and seedlings of Areca palm seedless. OT = opercular tegument; HA = haustorium; RO = roots; FLS = first leaf sheath; SLS = second leaf sheath; LE = leaflet. Bars = 1.0 cm.

At 59 days after sowing the protrusion of the haustorium was observed (Figure 2B). Were first observed the formation at 78 days after sowing on haustorium and late, 83 days after sowing, the first leaf sheath was observed (Figure 2C and 2D). At 122 days after sowing the second leaf sheath and the beginning of leaflets formation was observed (Figure 2E). Plantlets with fully leaflets were formed at 153 after sowing (Figure 2F).

The germination of pupunha seeds (*Bactris gasipaes* Kunth.) begins with the development of a mass of undifferentiated cells on micropylar depression, called germinal button; subsequently, this cell mass becomes cylindrical, with the differentiation of stem and root primordia, the first being surrounded by a closed sleeve, and at the same time, there is the development of adventitious roots in the embryonic axis (SILVA et al., 2006).

The biometry and morphology of fruits, seeds and the post-seminal development are important information for plant identification, differentiation of species, and storage and germination of seeds of ornamental palms, thus contains important information for future studies (PÊGO et al., 2013).

5. CONCLUSIONS

The areca pal fruits and seeds are both, elliptical shape and the weight of fruits and seeds are 1.70 and 1.04 receptivity.

There is positive correlation between fruit weight and length and diameter of the fruit and just like the diameter has a positive correlation with the diameter of the seed.

The mechanical scarification improves the seed germination.

The coconut dust is the most appropriate substrate to seed germination of areca palm.

The seed germination of Areca palm is hypogeal and the protrusion of the haustorium was observed at 59 days after sowing. In addition, the plantlets are fully grown at 153 after sowing.

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