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Physiological quality of mangaba seeds submitted to drying

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Mangaba (*Hancornia speciosa* Gomes) is a native fruit to Brazil of great importance in its areas of occurrence. The aim of the present study was to evaluate the physiological behavior of mangaba seeds submitted to desiccation. The survey was conducted in the Laboratory of Seeds Analyses of Embrapa Coastal Tablelands, Aracaju, SE, Brazil. The experimental design was completely randomized with five replicates of 25 seeds each. Seeds were submitted to treatments consisting of different drying times: 0 (control treatment), 24, 48 and 72 h. Seeds were placed in an oven with air circulation and temperature of 30ºC. The water content of seeds was determined and the germination test was used to evaluate the germination percentage, speed germination index and length and dry weight of seedlings. The seed water content decreased as a function of the drying periods, reaching 13% when seeds were submitted to 72 h of drying. Seeds submitted to drying periods up to 33 h showed decreased germination percentage, dry weight and length of seedlings; the germination rate index and plant growth were also affected after 34 h of drying. Drying periods longer than 34 h impair the physiological quality of mangaba seeds, affecting germination and vigor.

Key words: *Hancornia speciosa* Gomes, desiccation, water content.

INTRODUCTION

Mangaba (*Hancornia speciosa* Gomes) fruits are very appreciated due to their great aroma and flavor, good digestibility and high nutritional value (Parente et al., 1985), being source of vitamins A, B1, B2 and C, and phosphorus, calcium and proteins and widely use as frozen pulp for making juice, ice cream, jellies and candies. Mangaba is fruit species native to Brazil, belonging to the Apocynaceae family, with social, cultural and economic importance in areas of occurrence, and the State of Sergipe is the main producer (Silva et al., 2011).

In the Northeast region, the extractivism is the main form of exploitation of the species. There accelerated genetic erosion due to large real estate pressure in the coastal tablelands (Santos, 2010). The exploitation of a

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native species depends mainly on the domain of expertise regarding its occurrence, which is fundamental for the definition of exploitation strategies. In addition to having short longevity, which makes storage difficult, being necessary in general to sowing soon after fruit extraction, mangaba seeds are considered recalcitrant, in which reducing the water content can cause damages, impairing its viability and resulting in seed death (Barros et al., 2010).

Due to the recalcitrance of seeds, propagation has obstacles, and in addition, inhibiting substance contained in the fruit pulp may obstruct or hinder germination. Inhibitory substances present in the pulp are usually lost when seeds remain under drying conditions. However, knowledge about the level of tolerance of seeds to desiccation is necessary, since recalcitrant seeds do not tolerate dehydration at low water content and suffer damage when stored at low temperature (Sacandé et al., 2004). This type of seed does not show desiccation tolerance during development, thus, it does not suffer natural drying in the matrix plant, and being released with high water content and with reduction to a level considered critical will lead to loss of viability and even death (Roberts, 1973).

The loss of water during the drying process in recalcitrant seeds can cause various changes in their metabolism, resulting in deterioration (Pammenter and Berjak, 1999), since initial damage caused by drying is related to membrane disruption and, consequently, increased electrical conductivity and leaching of sugars (Chen and Burris, 1990).

Information on the critical and lethal water levels in seeds is necessary for the performance of drying and storage (Santos et al., 2010). In this sense, the aim of this study was to evaluate the physiological quality of mangaba seeds submitted to drying.

MATERIALS AND METHODS

The experiment was conducted at the Laboratory of Seed Analysis of Embrapa Coastal Tablelands, Aracaju-SE, from April to June 2014. *H. speciosa* fruits came from native trees located at the Experimental Field of Embrapa Coastal Tablelands, in the municipality of Itaporanga d'Ajuda, SE (11°06'40"S and 37°11'15" W), which were collected ripe under the canopy of different plants, packed in plastic bags and taken to the laboratory. Pulping was manually performed with the aid of a sieve, and then seeds were washed in running water to remove mucilage.

The experimental design was completely randomized, with four treatments (0, 24, 48, 72 h of drying) in five replicates of 25 seeds, totaling 125 seeds per treatment. Data obtained from variables measured in the experiment were submitted to analysis of variance and polynomial regression, testing the linear and quadratic models, choosing the one with the highest R^2. Analyses were performed using the SISVAR statistical software (Ferreira, 2011).

After processing, seeds were submitted to treatments consisting of different drying times: 0 (control treatment), 24, 48 and 72 h. Seeds corresponding to the control treatment were sown soon after processing in substrate composed of washed and autoclaved sand, and the other seeds were placed in an oven with air circulation at 30°C. In pre-established intervals, seed samples were collected for the performance of tests and determinations described as follows:

Water content

The water content was determined in oven at 105 ± 3°C for 24 h according to the Rules for Seed Analysis (Brazil, 2009), using five replicates of 20 seeds each per drying period.

Germination

The germination test was performed according to guidelines of the Rules for Seed Analysis - RAS (Brasil, 2009), using germination chambers of Biochemical Demand Oxigen type (BOD), equipped with fluorescent lamps under constant temperature of 30°C. After each drying period, five replicates with 25 seeds per treatment were sown in plastic trays containing washed and autoclaved sand as substrate. The counts began on the 15th day after sowing and germination percentage was performed on the 37th day after sowing, considering as normal seedlings those with well-developed essential structures.

Germination rate index

Germination rate index was carried out simultaneously to the germination test, with daily counts, always at the same time, from the fifteenth day until the end of the test, being calculated according to the following formula GRI = G1 / N1 + G2 / N2 + ... Gn / Nn, where GRI = germination rate index, G1, G2 and Gn = number of normal seedlings, computed in the first, second ... and last count, respectively; N1, N2, Nn = number of sowing days at first, second ... and last count, respectively (Maguire, 1962).

Length of seedlings

Seedlings were measured on the 37th day after sowing, with the help of a ruler graduated in centimeters, measuring from the roots up to the hypocotyl, and the result was divided by the number of seedlings.

Dry weight of seedlings

Seedlings were packaged in paper bags and placed in an oven at 80°C for 24 h, then weighed on an analytical scale and the result expressed in grams (Nakagawa, 1999).

Stem diameter

At the end of the experiment, the plants were evaluated for stem diameter, using a digital caliper (Aguiar et al., 2005).

Number of leaves

The leaves were counted in each test plant, withdrawing the average per plot (Alves et al., 2006).

RESULTS AND DISCUSSION

The analysis of variance for the study variables is found in Table 1. It was found that the drying periods significantly

Table 1. Analysis of variance for the study variables in *H. speciosa* seeds submitted to different drying times.

S.O.V.	df	WC	Mean square (MS)					
			GERM	GRI	DMS	LS	SD	NF
Treatmen t (Error)	3	536.25*	1759*	0.397*	0.0085*	39.30*	0.356*	79.794*
VC (%)	16	9.97	5.36	5.03	4.64	6.73	2.94	4.85

SOV, Source of variation; WC, water content (%); GERM, germination (%); GRI, germination rate index; DMS, Dry mass of seedlings (g); LS, length of seedlings (cm); SD, Stem diameter (cm); LN, number of leaves * significant at 5% for the F-test.

influenced the physiological quality of seeds (Figures 1 and 2).

Analyzing the germination percentage results (Figure 3), it was found that when seeds were submitted to 33 h of drying, there was an increase in the germination percentage, reaching 77%. The low germination percentage in the control treatment (46%) is usually related to the presence of inhibitors in seed mucilage (Oliveira and Valio, 1992), and the increase in the germination percentage is probably related to elimination of these inhibitors when seeds were submitted to drying; however, desiccation above 33 h affected the physiological quality of mangaba seeds, reaching 38% at 72 h of drying.

Recalcitrant seeds submitted to drying lose viability until reaching hydration level 3 (20 to 33% water content), when they are metabolically active and membranes are hydrated and probably at this level, metabolism is altered, making repair mechanisms less efficient (Marcos Filho, 2005). These metabolic changes are mainly related to the disruption of membranes, when these seeds reach water content below 25%, occurring to the loss of essential salts embryo development, and values close to those can be considered critical for recalcitrant seeds (Bewley and Black, 1994).

Similar results were found by Barros et al. (2010) on mangaba seeds. They also found that drying up to 36 h at laboratory conditions did not damage the physiological quality of seeds. Magistrali et al. (2013) concluded that desiccation for 1007 h and water content below 10% affected the germination percentage of *Genipa americana* seeds. In a study with *H. speciosa* seeds, Barros et al. (2006) found that there was a reduction in the germination percentage when the seeds had water content below 25%.

In relation to vigor, measured by the germination rate index, the results were similar to those obtained in the germination percentage (Figure 4). An increase in the speed germination index was observed when seeds remained under drying conditions for 34 h, reaching an index of 0.94, after this period, the germination rate decreased sharply.

The sensitivity of recalcitrant seeds to desiccation involves a complexity of components related to the physiological and biochemical characteristics intrinsic to the species and some factors such as desiccation rate and temperature (Berjak et al., 1993; Farrant et al., 1988). Therefore, the reduction in the germination percentage is the major consequence of seed deterioration, which is often preceded by decreases in germination rate (Matthews, 1985).

In *Inga ingoides* (Rich.) Willd seeds, the germination rate index of seeds was reduced after 26 h of drying and was reaching null values from 96 h (Laime et al., 2011). Drying of seeds of *Bumelia obtusifolia* Roem et Schult. Var. Excelsa (DC) reduced the emergence rate in greenhouse under laboratory conditions (Nascimento, 2013).

Similar to germination rate index and percentage, vigor determined by length and dry weight of seedlings (Figure 5) also were reduced as the drying time increased. Drying over a period of 37 h was responsible for maximum dry weight (0.11 g) of mangaba seedlings; after this time, the dry weight of seedlings was decreased. An increase in the length of seedlings was initially observed (21 cm), corresponding to 32 h of drying, and after this period, there was a reduction in the length of seedlings, reaching 12 cm at 72 h.

Depending on the drying conditions, physiological quality can be affected due to increased deterioration rate (Marcos Filho, 2005), probably because the drying temperature may have caused physiological changes, thereby reducing the availability of energy reserves for the supply of seedlings (Oliveira et al., 2011).

The results obtained by Santos et al. (2010) on *H. speciosa* seeds showed that the length of roots was decreased from 8.5 cm when seeds had water content of about 56% to 4 cm, reducing moisture content to 12%. In Braziliancherry seedlings (*Eugenia uniflora* L.), the greatest epicotyl length was obtained when seeds were dried in the shade at temperature of 27.5°C for a period of 72 h (Sena et al., 2010). Oliveira et al. (2011) concluded that the dry weight of seedlings from mangaba seeds submitted to drying under laboratory conditions and desiccator remained constant and close (0.0345 and 0.0307 g), respectively, over the evaluation periods. The drying time also influenced plant growth and similarly to germination and vigor, there was a decrease in stem diameter and leaves number (Figure 6). Drying over a period of 33 h provided the largest stem diameter (1.0 mm), and plants grown from seeds submitted to 34 h of drying reached the highest leaves plant number (15 leaves / plant). Drying periods above 34 h harmed the

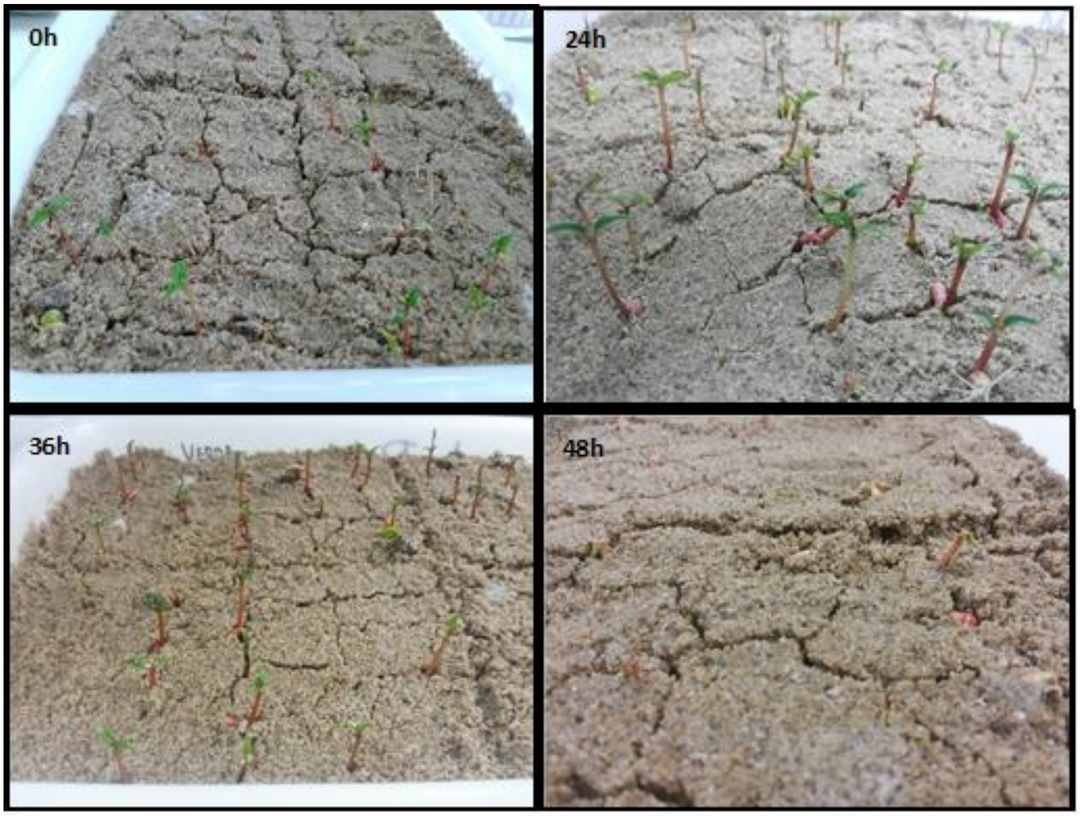

Figure 1. The initial water content of seeds was approximately 40% and a gradual reduction in the water content of seeds was observed during the drying process, reaching 13% with 72 h of drying. This high initial water content of seeds at maturation is usually related to sensitivity to desiccation, and seeds with these characteristics have short viability, especially under conditions of low temperatures and high air relative humidity (Leonhardt et al., 2010).

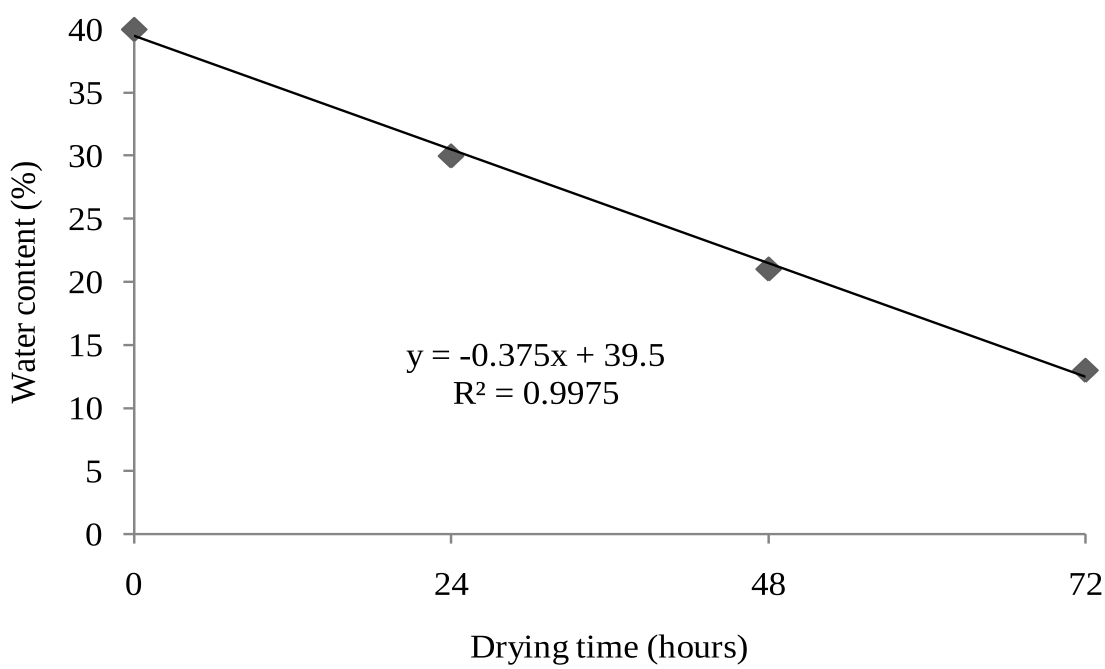

Figure 2. Water content of *H. speciosa* seeds of submitted to different drying periods. Aracaju, SE, 2014.

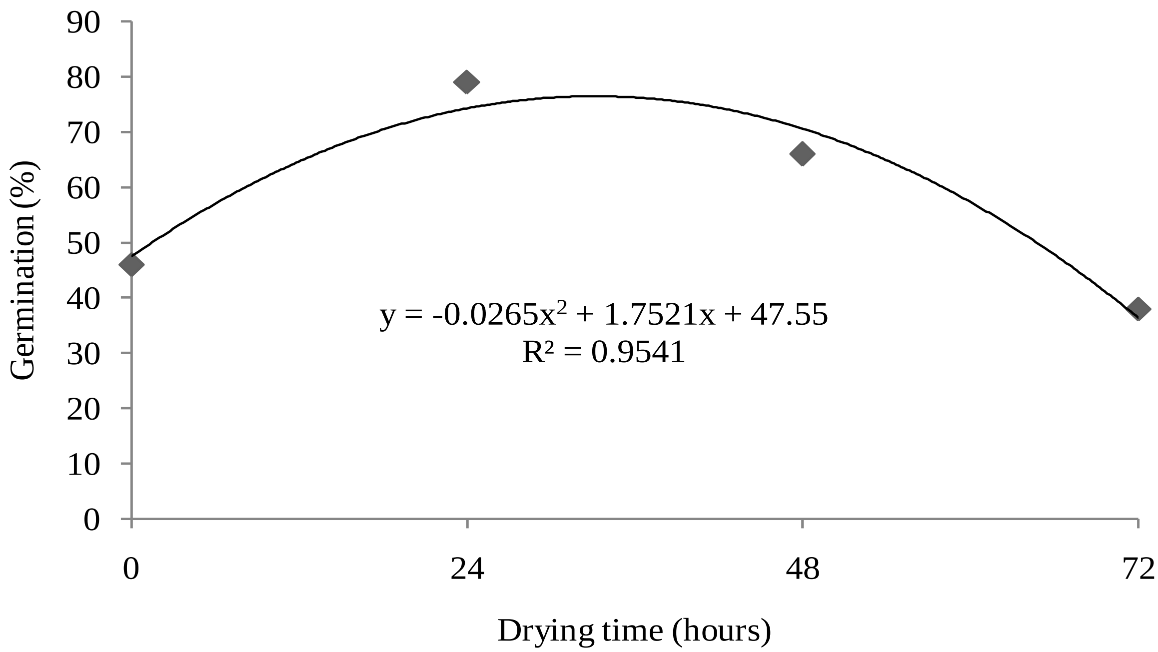

Figure 3. Germination percentage of *H. speciosa* seeds submitted to different drying periods. Aracaju, SE, 2014.

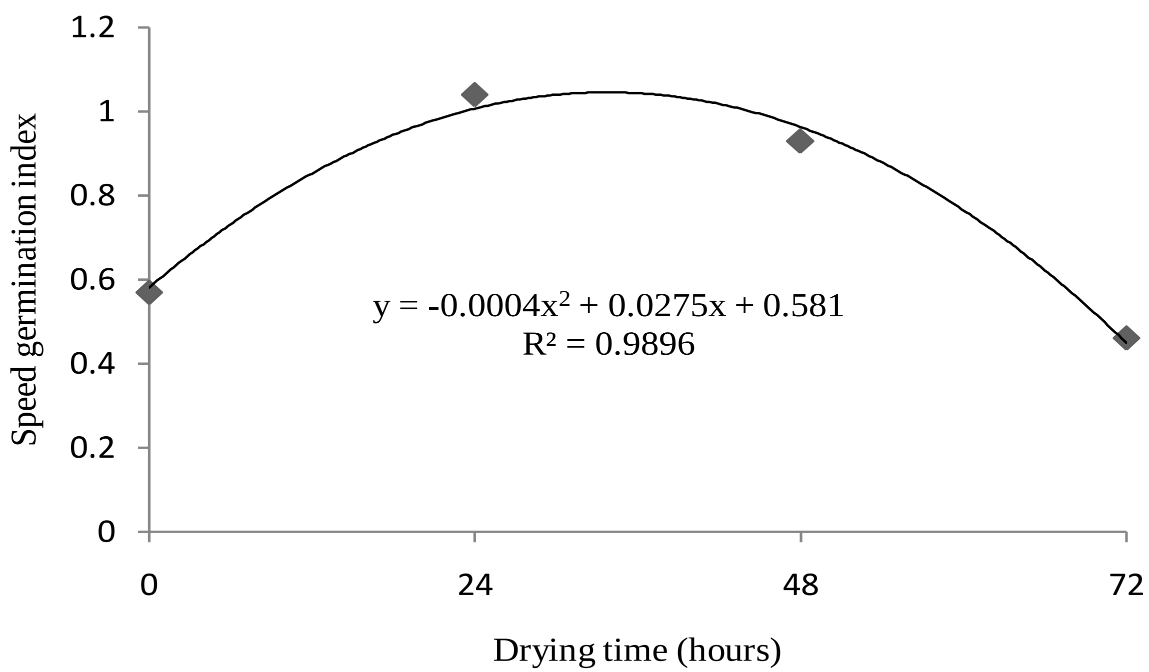

Figure 4. Speed germination index of *H. speciosa* seeds submitted to different drying periods. Aracaju, SE, 2014.

growth of mangaba plants, as this species is sensitive to desiccation. The decrease in plant growth probably occurred because drying has affected the seed storage tissue, with lower transfer to plant growth (Cardoso et al., 2015).

Conclusion

The drying of mangaba seeds for a period exceeding 34 h at temperature of 30°C compromises physiological quality and plant growth.

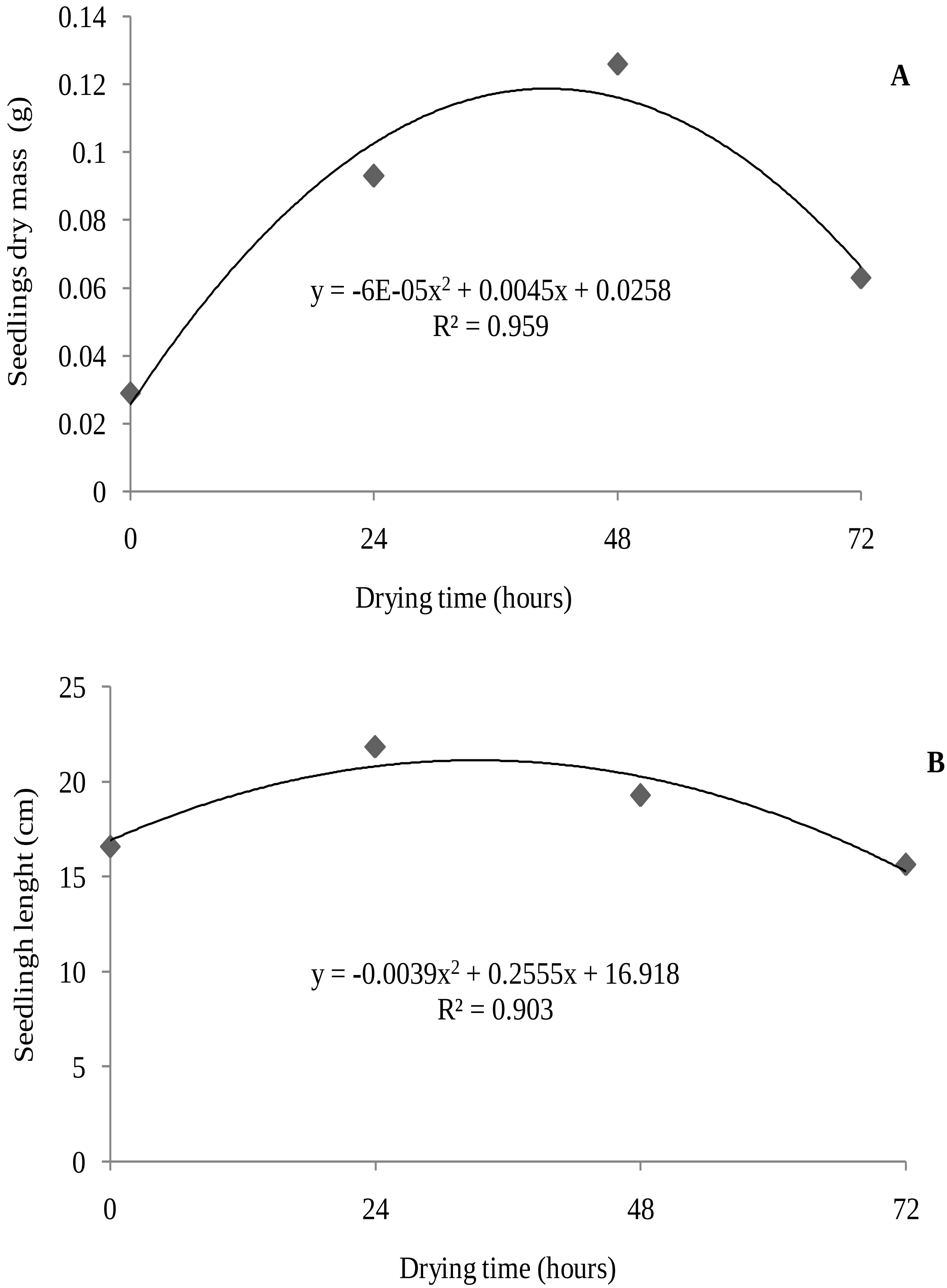

Figure 5. Dry mass (A) and length of seedling (B) derived from *H. speciosa* seeds submitted to different drying periods. Aracaju, SE, 2014.

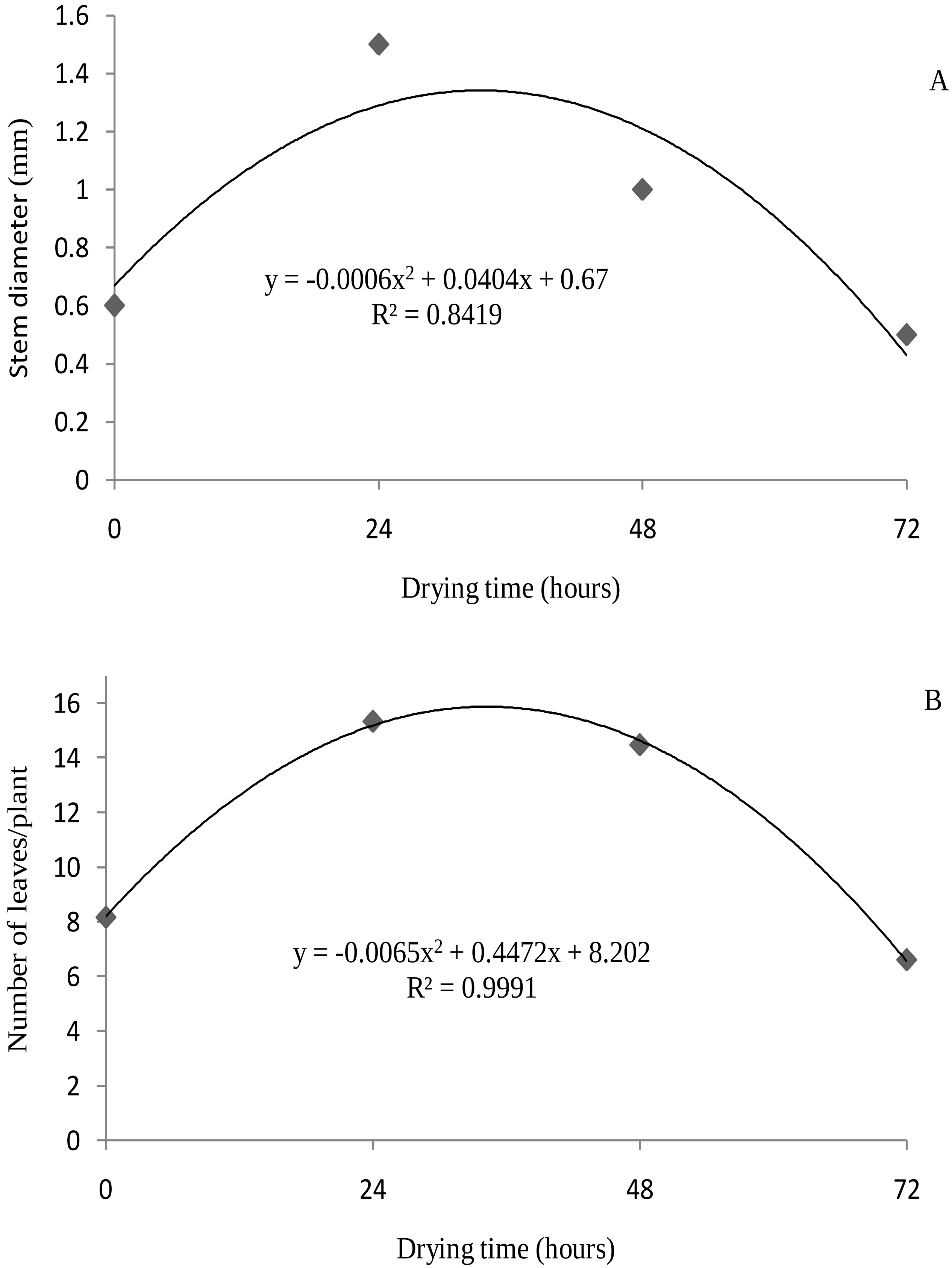

Figure 6. Stem diameter (A) and number of leaves (B) derived from *H. speciosa* seeds submitted to different drying periods. Aracaju, SE, 2014.

Conflict of Interests

The authors have not declared any conflict of interest.

REFERENCES

Aguiar FFA, Kanashiro S, Tavares AR, Pinto MM, Stancato GG, Aguiar J, Nascimento TDR (2005). Seed germination and seedling growth of *Caesalpinia echinata* Lam. (brazilwood): shading effect. Rev. Árv. 29(6):871-875.

Alves CZ, Sá ME, Binottil FS (2006). Effect of storage temperature and phytoregulators on germination of sweet passion fruit seeds and seedling development. Acta Sci. Agron. 28(3):441-448.

Barros DI, Bruno RLA, Nunes HV, Silva GC, Pereira WE, Mendonça RMN (2006). Different extraction methods aiming mangaba seeds quality. Rev. Bras. Frutic. 28(1):25-27.

Barros DI, Bruno, RLA, Nunes HV, Mendonça RMN, Pereira WE (2010). Physiological behavior of mangaba seeds submitted to desiccation. Rev. Acta Tecnol. 5(1):32-43.

Berjak P, Vertucci CW, Pammenter NW (1993). Effects of development status and dehydration rate on characteristics of water and desiccation – sensitivity in recalcitrant seed of *Camellia sinensis*. Seed Sci. Res. 3(3):155-166.

Bewley JD, Black M (1994). Seeds physiology of development and germination. New York: Plenum Press. P 445.

Brasil, Ministério da Agricultura e reforma Agrária (2009). Rules for Seed Analysis.Brasília: SNDA/DNDV/CLAV. P 398.

Cardoso EA, Alves EU, Alves AU (2015). Talisia esculenta seed quality in function of drying temperatures and times. Semina: Ciênc. Agric. 36(1):7-16.

Chen YG, Burris JS (1990). Role of carbohydrate in desiccation tolerance and membrane behavior in maturing maize seed. Crop Sci. 30(3):971-975.

Farrant JM, Pammenter NW, Berjak P (1988). Recalcitrance - a current assessment. Seed Sci. Technol. 16(1):1555-1566.

Ferreira DF (2011). SISVAR: a computer statistical analysis system. Ciênc. e Agrotecnol. 35(6):1039-1042.

Laime EMO, Oliveira DCS, Alves EU, Guedes RS (2011). Emergence and initial growth of seedlings of inga ingoides (Rich.) Willd. depending on the drying of seeds. Eng. Amb. 8(3):237-250.

Leonhardt C, Calil AC, Fior CS (2010). Myrcia seed germination glabra (O. Berg) D. Legrand and Myrcia palustris DC. - Myrtaceae armazenadas in cold storage. Iheringia – Botany series 65(1):25-33.

Magistrali PR, José AC, Faria JMR, Gasparin E (2013). Physiological behavior of *Genipa americana* L. seeds regarding the capacity for desiccation and storage tolerance. J. Seed Sci. 35(4):495-500.

Maguire JD (1962). Speed of germination-aid in selection and evaluation for seedlings emergence and vigor. Crop Sci. 2(1):176-177.

Marcos Filho J (2005). Fisiologia de sementes de plantas cultivadas. Piracicaba: FEALQ 495 p.

Matthews S (1985). Physiology of seed ageing. Outlook Agric. 14(2):89-94.

Nakagawa J (1999). Testes de vigor baseados no desempenho das plântulas. *In:* Krzyzanowski FC, Vieira RD, França Neto JB (1999). Vigor de sementes: conceitos e testes. 2. ed. Londrina: ABRATES. pp. 1-21.

Nascimento IL (2013). Determination of methodologies for seed germination and vigor of quixabeira (*Bumel obtusifolia* ROEM ET SCHULT. VAR. EXCELS (DC) MIG.). Rev. Arv. 37(4):701-706.

Oliveira LM, Silva EO, Bruno RLA, Alves EU (2011). Periods and dry environments in the seeds quality of *Genipa americana* L. Semina: Ciênc. Agr. 32(2):495-502.

Oliveira LMQ, Valio IFM (1992). Effects of moisture content on germination of seeds of *Hancornia speciosa* Gom. (Apocynaceae). Ann. Bot. 69(1):1-5.

Pammenter, NW, Berjak P (1999). Areview of recalcitrant seed physiology in relation to desiccation tolerance mechanisms. Seed Sci. 9(1):13-37.

Parente TV, Borgo LA, Machado JWB (1985). Chemical characteristics of fruit mangaba (*Hancornia speciosa* Gomes) Cerrado of geo-economic region of the Federal District. Cienc. e Cult. 37(1):96-98.

Roberts EH (1973). Predicting the storage life of seeds. Seed Sci. Technol. 1(3):499-514.

Sacandé M, Joker D, Dulloo ME, Thomsen KA (2004). Comparative storage biology of tropical tree seeds. Rome: IPGRI. P 363.

Santos PCG, Guedes RS, Silva KB, Cardoso EA, Lima CR (2010). Quality of *Hancornia speciosa* Gomes seeds in function of drying periods. Semina: Ciênc. Agric. 31(2):343-352.

Sena LHM, Matos VP, Ferreira EGBS, Sales AGFA, Pacheco MV (2010). Physiological quality of surinam cherry seeds submitted to different procedures of drying and substrates 1. Rev. Bras. de Eng. Agr. e Amb. 14(4):405-411.

Silva AVC, Santos ARF, Wickert E, Silva Júnior JF, Costa TS (2011). Genetic diversity between *Hancornia speciosa* Gomes varieties. Agrár. – Rev. Bras. de Ciênc. Agric. 6(4):572-578.