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'Jurema-de-embira' seed germination under water stress and at different temperatures

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Mimosa ophthalmocentra Mart. ex Benth
Fabaceae
forest species
Caatinga
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ABSTRACT
The process of water imbibition by the seed depends on temperature and water availability, which according to the absorbed water retention capacity will determine the success of the germination process. Thus, this study aimed to investigate the effects of water stress on the germination and vigor of 'jurema-de-embira' seeds under different temperatures. The experimental design was completely randomized in a 7 x 4 factorial scheme (osmotic potential and temperature) with four replicates of 25 seeds each. The osmotic potentials of 0, -0.1, -0.2, -0.3, -0.4, -0.5 and -0.6 MPa at temperatures of 25, 30 and 35 °C and alternated of 20-30 °C, under photoperiod of 8 h, were evaluated. Germination percentage, germination speed index, shoot and root length, shoot dry biomass, root dry biomass and total biomass were evaluated. Water stress negatively affected the germination and vigor of 'jurema-de-embira' seedlings from the potential of -0.2 MPa on, whose effects are more evident at the temperature of 35 ° C. The alternated temperature of 20-30 °C allowed greater tolerance to water stress for the germination of 'jurema-de-embira' seeds.

Palavras-chave:
Mimosa ophthalmocentra Mart. ex Benth
Fabaceae
espécie florestal
Caatinga
potenciais osmóticos

Germinação de sementes de jurema-de-embira sob estresse hídrico e em diferentes temperaturas

RESUMO
O processo de embebição de água pelas sementes é dependente da temperatura e da sua disponibilidade que, de acordo com a capacidade de retenção da água absorvida, determinará o sucesso do processo de germinação. Desta forma, objetivou-se verificar os efeitos do estresse hídrico na germinação e no vigor de sementes de jurema-de-embira, em diferentes temperaturas. O delineamento experimental foi inteiramente casualizado, em esquema fatorial 7 x 4 (potencias osmóticos e temperaturas) com quatro repetições de 25 sementes cada uma. Foram avaliados os potenciais osmóticos de 0; -0,1; -0,2; -0,3; -0,4; -0,5 e -0,6 MPa nas temperaturas de 25, 30 e 35 °C e alternadas de 20-30 °C, sob fotoperíodo de 8 h. Avaliaram-se a porcentagem e o índice de velocidade de germinação, comprimento da parte aérea e da raiz, massa seca da parte aérea, da raiz e total. O estresse hídrico afetou negativamente a germinação e o vigor das plântulas de jurema-de-embira a partir do potencial de -0,2 Mpa, cujos efeitos são mais evidentes na temperatura de 35 ºC. A temperatura alternada de 20-30 ºC permitiu maior tolerância ao estresse hídrico para a germinação de sementes de jurema-de-embira.

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Introduction

Mimosa ophthalmocentra Mart. ex Benth. is a species native to the Caatinga biome, popularly known as 'jurema-de-embira' (Cavalcanti et al., 2009). Its occurrence is also commonly recorded in areas of riparian forest (Lacerda et al., 2007) and regeneration (Sampaio et al., 2010), being a species with multiple uses, with high energetic and timber potential (Figueirôa et al., 2005).

The information on the techniques of propagation of arboreal species of the Caatinga is still considered as scarce. Therefore, it becomes important to know the factors that limit the development of the species, particularly water deficit, a common situation in the semi-arid region, where the Caatinga biome is inserted.

Water is one of the most important factors that affect germination, because it reactivates the metabolism and is involved in all other steps of germination (Marcos-Filho, 2015). Very negative osmotic potentials can delay or reduce germination. Hence, there is the need for a minimum level of water availability for the seed to germinate, which will depend on its chemical composition and permeability of the tegument (Verslues et al., 2006). Thus, it is significant the presence of an adequate level of hydration that allows the reactivation of the metabolic processes, culminating in the growth of the embryo axis (Marcos-Filho, 2015).

In this context, some studies have been conducted using solutions with different osmotic potentials to moisten the substrate, such as Jeller et al. (2003), with *Cassia excelsa* Schrad.; Ferraz-Grande & Takaki (2006), with seeds of *Caesalpinia peltophoroides* Benth.; Stefanello et al. (2006), with seeds of *Foeniculum vulgare* Miller. and Pelegrini et al. (2013), with seeds of *Erythrina falcata* Benth.

Therefore, this study aimed to evaluate the effects of water stress on the germination and vigor of 'jurema-de-embira' seeds at different temperatures.

Material and Methods

The 'jurema-de-embira' seeds were obtained in 2014 through the collection of ripe fruits (pods) from 25 matrices located in the municipality of Mossoró – RN (5º 11' 15'' S, 37º 20' 39'' W and altitude of 16 m). After collecting the fruits, the seeds were manually removed, cleaned, purged, placed in tin cans and maintained in cold and dry chamber (15 °C and 50% RH of the environment) until their utilization.

The statistical design was completely randomized, in 4 x 7 factorial scheme (temperatures x osmotic potentials) and each treatment was composed of 4 replicates of 25 seeds.

For exhibiting tegument dormancy, the tips of the seeds were cut with scissors on the opposite end of the hilum. Then, they were planted on Germitest paper towel, hydrated with PEG 6000 solution, using a volume of 2.5 times the dry weight of the paper, produced according to the tabulated values proposed by Villela et al. (1991) to simulate the osmotic levels of 0, -0.1, -0.2, -0.3, -0.4, -0.5 and -0.6 MPa.

The germination tests were conducted in Biochemical Oxygen Demand (B.O.D.) germinators, regulated at the temperatures of 25, 30, 35 °C and alternated of 20-30 ºC, with photoperiod of 8 h of light. Daily counts were made until the 7th day after sowing, considering as germinated the seeds that formed normal seedlings (Brasil, 2009).

The analyzed variables were: a) germination percentage - expressed in percentage of normal seedlings; b) germination speed index - simultaneously conducted with the germination test, in which the seedlings were daily evaluated until the 7th day after sowing, and calculated according to the equation proposed by Maguire (1962); c) shoot and root length - at the end of the germination test, the root length (base of collar to root tip) and shoot length (base of collar to the tip of the apical meristem) of all normal seedlings of the experimental unit were measured using a ruler graduated in centimeters; d) shoot, root and total dry matter of the seedlings - all normal seedlings of the experimental unit were divided into roots and shoots and dried in a forced-air oven at 65 ºC until constant weight (48 h), being subsequently weighed on a precision analytical scale (0.01 g), with values expressed in mg plant^{-1}. Total dry matter was determined by the sum of shoot and root dry matter.

The results were subjected to analysis of variance by F test, at 0.05 probability level using the statistical program Sisvar® (Ferreira, 2011). In case of significance, the data were subjected to regression analysis using the program SigmaPlot®. The model was selected considering the biological explanation and significance of the mean square of the regression.

Results and Discussion

The water stress affected the formation of normal seedlings of 'jurema-de-embira' from the potential of -0.1 MPa on at temperature of 35 ºC. For the other temperatures, the negative effects of the water stress were observed from the potential of -0.2 MPa on, with germination percentages lower than 20% of normal seedlings at the potential of -0.4 MPa (Figure 1A).

The reduction of germination due to the increase in water deficit was also observed by Miranda et al. (2014) in seeds of *Prosopis juliflora* (Sw.) D.C. These authors reported that, at the highest temperatures (35 and 40 ºC), the reduction was faster than at the lowest temperatures (25 and 30 ºC).

The highest GSI was recorded at the temperature of 35 ºC and water potential of 0 MPa (Figure 1B), which occurred because higher temperatures increased the speed of the metabolic processes, shortening the duration of the phase II of the imbibition process. According to Nascimento (2005), very low or very high temperatures can alter both the speed and final percentage of germination. Generally, low temperatures reduce the germination speed, while high temperatures increase it.

At all temperatures, there was a reduction in germination speed from -0.1 MPa on and the temperature of 35 ºC led to the highest reductions. On the other hand, the alternated temperatures of 20-30 °C caused lower reductions in germination speed until the osmotic potential of -0.5 MPa.

Seeds of *C. peltophoroides* suffered reductions in GSI under water stress, but without significant differences from -0.2 to -0.4 MPa (Ferraz-Grande & Takaki, 2006). In *C. excelsa*, there was tolerance until -0.8 MPa, with significant reduction from -0.6 MPa on at 27 ºC (Jeller et al., 2003). For *F. vulgare* seeds,

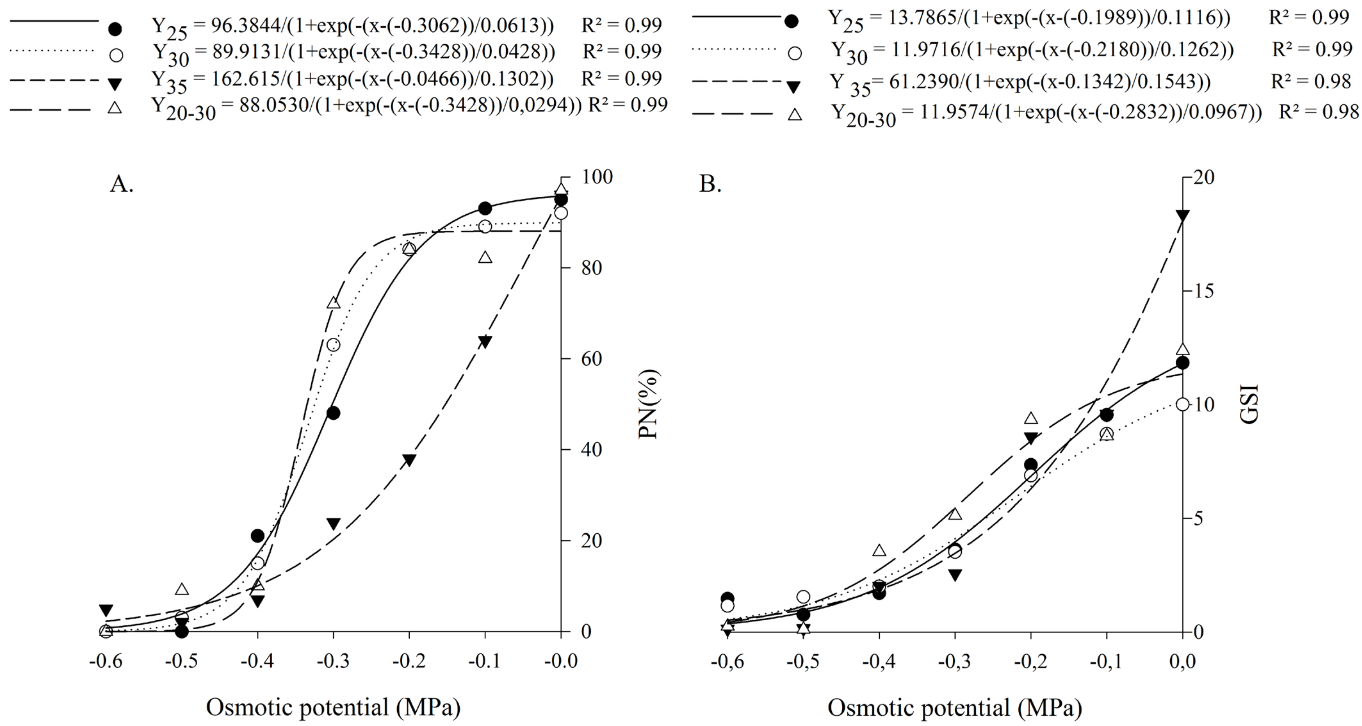

Figure 1. Percentage of normal seedlings – PN (A) and germination speed index - GSI (B) of 'jurema-de-embira' (*Mimosa ophthalmocentra* Mart. ex Benth.), subjected to water stress at different temperatures

there was a linear reduction of germination and speed, reaching zero at -0.3 MPa (Stefanello et al., 2006). In *E. falcata* seeds, the reduction in water availability to potentials lower than -0.4 MPa drastically inhibited the germination percentage and speed (Pelegrini et al., 2013).

In seeds of *Bulnesia retama* (Gill. ex. Hook.), Rivera et al. (2007) observed that, at lower values of water availability, the germination speed was affected by low and high temperatures (18 and 32 °C, respectively), and the lowest reduction due to the decrease in water availability occurred at intermediate temperatures (25 °C).

Shoot length was affected at all temperatures, from the water availability of -0.1 MPa on, except for the temperature of 30 °C, at which the reduction only occurred from -0.2 MPa on. As observed for the GSI, seedlings subjected to the temperatures of 35 and 20-30 °C, suffered the highest and lowest reductions of shoot length, respectively (Figure 2A).

Regardless of temperature, with the increase in water deficit, the 'jurema-de-embira' starts to invest in the production of roots, whose effect is more evident between the osmotic potentials of -0.2 and -0.3 MPa, especially at the alternated temperatures of 20-30 °C. From this point on, there was a reduction in the root system. At all temperatures, the values of root length are only inferior to those in the condition of full water supply (0 MPa) at potentials below -0.5 MPa (Figure 2B).

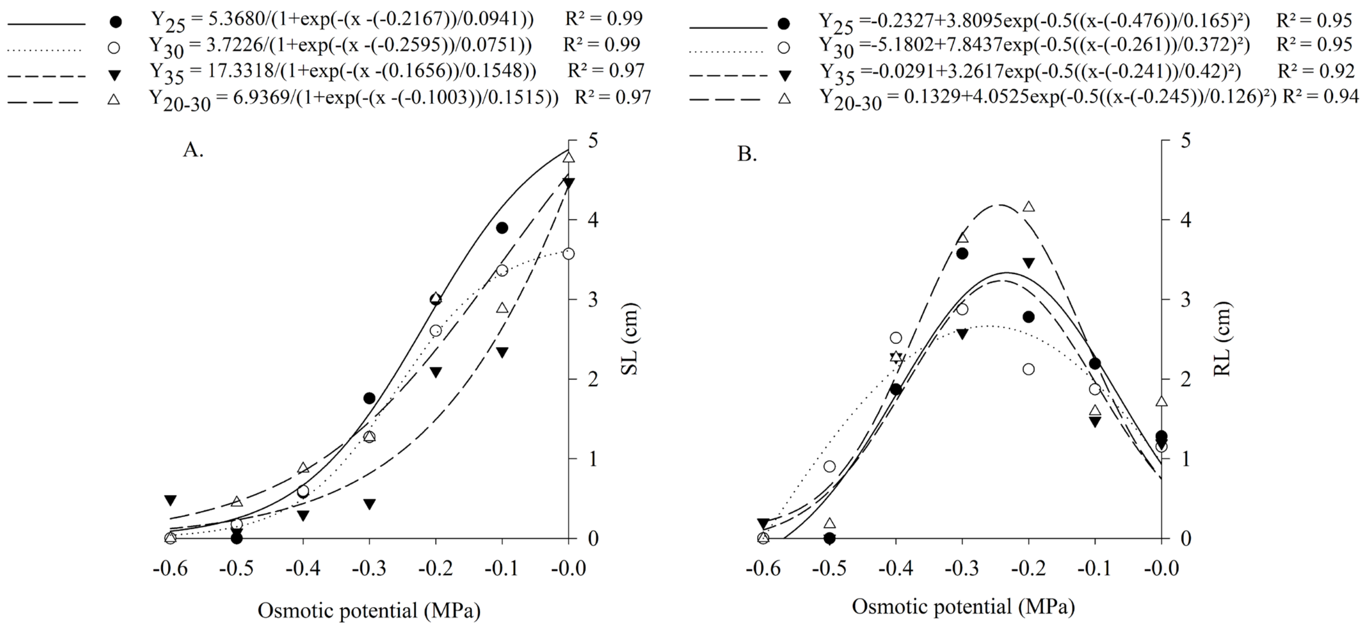

Figure 2. Shoot length - SL (A) and root length - RL (B) of seedlings of 'jurema-de-embira' (*Mimosa ophthalmocentra* Mart. ex Benth.), subjected to water stress at different temperatures

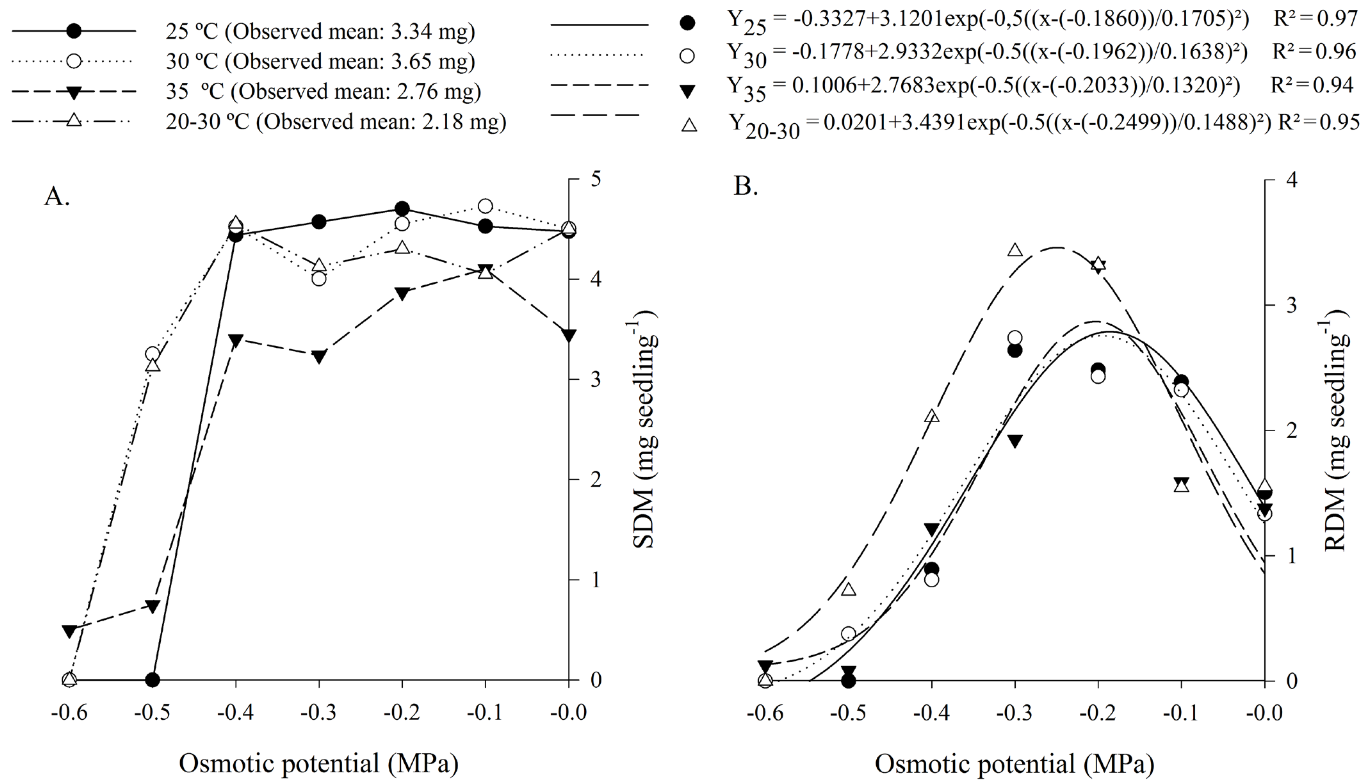

Figure 3. Shoot dry matter - SDM (A) and root dry matter - RDM (B) of seedlings of 'jurema-de-embira' (*Mimosa ophthalmocentra* Mart. ex Benth.), subjected to water stress at different temperatures

The increase in root length when plants are subjected to moderate water deficits is due to the need for the root system to be able to absorb water at greater depths (Ávila et al., 2007).

In seedlings of *Moringa oleifera* L., Rabbani et al. (2012) observed that root and shoot lengths were reduced as the water availability decreased, and root length was more severely affected by the water stress, different from the result observed in the present study. The authors attribute this reduction to the delay in the emergence of the hypocotyl and a lower root growth rate caused by the reduction in cell expansion and, as a consequence, decrease in cell turgor.

Although there were reductions in shoot length from -0.1 MPa on, the dry matter showed a different behavior, with more evident reductions from -0.4 MPa on and no fit of the curve (Figure 3A)

In seedlings of *M. oleifera*, Rabbani et al. (2012) reported increase in the biomass from -0.1MPa on and a reduction for the subsequent potentials, which allows to infer about the potential of the water restriction, which can improve the performance of the 'moringa' seeds, acting as osmotic conditioning (Santos et al., 2011).

The behavior of the investment in root dry matter was similar to that of root length, in which, with the increase in water deficit, the species starts to invest in greater accumulation of biomass in the roots, and this effect was more evident between the osmotic potentials of -0.1 and -0.3 MPa. The greater growth of roots occurred under alternated temperatures of 20-30 ºC, at which the effects of water deficit were more evident from the potential of -0.5 MPa on (Figure 3B).

For total dry matter, with the reduction in water availability, there was a slight increase in relation to the control (0 MPa). The reduction in total dry matter of the seedlings occurred from -0.4 MPa on, and the highest and lowest reductions of biomass were observed at the temperatures of 35 and 20-30 ºC, respectively (Figure 4).

Similarly, Gordin et al. (2015) observed reductions of dry matter in seedlings of *Guizotia abyssinica* Cass., which followed the trend of reductions in growth, and the effects were more abrupt at -0.4 MPa.

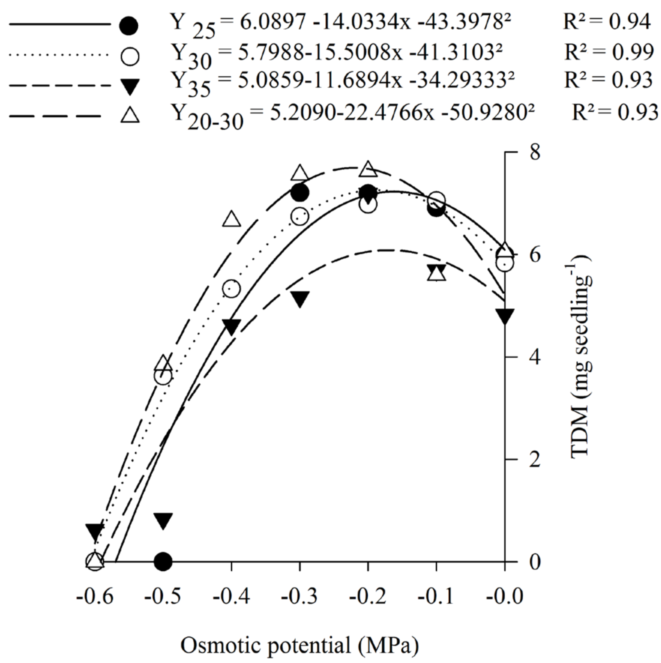

Figure 4. Total dry matter - TDM of seedlings of 'jurema-de-embira' (*Mimosa ophthalmocentra* Mart. ex Benth.), subjected to water stress at different temperatures

Conclusions

1. Water stress negatively affects the germination of 'jurema-de-embira' seeds and the initial development of its seedlings from the potential of -0.2 MPa on, and the effects were more evident at temperature of 35 °C.

2. The alternated temperatures of 20-30 °C allow higher tolerance to water stress for the germination of 'jurema-de-embira' seeds.

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