

GERMINATION OF CAATINGA NATIVE SPECIES UNDER SALT STRESS CONDITIONS

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ABSTRACT: The physiological tolerance mechanisms of some plants to salt and water stress during germination are already well known. However, little is known about these mechanisms in native Caatinga species, based on this, this study aimed to evaluate the influence of stress on seed germination of the Caatinga native species, *Piptadenia stipulacea* (jurema blanca), *Mimosa caesalpiniaefolia* (sabiá), *Caesalpineia ferreae* (jucá) and *Pityrocarpa moniliformis* (catanduva). Salt treatments corresponded to 0; 40.36; 80.72; 121.09 and 165.41 mM NaCl. The following variables were evaluated: percentage of germination (% G), germination speed index (GSI) and mean germination time (MGT). No significant differences were found for %G of *P. stipulaceae*; *C. ferreae* and *P. moniliformis* for salt treatments. Regarding GSI, the analyzed species presented differences between treatments, except for *P. stipulaceae* and *P. moniliformis* showed to be the most tolerant to salt stress during the germination phase, because they presented high levels of germination, even in the higher doses of salt.

KEYWORDS: seed development, salinity, tolerance.

GERMINAÇÃO DE ESPÉCIES NATIVAS DA CAATINGA SOB CONDIÇÕES DE ESTRESSE SALINO

RESUMO: Os mecanismos fisiológicos de tolerância de algumas plantas aos estresses salino e hídrico, durante a fase germinativa, já são bastante conhecidos. Entretanto, pouco se conhece sobre esses mecanismos em espécies nativas da Caatinga, baseado nisso, este estudo objetivou avaliar a influência do estresse salino sobre a germinação de sementes das espécies nativas da caatinga, *Piptadenia stipulacea* (jurema branca), *Mimosa caesalpiniaefolia* (sabiá), *Caesalpineia ferreae* (jucá) e *Pityrocarpa moniliformis* (catanduva). Os tratamentos salinos

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foram 0; 40,36; 80,72; 121,09 e 165,41 mM de NaCl. Avaliaram-se as variáveis: porcentagem de germinação (%G), índice de velocidade germinação (IVG) e tempo médio de germinação (TMG). Não foram encontradas diferenças significativas no %G da jurema Branca, jucá e catanduva para os tratamentos salinos, já com relação ao IVG as espécies analisadas apresentaram diferenças entre os tratamentos, com exceção do Jucá. A jurema Branca e a catanduva se mostraram como as mais tolerantes ao estresse salino durante a fase germinativa, por terem apresentado altos níveis de germinação, mesmo nas doses mais elevadas de sal.

PALAVRAS-CHAVE: desenvolvimento das sementes, salinidade, tolerância.

INTRODUCTION

Seed germination is fundamental to the spread of species and the preservation of its abundance in the ecosystem. According to Braga et al. (2009), germination period is important for the survival of forest species, especially in areas where water availability is limited during a period of the year.

Piptadenia stipulacea, *Mimosa caesalpinifolia* Benth, *Caesalpineia férrea* e a *Pityrocarpa moniliformis*, popularly known by jurema branca, sabiá, jucá and catanduva, respectively, are native species of the Caatinga, widely distributed in the Northeast region of Brazil (Andrade, 2007). These are very recommended in the recovery of degraded areas and forest restoration, and also used for the production of firewood, coal, carpentry (Lorenzi, 1992). In addition, they stand out as forage for feeding goats and other animals (Maia, 2004).

According to Lima et al. (2006), there is not enough information for management and analysis of seeds of most native forest species of Northeast Brazil. For this reason, study of seed germination and knowledge about how stress influences this process has a special emphasis on ecophysiology to evaluate tolerance limits, species adaptability (Larcher, 2000) and distribution of these species.

Physiological responses of plant species to abiotic stresses, such as water and saline stress, have been widely reported by several authors (Munns; Tester, 2008; Voigt *et al.*, 2009; Marques et al., 2013; Alencar *et al.*, 2015). The physiological mechanisms of tolerance to these stresses have been studied in plant species during the germinative phase (Voigt et al., 2009, Marques et al., 2013, Alencar et al., 2015). However, little is known about mechanisms of seed adaptation of native species, especially of the northeastern semiarid region, with conditions of

water restriction and salinity in the soil, and how these seeds can initiate their vegetative development in this natural environment.

The objective of this study was evaluate the influence of saline stress on seed germination of four native species of caatinga biome: *Piptadenia stipulacea*, *Mimosa caesalpiniaefolia* Benth, *Caesalpineia férrea* and *Pityrocarpa moniliformis*, in order to obtain informations that may indicate which species are more tolerant to this type of stress and that can direct studies on the abundance and distribution of these species in this biome.

MATERIAL AND METHODS

Initially, the seeds were treated with 0.5% sodium hypochlorite (NaClO) solution. Subsequently, they were submitted to dormancy breakdown by immersion in sulfuric acid (H₂SO₄) for 30 minutes. After, the seeds were placed to germinate in boxes of the gerbox type on germitest paper moistened with saline solutions of 0; 40.36; 80.72; 121.09 and 165.41 mM NaCl, corresponding to osmotic concentrations of 0 (distilled water); -0.2; -0.4; -0.6 and -0.8 MPa, respectively. Afterwards, these seeds were submitted to germination test in BOD chambers at 25°C under white light and 12 h light / 12 h dark photoperiod to evaluate the tolerance of seeds to saline stress.

The experiment was conducted in a completely randomized design, consisting of 5 treatments, with 8 replicates containing 25 seeds each. The saline treatments corresponded to the different concentrations of NaCl at 0 (T1); 40.36 (T2); 80.72 (T3); 121.09 (T4) and 165.41 mM (T5). The germination counts were performed daily, considering the number of seedlings emerged per day, until this number was constant. This procedure was performed from the third day of the beginning of the test and was signaled at 7, 12 and 9 days of counting for *Piptadenia stipulacea*, *Mimosa caesalpiniiifolia* Benth, *Caesalpineia férrea* and *Pityrocarpa moniliformis*, respectively.

After the experimental period, the percentage of germination (%G) (Laboriau, 1983), germination speed index (GSI) (Maguire, 1962) and mean germination time (MGT) were determined (Laboriau, 1983).

The data were submitted to analysis of variance (ANOVA) and in the significant models by the F test. The multiple means comparison was performed using the Tukey test, at 5% probability. Data processing and statistical analysis were performed using the Assistat statistical software, version 7.7 Beta (Silva & Azevedo, 2009).

RESULTS AND DISCUSSION

Table 1 shows the average squares of the variables: % G, GSI, MGT of the seeds of *P. stipulacea*, *M. caesalpiniiifolia* Benth, *C. ferrea* and *P. moniliformis*, submitted to 5 different salinity treatments. The percentages of germination for the species *P. stipulacea*, *C. ferrea* and *P. moniliformis* did not vary according to the salinity levels evaluated for the species. However, there were significant differences ($p < 0.01$) in the GSI and MGT variables when submitted to different saline concentrations, except for *C. ferrea*, which did not present any significant differences between them for any of the parameters evaluated in this study. On the other hand, *M. caesalpiniiifolia* presented significant differences in the %G and GSI variables, while the MGT was not significant.

Some authors have reported the negative effect on germination of seeds subjected to saline stress, such as for pinhão-manso (Alencar et al., 2015) and cajueiro anão precoce (Voigt et al., 2009; Marques et al., 2013). In addition to the negative effect on the germination parameters, these authors also mentioned that the exposure to saline stress contributes to delay of the mobilization of reserves, which compromises the development of the seedlings, affecting their development.

In relation to the germination counts, *P. stipulacea* seeds presented good germination percentage levels, with the highest value observed in treatment 1 (control) with 97% of the germinated seeds and the lowest value found in the treatment 5 (165.41 MM NaCl) with 91.5%. However, there were no significant differences when compared to different salinity levels. The highest values presented for the variable IVG are observed in treatments 1, 2 and 3, which presented significant differences of the treatments 4 and 5, which presented the lowest values, showing that the higher salinity, lower GSI (Table 2).

A lower germination speed is a strategy that allows species to establish themselves rapidly in a specific environment, taking advantage of favorable environmental conditions for the development of new individuals (see Borghetti & Ferreira, 2004). According to Martins et al. (2000), the longer time seedling takes to emerge and remain in the early stages of development, the more vulnerable it will be exposed to adverse environmental conditions.

For the species *M. caesalpiniiifolia*, it was observed that there was a significant difference between the % G and GSI variables for the treatments studied. Treatment 2 obtained the highest mean of % G with 54%, differing statistically from treatments 4 and 5 that obtained the lowest averages, 20% and 10%, respectively. The largest GSI was presented by treatment 2 of 23.06,

which differed statically from treatments 4 and 5, which obtained the lowest values of 6.50 and 4.21, respectively. For the MGT variable, no significant differences were observed (Table 3).

For *C. ferrea*, is interesting to note that the exposure of its seeds to saline stress did not promote significant changes in the % G, GSI and MGT variables, even in the higher salt treatments when compared to the control. This result suggests that this species has a certain tolerance to saline stress (Table 4).

P. moniliformis seeds showed excellent germination even in saline conditions, with the highest germination presented by treatment 1, 93.50% and the lowest germination by treatment 5, 88%. However, there was no significant difference between the treatments studied. The highest GSI were presented by treatments 1 and 2, namely: 29.24 and 28.01, respectively, differing statistically from treatment 5 that presented the lowest GSI. MGT did not present means differing significantly between treatments (Table 5).

In study carried out with seeds of *Caesalpinia pyramidalis* Tul. (Catingueira), Santos et al. (2016) observed that the germination percentage of these seeds was not negatively influenced by the concentrations of -0.4 and -0.8 Mpa of NaCl. However, the effect of salinity on germination of *Gallesia integrifolia* (pau d'algo) seeds in the osmotic potentials of 0.0, -0.6 and -1.2 MPa was evaluated by Lopes et al. (2015), which observed that when subjected to the most negative osmotic potentials, the GSI is affected.

CONCLUSION

Among the species studied, *P. stipulacea* and *P. moniliformis* presented high percentages of germination even in the highest salt doses, suggesting that these species were the most tolerant to salt stress during the germination phase. This may indicate their better adaptation to the excess of salt or water scarcity in the soil, a common aspect in semi-arid environments. These results may use as a stimulus for new research that relates occupation and distribution of species in these environments.

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Table 1. Summary of the variance analysis of the variables: percentage of germination (% G), germination speed index (GSI), mean germination time (MGT) for *Piptadenia stipulacea*, *Mimosa caesalpinifolia* Benth, *Caesalpineia férrea* and *Pityrocarpa moniliformis*

<i>Piptadenia stipulacea</i>				
Variables	QM Treatment	QM Residue	F	CV (%)
%G	43,4	36,17	1,1998 ns	6,39
GSI	125,22	8,17	15,3234 **	12,76
MGT	0,33	0,03	8,7521 **	3,77
<i>Mimosa caesalpinifolia</i> Benth.				
Variáveis	QM Treatment	QM Residue	F	CV (%)
%G	2533,60	281,31	9,0063 **	59,27
GSI	509,68	51,75	9,8489 **	61,58
MGT	18,55	7,49	2,4773 ns	37,26
<i>Caesalpineia férrea</i>				
Variáveis	QM Treatment	QM Residue	F	CV (%)
%G	207,40	561,42	0,3694 ns	28,93
GSI	29,64	31,29	0,9474 ns	32,48
MGT	0,24	0,21	1,1290 ns	5,31
<i>Pityrocarpa moniliformis</i>				
Variáveis	QM Treatment	QM Residue	F	CV (%)
%G	50,4	46,85	1,0756 ns	7,49
GSI	61,66	10,13	6,0840 **	12,17
MGT	0,24	0,1	2,2672 ns	3,99

** significant at the 1% probability level ($p < 0.01$)* Significant at the 5% probability level ($0.01 = < p < 0.05$)ns not significant ($p > = 0.05$)**Table 2.** Means obtained in each treatment for the variables: Germination percentage (% G), germination speed index (GSI), mean germination time (MGT) for *Piptadenia stipulacea*

Variables	T1 (0 MPa)	T2 (-0,2 MPa)	T3 (-0,4 MPa)	T4 (-0,6 MPa)	T5 (-0,8 MPa)
%G	97,00a	96,00a	93,50a	92,50a	91,50a
GSI	26,34a	25,01a	24,17a	19,40b	17,10b
MGT	5,00c	5,06bc	5,06bc	5,29ab	5,49a

Averages followed by the same letter do not differ statistically from each other. The Tukey test was applied at a 5% probability level.

Table 3. Means obtained in each treatment for the variables: Germination percentage (% G), germination speed index (GSI), mean germination time (MGT) for *Mimosa caesalpinifolia Benth*

Variables	T1 (0 MPa)	T2 (-0,2 MPa)	T3 (-0,4 MPa)	T4 (-0,6 MPa)	T5 (0,8 MPa)
%G	18,00 bc	54,00 a	39,00 ab	20,00 bc	10,50 c
IVG	7,73 bc	23,06 a	16,89 ab	6,50 c	4,21 c
TMG	6,41 a	8,64 a	8,58 a	7,94 a	5,14 a

Averages followed by the same letter do not differ statistically from each other. The Tukey test was applied at a 5% probability level.

Table 4. Means obtained in each treatment for the variables: Germination percentage (% G), germination speed index (GSI), mean germination time (MGT) for *Caesalpinia ferrea*

Variables	T1 (0 MPa)	T2 (-0,2 MPa)	T3 (-0,4 MPa)	T4 (-0,6 MPa)	T5 (0,8 MPa)
%G	81,50 a	80,50 a	90,50 a	80,00 a	77,00 a
GSI	18,08 a	17,45 a	19,53 a	16,73 a	14,31 a
MGT	8,78 a	8,50 a	8,60 a	8,82 a	8,93 a

Averages followed by the same letter do not differ statistically from each other. The Tukey test was applied at a 5% probability level.

Table 5. Means obtained in each treatment for the variables: Germination percentage (% G), germination speed index (GSI), mean germination time (MGT) for *Pityrocarpa moniliformis*

Variables	T1 (0 MPa)	T2 (-0,2 MPa)	T3 (-0,4 MPa)	T4 (-0,6 MPa)	T5 (0,8 MPa)
%G	93,50 a	93,50 a	89,50 a	92,50 a	88,00 a
GSI	29,24 a	28,01 a	25,38 ab	26,09 ab	22,00b
MGT	8,15 a	8,12 a	8,11 a	8,28 a	8,53 a

Averages followed by the same letter do not differ statistically from each other. The Tukey test was applied at a 5% probability level.