CC&T

ISSNe 0104-1096

Cadernos de Ciência & Tecnologia

www.embrapa.br/cct

Initial development of Brazilian fire tree subjected to different substrates and saline water levels

Aécio Dantas de Sousa Junior[1]
Ademilson Coneglian[2]
Pedro Henrique Pinto Ribeiro[3]
Henrique Oldoni[4]
Fábio Santos Matos[5]
Jhécika da Silva Furtado[6]

ABSTRACT

To make the tree cultivation for commercial purposes less vulnerable to inclement environment conditions in Goiás state, Brazil, it is necessary to spread other fast-growing species with timber potential, such as the Brazilian fire tree [*Schizolobium parahyba* (Vell.) S. F. Blake], locally known as *guapuruvu*. However, little is known on the initial physiological performance of this species. The present work aimed to evaluate the initial development of the Brazilian fire tree in three different substrates, in order to determine the critical salinity levels for its cultivation. A completely randomized experimental design was carried out with 15 treatments and 7 replicates, in a 5x3 factorial arrangement corresponding to five salinity levels and three substrates. The following variables were evaluated: plant height, stem diameter, number of leaves, mass of fresh roots and shoots, and mass of dry roots and shoots. Data were subjected to the analysis of variance, as well as to the Tukey´s test and the regression analysis. The seedlings of Brazilian fire tree are sensitive to salinity, and may be classified as glycophytes because of the damage to growth that they undergo when subjected to irrigation water with electric conductivity lower than 1.5 dS m^{-1}. The commercial substrate Terral Solo promotes more vigorous vegetative growth to the seedlings of the Brazilian fire tree substrates with sugarcane bagasse and sand.

Index terms: *Schizolobium parahyba*, electrical conductivity, salt stress, seedling, timber potential.

Desenvolvimento inicial do guapuruvu submetido a diferentes substratos e níveis de água salina

RESUMO

Para tornar o cultivo de árvores para fins comerciais menos vulnerável às intempéries do ambiente no estado de Goiás, é necessária a difusão de outras espécies de rápido crescimento e potencial madeireiro como o guapuruvu (*Schizolobium parahyba*).

Ideias centrais

- Cultivation techniques using lower quality water, such as saline water in irrigation, are necessary given the current scenario where climate change and the growing increase in areas subject to abiotic stress are realities in forest cultivation
- Forest species that are less demanding on the level of chemical fertility available in the soil, allows the implementation of commercial plantations in acid soils and with low nutrient availability
- Studying the development of seedlings in conditions of water deficit and salinity can support information on success and profitability in commercial plantations

Recebido em
08/08/2019

Aprovado em
14/10/2019

Publicado em
29/11/2019

[1] Engenheiro Florestal, Mestre em Ciências Florestais (UFRN/2017), Doutorando em Ciências Ambientais e Florestais, Programa de Pós-Graduação em Ciências Ambientais e Florestais, Universidade Federal Rural do Rio de Janeiro, Seropédica, RJ. E–mail: aecio.dantas@hotmail.com.

[2] Engenheiro Florestal, Doutor em Agronomia - Energia da Agricultura, Docente, Universidade Estadual de Goiás, Campus Ipameri, Ipameri, GO. E–mail: coneglian@ueg.br.

[3] Tecnólogo em Irrigação e Drenagem, Doutor em Agronomia, Irrigação e Drenagem, Supervisor Comercial, Valley/Valmont, Uberaba, MG. E–mail: pedro.ribeiro@valmont.com

[4] Engenheiro Agrícola, Mestre em Engenharia Agrícola (UNIVASF/2015), Doutorando em Agronomia: Irrigação e Drenagem, Universidade Estadual Paulista Júlio de Mesquita Filho, Botucatu, SP. E–mail: henriqueoldoni@gmail.com.

[5] Engenheiro Agrônomo, Doutor em Fitotecnia, Docente da Universidade Estadual de Goiás, Campus Ipameri, Ipameri, GO. E–mail: fabio.agronomia@hotmail.com.

[6] Discente, Bacharelado em Engenharia Florestal, Universidade Estadual de Goiás, Campus Ipameri, Ipameri, GO. E–mail: jhecikasilva@hotmail.com.

No entanto, pouco se conhece ainda sobre o desempenho fisiológico inicial desta espécie. O presente estudo teve como objetivo avaliar o desenvolvimento inicial de mudas de guapuruvu em três diferentes substratos, a fim de determinar os níveis críticos de salinidade para o seu cultivo. Um delineamento inteiramente casualizado foi utilizado com 15 tratamentos e 7 repetições, em arranjo fatorial 5x3 correspondente a cinco níveis de salinidade e três substratos. As seguintes variáveis foram avaliadas: altura de planta, diâmetro caulinar, número de folhas, massa de matéria fresca das raízes e da parte aérea e massa de matéria seca das raízes e da parte aérea. Os dados foram submetidos à análise de variância, ao teste de Tukey e à análise de regressão. As mudas de guapuruvu são sensíveis à salinidade e podem ser classificadas como glicofitas em razão de danos ao seu crescimento, quando submetidas à irrigação com água de condutividade elétrica inferior a 1,5 dS m^{-1}. O substrato comercial Terral Solo promove melhor desenvolvimento das mudas de guapuruvu do que os substratos com bagaço de cana-de-açúcar e de areia.

Termos para indexação: *Schizolobium parahyba*, condutividade elétrica, estresse salino, mudas, potencial madeireiro.

INTRODUCTION

In Brazil, the planted area with trees for industrial purposes reached 7.84 million hectares in 2016, which means 0,5% growth in comparison to that of 2015. Wood supply to the most diverse segments of the national industry is concentrated in few species, among which 72% of this total is eucalyptus, and 20.7% pine trees. The other cultivated species are: acacia (*Acacia* spp.), teak (*Tectona grandis*), rubber tree (*Hevea brasiliensis*), and "paricá" (*Schizolobium amazonicum*) (IBÁ, 2017).

In Goiás state, the current scene for the sector shows a planted area of 124,297 thousand hectares of eucalyptus, 9,087 thousand hectares of pine and 5,000 thousand of other species (IBÁ, 2015). Although the state has a high potential for the cultivation of forest species, eucalyptus and pine plantations are quantitatively the most representative ones. Therefore, it is necessary to spread other fast-growing species with timber potential, such as *Schizolobium parahyba*, in order to make the activity less vulnerable to inclement weather.

Schizolobium parahyba is a pioneer species popularly known as *guapuruvu* (Brazilian fire tree), with a monopodial growth, forming a wide and umbelliform crown. It reaches 15-40 m height and 0.50-1.00 m diameter, with a straight and cylindrical trunk. This species is indicated for mixed, or pure plantations, and also for the recovery of degraded areas. Its wood has a low density (0.32 to 0.40 g cm^{-3}), easy workability, high permeability to preservative solutions, and can be used in the manufacture of shoe heels, light boxing, plywood, panel core, paper, and cellulose (Carvalho, 2003; Locatelli et al., 2007).

In the Cerrado domain, there are some variation of soil classes, and acid dystrophic Latosols prevail (Santos et al., 2013). Brazilian fire tree is undemanding for the level of chemical fertility available in the soil, being therefore appropriate for commercial plantations in acid soils with low availability of nutrients (Carvalho, 2003; Coneglian et al., 2016).

Seedling quality is essential for a successful establishment of forest species in the field (Garcia & Sousa, 2015). Climate changes and the increasing expansion of areas subjected to abiotic stress increase the need to elucidate the mechanisms driving *Schizolobium parahyba* growth under water deficit and salinity conditions, in order to guarantee profitability in commercial plantations. Using irrigation is essential to obtain vigorous forest species because water restriction may become an obstacle for the success of these populations. The current scene with constant droughts and crisis in water supply, in large urban centers, stimulates the conduction of research on the use of lower-quality water, such as saline water (Oliveira et al., 2014; Souza et al., 2015), although an adequate irrigation management is indispensable (Nery et al., 2009) because salinity may cause deleterious effects on plant development (Silva et al., 2009; Oliveira et al., 2010), making the plantation economically unviable.

Salinity affects many aspects of plant metabolism, causing the reduction of transpiration, photosynthesis, translocation, and respiration, besides compromising water absorption by roots, and possibly affecting growth and yield (Gomes et al., 2005; Lopes & Macedo, 2008). However, not all crops respond equally to salinity, as some of them produce acceptable yields at high-saline levels,

Cadernos de Ciência & Tecnologia, Brasília, v. 36, n. 3, e26520, 2019
DOI: 10.35977/0104-1096.cct2019.v36.26520

while others are sensitive to relatively low-saline levels (Ribeiro, 2013). According to Garcia et al. (2010), the damages caused by salinity depend on the application duration, severity, and on plant growth stage.

The present work aimed to evaluate the initial development of *Schizolobium parahyba* (Vell.) S. F. Blake (Leguminosae, Caesalpinoideae) seedlings, subjected to three different substrates, in order to determine the critical levels of salinity for its cultivation.

MATERIALS AND METHODS

The experiment was carried out in a greenhouse, in the Universidade Estadual de Goiás, Campus Ipameri, in the municipality of Ipameri (17°43’19’’S, 48°09’35’’W, at 773 m altitude), GO, Brazil, between April and June 2015. The climate of the region is defined as tropical with dry winter and humid summer (Aw), according to the Köppen-Geiger’s classification (Cardoso et al., 2014). During the experimental period, the highest temperature inside the greenhouse was 43ºC, with mean values of approximately 27ºC as maximum, and 11ºC as minimum. In this same period, the relative air humidity varied from 19 to 99%. These values were obtained using a digital hygrometer Tomate, model PD002.

The experimental design was completely randomized, with 15 treatments and 7 replicates, totaling 105 sampling units, in a 5x3 factorial arrangement corresponding to five different levels of salinity (factor salinity) in irrigation water at the following values for electrical conductivity (ECw): S1 = 0.03; S2 = 1.5; S3 = 3.0; S4 = 4.5 and S5 = 6.0 dS m^{-1}, and three different substrates (factor substrate): sand, sugarcane bagasse (SB), and commercial substrate Terral Solo (CS) (Table 1).

Table 1. Distribution of treatments: substrate *vs.* saline distribution.

Treatment	Sand/irrigation
T1	Absence of saline solution
T2	1.5 dS m^{-1} saline solution
T3	3.0 dS m^{-1} saline solution
T4	4.5 dS m^{-1} saline solution
T5	6.0 dS m^{-1} saline solution
	Sugarcane bagasse/irrigation
T6	Absence of saline solution
T7	1.5 dS m^{-1} saline solution
T8	3.0 dS m^{-1} saline solution
T9	4.5 dS m^{-1} saline solution
T10	6.0 dS m^{-1} saline solution
	Commercial substrate/irrigation
T11	Absence of saline solution
T12	1.5 dS m^{-1} saline solution
T13	3.0 dS m^{-1} saline solution
T14	4.5 dS m^{-1} saline solution
T15	6.0 dS m^{-1} saline solution

The solution of each irrigation with the desired ECw level was obtained by adding iodine-free commercial sodium chloride (Na^+Cl^-) to public-supply water. The quantity of Na^+Cl^- used to prepare the solution was determined with basis on the initial ECw, according to the methodology proposed by Richards (1954), also used by Ribeiro (2013), in the following equation:

QNaCl = 640 x (desired ECw – initial ECw)

in which: QNaCl is the quantity (mg L^{-1}) of sodium chloride; and ECw is the electrical conductivity (dS m^{-1}) of water.

Seed were provided by the experimental farm of CATI (Coordenadoria de Assistência Técnica Integral, São Paulo State), in the Municipality of Pederneiras, SP, Brazil. Seed were subjected to dormancy break through immersion in boiling water at 95ºC for 10 min, and immersed in water at room temperature for 24 hours, as proposed by Bianchetti & Ramos (1981). Sowing was performed in daily irrigated tubes with public-supply water, without the addition of salts, for 15 days, to establish the seedlings in their respective substrates. After that, 40 seedlings per substrate were selected to compose the treatments and continue the study.

From 15 days after sowing on, seedlings started to be irrigated with the saline solutions. Each treatment received 210 mL of water, and the seedlings were individually irrigated with 30 mL of solution per day, for 60 days, totaling 75 days of experiment.

Plant height (PH), stem diameter (SD), number of leaves (NL), and irrigation drainage (ID) data were collected every five days. The materials used to obtain the data were: a graduated ruler, a digital caliper, and graduated plastic collectors. ID was obtained using collectors that were placed below each tube, before the daily irrigation, and removed after 24 hours. For each treatment, the samples were homogenized, measured, and analyzed in the laboratory for ECw and pH.

At the end of the experiment, for the determination of mass of fresh roots (MFR), mass of fresh shoots (MFS), mass of dry roots (MDR), and mass of dry shoots (MDS), the seedlings were divided into shoots and roots, then weighed, subjected to drying at 70°C for 72 hours, and weighed again until a constant mass was obtained, in order to determine the dry matter mass.

The data were subjected to the analysis of variance by the F test. In cases of significant difference, the Tukey´s test was applied for multiple comparison between the means for the factor substrate, and the polynomial regression analysis was performed for the factor salinity, both at 5% probability. All analyses were performed using the software ASSISTAT 7.7 (Silva & Azevedo, 2016).

RESULTS AND DISCUSSION

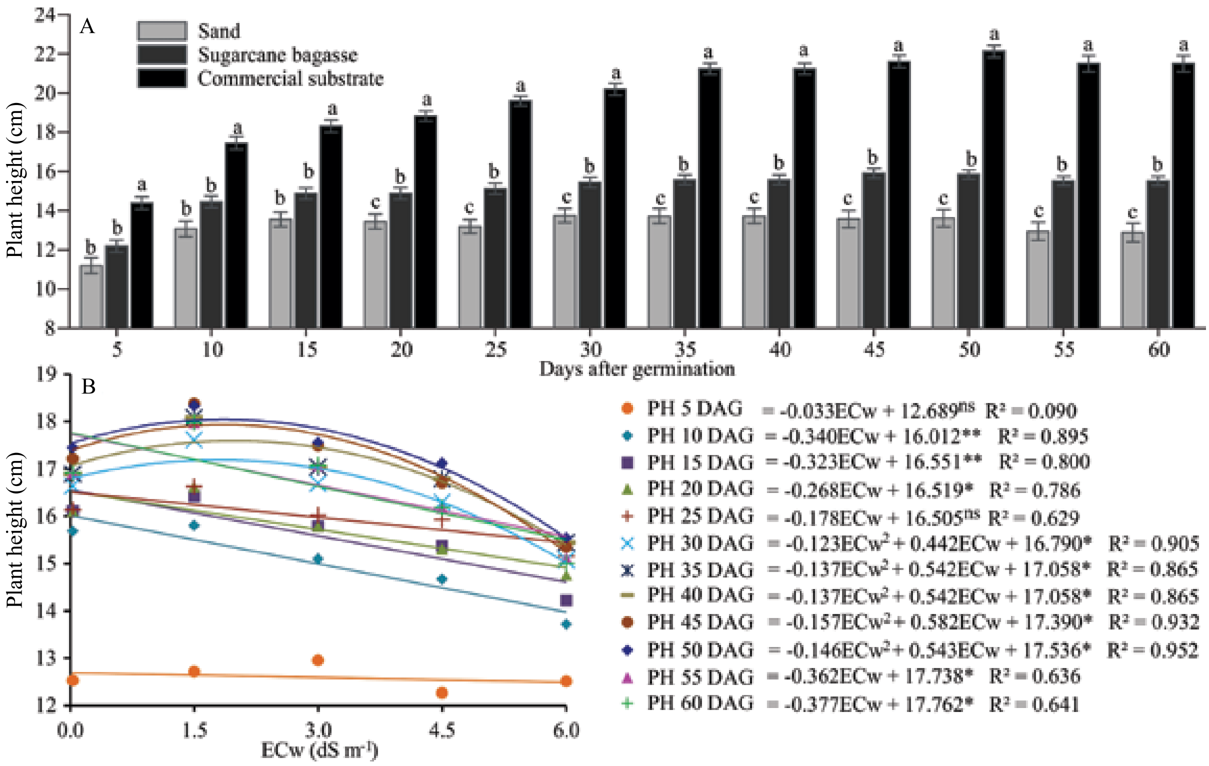
After 12 days of irrigation with saline, the seedlings showed the first symptoms of apical bud burn, growth reduction, and leaf yellowing, in the treatments with 4.5 and 6.0 dS m^{-1}, in all substrates; and the beginning of apical bud burn appeared in the treatments established in the sand. The high ECw absorbed by plants treated with the highest-salinity levels certainly made the water potential of the solution sufficiently negative to reduce absorption and, under these circumstances, water-dependent events such as growth and initiation of leaf primordia were reduced. The reduction of tissue hydration, leaf area, and growth has been observed in eucalyptus plants irrigated with saline water (Souza et al., 2015). According to Taiz & Zeiger (2013), the imbalance of ions in the cytosol, especially between sodium and potassium due to loss of selectivity of the plasma membrane, may result in decrease of the enzymatic activity and in irreversible damages to plants. Damages observed in the apical bud are caused by the toxic effect of salt, which occurred earlier in the sand substrate than in the other treatments because of the lower interaction between ions.

Besides reducing the initiation of new leaves, water imbalance intensifies the senescence of this structure through the degradation of proteins and chlorophylls. Such degradation is possibly associated with the toxic effect and water status of the plant. In addition, the nutritional imbalance, especially the nitrogen deficiency, is the triggering cause of leaf senescence (Matos et al., 2012). Our results corroborate those obtained by Vale et al. (2006) and Matos et al. (2013), for jatropha plants under different salinity levels.

Cadernos de Ciência & Tecnologia, Brasília, v. 36, n. 3, e26520, 2019
DOI: 10.35977/0104-1096.cct2019.v36.26520

Under saline conditions, the nutritional imbalance and toxic effects of salt are extremely harmful and may lead to plant death. However, in the present study, it was possible to observe that, as ECw increased, plant dry matter decreased significantly. Under these conditions of high tension in the soil solution, the plant reduce its stomatal opening, to minimize transpiration, which contributes to lower-CO_2 inflow, photosynthesis, and mass accumulation, as reported by Souza et al. (2015) in their study on eucalyptus under saline water irrigation.

It was not possible to observe a significant effect ($p>0.05$) between the studied factors (substrates x salinity) on the variable PH in any of the days after germination (DAG). However, a significant effect occurred for both factors individually (Figures 1 A and 1 B). Without considering the salinity levels, along the entire evaluation period, PH was significantly higher in seedlings cultivated in CS than in the substrates sand and SB, which significantly differed from 20 DAG on (Figure 1 A).



Means followed by equal letters do not differ significantly by the Tukey´s test, at 5% probability. Vertical bars in the columns represent mean standard errors. *, ** Regressions respectively significant at 5 and 1% probability.[ns]Nonsignificant (at 5%).

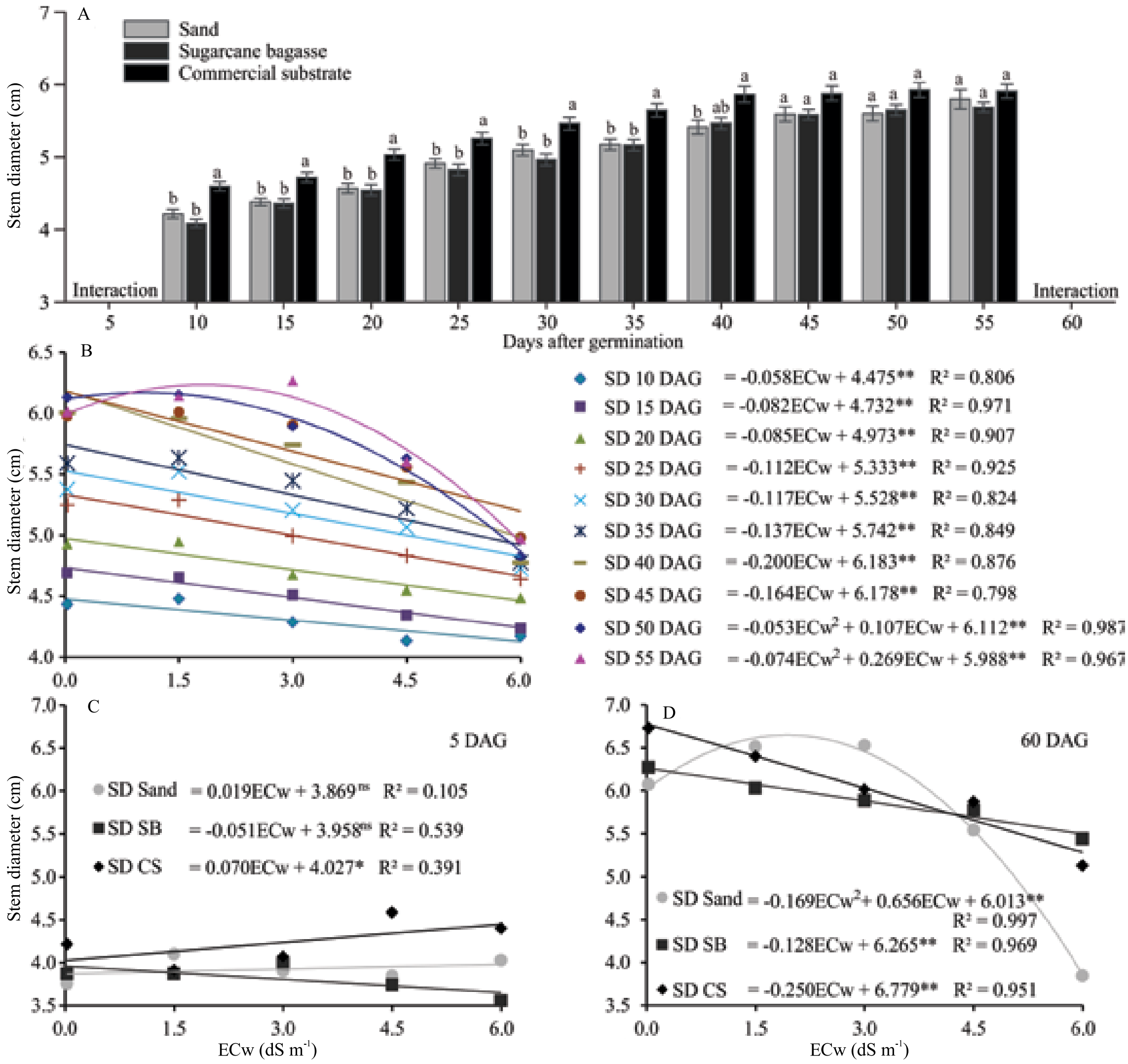
Figure 1. Plant height (PH) of Brazilian fire tree (*Schizolobium parahyba*) cultivated in three types of substrate: A, irrigated using saline solutions; B, with different levels of electrical conductivity (ECw); and in different days after germination (DAG). Ipameri, GO, Brazil, 2016.

This result is due to the differences between physical and chemical properties of the substrates. Carvalho (2005) reports that planted Brazilian fire tree exhibits a better growth in well-drained, wet soils with good fertility, and texture from loam to clay, although it occurs spontaneously under low--soil fertility conditions. Unlike the substrates sand and SB, these properties are found in commercial substrates which, according Guerrini & Trigueiro (2004, should have properties that allow of the water retention, nutrients, and oxygen in sufficient and required amounts for production, which promotes better conditions for seedling development.

The increase of the level of irrigation water salinity led to the linear reduction of PH at 10, 15, 20, 55, and 60 DAG, and to quadratic reduction from 30 to 50 DAG (Figure 1 B). In general, during the evaluated DAG, higher-PH values were found at salinity levels between 0.03 and 3.0 dS m^{-1}, which evidences a higher growth of the Brazilian fire tree seedlings from low to moderate salinity levels. The PH reduction with the increment of salinity levels has been observed in many studies on salinity tests in reforestation seedlings, such as jatropha (Andréo-Souza et al., 2010; Matos et al., 2013) and acacia (Mezanur-Rahman et al., 2016).

The reduction of PH mean values along the DAG is evidenced at the end of the experiment, after 30, 45, and 50 DAG, for the treatments with the substrates sand, SB, and CS, respectively (Figure 1 A); and after 50 DAG, at salinity levels above 0.40 dS m^{-1} (Figure 1 B).

The interaction between factors (substrate x salinity) had a significant effect on SD only at 5 and 60 DAG (Figures 2 C and 2 D). Linear increase of SD in Brazilian fire tree seedlings cultivated in CS, with the increment ofn ECw levels at 5 DAG (Figure 2 C) may not be associated with the factor salinity, but with other environmental factors, such as sowing depth and seed vigor because, at 5 DAG only, salinity had not yet caused damages to the seedlings, as those in the substrates sand and SB. However, at 60 DAG, SD decreased with the increment of salinity levels in the three substrates, with a linear reduction for this parameter in CS and SB, and a quadratic reduction of it in plants cultivated



Means followed by equal letters do not differ significantly, by the Tukey´s test, at 5% probability. Vertical bars in the columns represent mean standard error. *, ** Regressions respectively significant at 5% and 1% probability. nsNonsignificant ($p > 0.05$). SB and CS: sugarcane bagasse, and commercial substrate, respectively.

Figure 2. Stem diameter (SD) (A, B, C, and D) of Brazilian fire tree (*Schizolobium parahyba*) cultivated in three types of substrate, irrigated using saline solutions at different levels of electrical conductivity (ECw), and in different days after germination (DAG). Ipameri, GO, Brazil, 2016.

in sand (Figure 2 D). In sand, plant SD was lower than that in plants in the other substrates, when the seedlings were subjected to salinity levels above 4.3 dS m^{-1}. This fact shows that CS and SB promote better conditions for seedling development of Brazilian fire tree subjected to high-salinity levels.

For the other DAG, the factor substrate led to significant difference ($p < 0.05$) for SD mean values until 40 DAG (Figure 2 A). Higher SD values were observed in seedlings cultivated in CS, while in the other substrates it showed no significant difference. Therefore, CS promoted a better initial development for the seedlings, as also observed for PH; the physical and chemical characteristics of this substrate are more favorable to seedling production, and the seedlings can be transplanted earlier than those cultivated in the substrates sand and SB.

The increment of ECw levels, irrespective of the substrate used, caused a linear reduction of SD from 10 to 45 DAG, and a quadratic reduction at 50 and 55 DAG (Figure 2 B). Such reduction can be explained by the action of the saline water, that caused osmotic stress, reduction of cell turgor, and reduction of the expansion capacity of the polysaccharide network (Tenhaken, 2015), resulting in the decrease of SD growth.

There was a significant interaction ($p < 0.05$) between factors (substrate x salinity) for NL at 30, 45, 50, 55, and 60 DAG (Figures 3 B to 3 F). Only for seedlings cultivated in CS, the reduction of NL with the increment of the irrigation water salinity is shown by significant regression models, as linear at 30 DAG (Figure 3 B) and quadratic for the other DAG that showed significant interaction (Figures 3 C to 3 F).

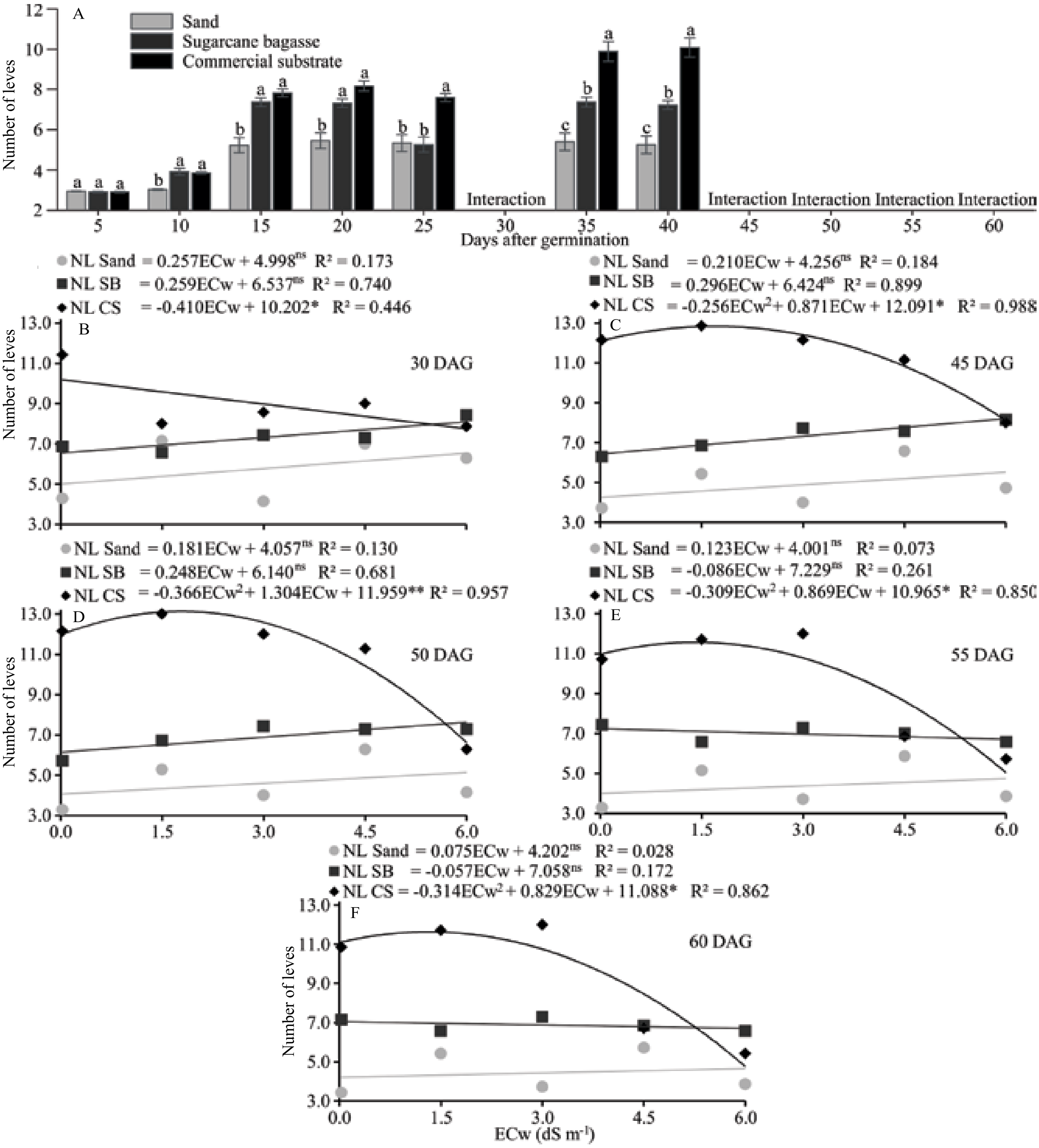
Maximum number of leaves (between 11 and 13 leaves) in seedlings cultivated in CS was observed at salinity levels around 1.5 dS m^{-1} at all DAG that showed interaction, except 30 DAG (Figures 3 B to 3 F). However, the CS, compared with the others, led to higher NL up to salinity levels between 4.5 and 6.0 dS m^{-1}, which evidences a higher resistance of the seedlings to salinity when cultivated in this type of substrate. In addition, seedlings cultivated in SB, although the regression analysis was not significant in any of the interactions, had higher NL at almost all salinity levels. These results indicate that the negative effect of saline irrigation is more intense on Brazilian fire tree seedlings in environments free from organic material (sand substrate). Presence of humic compounds promotes conditions for the plant to experience less stress, due to the improvement in soil physical properties, stimulus to root development and reduction in the osmotic potential inside the roots (Liang et al., 2005; Nunes et al., 2012).

On the days after emergence that showed interaction (from 5 to 45 DAG, except 30 DAG), the factor salinity did not interfere with NL, since the regression analysis was not significant. At these days, except for 5 DAG, only the factor substrate interfered significantly ($p < 0.05$), and the highest mean values were observed in seedlings cultivated in SB and CS until 20 DAG and in SB at the other days (Figure 3 A). This result confirms those observed for the other variables (Figures 1 and 2), in which CS led to better conditions for the development of Brazilian fire tree seedlings, regardless of the salinity levels.

There was a reduction in NL along the DAG, especially at the highest salinity levels (Figure 3). The reduction and fall of leaves after a certain period of seedling development results from substrate salinization, due to the accumulation of salts with the frequent irrigations in the treatments with saline water, which led to salt stress on the seedlings and possible inhibition in the formation of leaf primordia (Mezanur-Rahman et al., 2016).

Given the results presented in Figures 1 and 2, and Figure 3, the use of SB was not technically viable in the cultivation of Brazilian fire tree seedlings, compared with CS. However, its utilization under saline conditions should be better evaluated in future studies, using different proportions of this agroindustrial residue combined with other types of substrates, considering that sugarcane bagasse is a widely available material (Hofsetz & Silva, 2012), with relatively low cost.

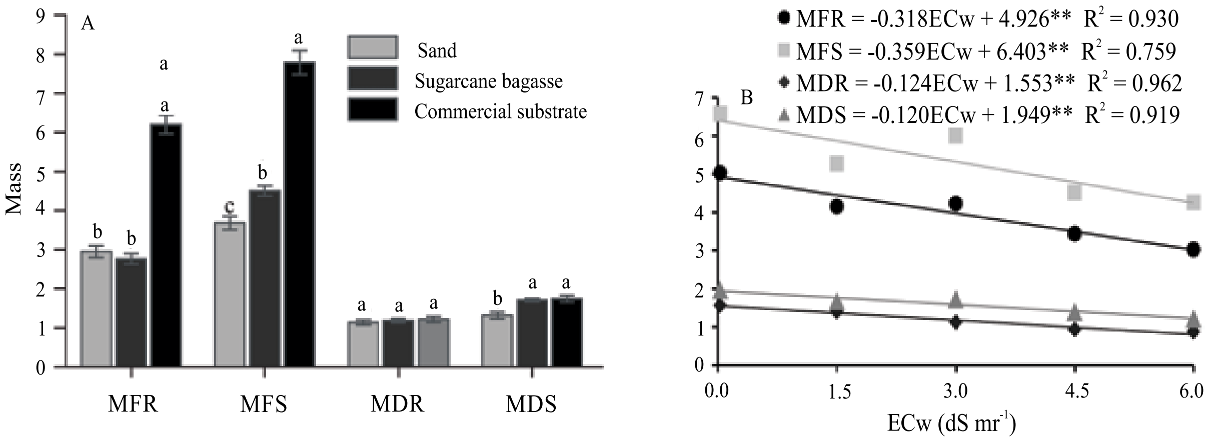
There was no significant interaction (p > 0.05) between both factors evaluated for the values of shoots and roots. However, the plant mass was significantly affected by the individual factors, except for the MDR, which was not significantly affected by the substrates (Figure 4).



Means followed by equal letters do not differ significantly, by the Tukey´s test, at 5% probability. Vertical bars in the columns represent mean standard error. *, **Regressions significant at 5% and 1% probability. nsNonsignificant (p > 0.05). SB and CS: sugarcane bagasse and commercial substrate, respectively.

Figure 3. Number of leaves (NL) (A, B, C, D, E and F) of Brazilian fire tree (*Schizolobium parahyba*) cultivated in three types of substrate, irrigated using saline solutions with different levels of electrical conductivity (ECw), and in different days after germination (DAG). Ipameri, GO, Brazil, 2016.

Cadernos de Ciência & Tecnologia, Brasília, v. 36, n. 3, e26520, 2019
DOI: 10.35977/0104-1096.cct2019.v36.26520



Means followed by equal letters do not differ significantly, by the Tukey´s test, at 5% probability. Vertical bars in the columns represent mean standard error. **Significant at 1% probability by the regression analysis. MFR, mass of fresh roots; MFS, mass of fresh shoots; MDR, mass of dry roots; MDS, mass of dry shoots.

Figure 4. Seedling mass of Brazilian fire tree (*Schizolobium parahyba*): A, cultivated in three types of substrate; and B, irrigated using saline solutions at different levels of electrical conductivity (ECw). Ipameri, GO, Brazil, 2016.

Seedlings of Brazilian fire tree cultivated in CS showed higher values of MFR, MFS, and MDS than those in other treatments, regardless of salinity levels, and this last variable did not differ significantly from that obtained in seedlings cultivated in SB (Figure 4 A). In addition, the MFS was significantly higher in SB than in sand. These results were expected because PH, SD, and NL were significantly higher when the seedlings were cultivated in CS (Figures 1, 2. and 3), in most of the evaluated days after germination. Higher values of fresh matter mass found in CS are mainly due to the greater water availability supplied to the seedlings by this substrate. However, higher values of dry matter mass, for shoots only, found in SB and CS, are due to the better nutritional conditions in these two substrates, compared with the sand.

The increment of salinity levels caused a linear mass reduction of shoots and roots (Figure 4 B). This fact show the effects of low-salinity levels on the seedling production of Brazilian fire tree. Higher fresh mass of seedlings in the treatment with commercial substrate is an indication of a higher--water retention and a consequent maintenance of leaf hydration. The differences for dry shoot mass indicate that seedlings produced in commercial substrate exhibit a higher growth and vigor, which are determinant for the Brazilian fire tree establishment in the field.

CONCLUSIONS

1) Seedlings of Brazilian fire tree (*Schizolobium parahyba*) are sensitive to salinity, and may even be classified as glycophytes because they undergo damage to the growth when treated with irrigation water at 1.5 dS m^{-1} electric conductivity.

2) Plants irrigated using water with electrical conductivity above 1.5 dS m^{-1} show reductions for the number of leaves, plant height, stem diameter, and mass of shoots and roots, which compromises their initial development.

3) The commercial substrate Terral Solo, compared with the substrates sugarcane bagasse and sand, promotes a better development of Brazilian fire tree seedlings, either with or without saline stress.

ACKNOWLEDGEMENTS

To Goiás State University (UEG), for providing all necessary structure to the execution of this research project and for buying the substrate; to the company Caramuru, for donating the sugarcane bagasse; and to the students linked to the Laboratory of Forest Products and Bioenergy of UEG – Campus Ipameri, for all the assistance during the analyses.

REFERENCES

ANDRÉO-SOUZA, Y.; PEREIRA, A.L.; SILVA, F.F.S. da; RIEBEIRO-REIS, R.C.; EVANGELISTA, M.R.V.; CASTRO, R.D. de; DANTAS, B.F. Efeito da salinidade na germinação de sementes e no crescimento inicial de mudas de pinhão-manso. **Revista Brasileira de Sementes**, v.32, p.83-92, 2010. DOI: https://doi.org/10.1590/S0101-31222010000200010.

BIANCHETTI, A.; RAMOS, A. Quebra de dormência de sementes de guapuruvu (*Schizolobium parahyba* (Vellozo) Blake). **Boletim de Pesquisa Florestal**, v.3, p.69-76, 1981.

CARDOSO, M.R.D.; MARCUZZO, F.F.N.; BARROS, J.R. Classificação climática de Köppen-Geiger para o Estado de Goiás e o Distrito Federal. **ACTA Geográfica**, v.8 p.40-55, 2014. DOI: https://doi.org/10.5654/acta.v8i16.1384.

CARVALHO, P.E.R. **Espécies arbóreas brasileiras**: recomendações silviculturais de espécies florestais. Brasília: Embrapa Informação Tecnológica; Colombo: Embrapa Florestas, 2003. v.1, 1039p.

CARVALHO, P.E.R. **Guapuruvu**. Colombo: Embrapa Florestas, 2005. 10p. (Embrapa Florestas. Circular técnica, 104).

CONEGLIAN, A.; RIBEIRO, P.H.P.; MELO, B.S.; PEREIRA, R.F.; DORNELES JUNIOR, J. Initial growth of *Schizolobium parahybae* in Brazilian Cerrado soil under liming and mineral fertilization. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.20, p.908-912, 2016. DOI: https://doi.org/10.1590/1807-1929/agriambi.v20n10p908-912.

GARCIA, E.A.; SOUZA, J.P. de. Avaliação da qualidade de mudas de *Schizolobium parahyba* em função de diferentes aplicações de adubos fosfatado. **Tekhne e Logos**, v.6 , p.51-59, 2015.

GARCIA, G. de O.; NAZÁRIO, A.A.; MORAES, W.B.; GONÇALVES, I.Z.; MADALÃO, J.C. Respostas de genótipos de feijoeiro à salinidade. **Engenharia na Agricultura**, v.18, p.330-338, 2010. DOI: https://doi.org/10.13083/reveng.v18i4.73.

GOMES, E.W.F.; WILLADINO, L.; MARTINS, L.S.S.; SILVA, S. de O. e; CÂMARA, T.R. Variabilidade genética de genótipos de bananeira (*Musa* spp.) submetidos ao estresse salino. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.9, p.171-177, 2005. DOI: https://doi.org/10.1590/S1415-43662005000200004.

GUERRINI, I.A; TRIGUEIRO, R.M. Atributos físicos e químicos de substratos compostos por biossólidos e casca de arroz carbonizada. **Revista Brasileira de Ciência do Solo**, v.28, p.1069-1076, 2004. DOI: https://doi.org/10.1590/S0100-06832004000600016.

HOFSETZ, K.; SILVA, M.A. Brazilian sugarcane bagasse: energy and non-energy consumption. **Biomass and Bioenergy**, v.46, p.564-573, 2012. DOI: https://doi.org/10.1016/j.biombioe.2012.06.038.

IBÁ. Indústria Brasileira de Árvores. [**Relatório IBÁ 2015**]. Brasília, 2015. 77p. Disponível em: <http://www.iba.org/images/shared/iba_2015.pdf>. Acesso em: 3 set. 2018.

IBÁ. Indústria Brasileira de Árvores. **Relatório 2017**. Brasília, 2017. 80p. Disponível em: <http://iba.org/images/shared/Biblioteca/IBA_RelatorioAnual2017.pdf>. Acesso em: 9 out. 2017.

LIANG, Y.; SI, J.; NIKOLIC, M.; PENG, Y.; CHEN, W.; JIANG, Y. Organic manure stimulates biological activity and barley growth in soil subject to secondary salinization. **Soil Biology & Biochemistry**, v.37, p.1185-1195, 2005. DOI: https://doi.org/10.1016/j.soilbio.2004.11.017.

LOCATELLI, M.; MELO, A.S.; LIMA, L.M.L. de; VIEIRA, A.H. Deficiências nutricionais em mudas de *Schizolobium parahyba* var. amazonicum. **Revista Brasileira de Biociências**, v.5, p.648-650, 2007. Supl. 2.

LOPES, J.C.; MACEDO, C.M.P. de. Germinação de sementes de couve chinesa sob influência do teor de água, substrato e estresse salino. **Revista Brasileira de Sementes**, v.30 p.79-85, 2008. DOI: https://doi.org/10.1590/S0101-31222008000300011.

MATOS, F.S.; OLIVEIRA, L.R. de; FREITAS, R.G. de; EVARISTO, A.B.; MISSIO, R.F.; CANO, M.A.O.; DIAS, L.A. dos S. Physiological characterization of leaf senescence of *Jatropha curcas* L. populations. **Biomass and Bioenergy**, v.45, p.57-64, 2012. DOI: https://doi.org/10.1016/j.biombioe.2012.05.012.

MATOS, F.S.; ROCHA, E.C.; CRUVINEL, C.K.L.; RIBEIRO, R.A.; RIBEIRO, R.P.; TINOCO, C.F. Desenvolvimento de mudas de pinhão-manso irrigadas com água salina. **Revista Brasileira de Ciência do Solo**, v.37, p.947-954, 2013.DOI: https://doi.org/10.1590/S0100-06832013000400012.

MEZANUR-RAHMAN, M.; ANAMUL-HAQUE, M.; ARAFAT-ISLAM-NIHAD, S.; MAHMUDUL-HASAN-AKAD, M.; RUHUL-AMIN-HOWLADER, M. Morpho-physiological response of *Acacia auriculiformis* as influenced by seawater induced salinity stress. **Forest Systems**, v.25, e071, 2016. DOI: https://doi.org/10.5424/fs/2016253-09386.

NERY, A.R.; RODRIGUES, L.N.; SILVA, M.B.R.; FERNANDES, P.D.; CHAVES, L.H.G.; DANTAS NETO, J.; GHEYI, H.R. Crescimento do pinhão-manso irrigado com águas salinas em ambiente protegido. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.13 p.551-558, 2009. DOI: https://doi.org/10.1590/S1415-43662009000500007.

NUNES, J.C.; CAVALCANTE, L.F.; LIMA NETO, A.J. de; REBEQUI, A.M.; DINIZ, B.L.M.T.; GHEYI, H.R. Comportamento de mudas de nim à salinidade da água em solo não salino com biofertilizante. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.16, p.1152-1158, 2012. DOI: https://doi.org/10.1590/S1415-43662012001100002.

OLIVEIRA, F. de A. de; ALVES, R. de C.; BEZERRA, F.M.S.; LIMA, L.A.; CAVALCANTE, A.L.G.; MEDEIROS, J.F. de. Interação entre a salinidade e bioestimulante no desenvolvimento inicial do pinhão-manso. **Irriga**, v.19, p.694-704, 2014. DOI: https://doi.org/10.15809/irriga.2014v19n4p694.

OLIVEIRA, I.R.S. de; OLIVEIRA, F.N. de; MEDEIROS, M.A. de; TORRES, S.B.; TEIXEIRA, F.J.V. Crescimento inicial de pinhão-manso (*Jatropha curcas* L.) em função da salinidade da água de irrigação. **Revista Caatinga**, v.23, p.40-45, 2010.

RIBEIRO, P.H.P. **Cultivo do girassol irrigado com água salina sob doses de nitrogênio**. 2013. 96p. Dissertação (Mestrado) - Universidade Federal de Campina Grande, Campina Grande.

RICHARDS, L.A. (Ed.). **Diagnosis and improvement of saline and alkali soils**. Washington: USDA, 1954. 160p. (Agricultural Handbook, nº 60).

SANTOS, H.G. dos; JACOMINE, P.K.T.; ANJOS, L.H.C. dos; OLIVEIRA, V.A. de; LUMBRERAS, J.F.; COELHO, M.R.; ALMEIRA, J.A. de; CUNHA, T.J.F.; OLIVEIRA, J.B. de. **Sistema brasileiro de classificação de solos**. 3.ed. rev. e ampl. Brasília: Embrapa, 2013. 353p.

SILVA, E.N. da; SILVEIRA, J.A.G.; RODRIGUES, C.R.F.; LIMA, C.S. de; VIÉGAS, R.A. Contribuição de solutos orgânicos e inorgânicos no ajustamento osmótico de pinhão-manso submetidos à salinidade. **Pesquisa Agropecuária Brasileira**, v.44, p.437-445, 2009. DOI: https://doi.org/10.1590/S0100-204X2009000500002.

SILVA, F. de A.S. e; AZEVEDO, C.A.V. de. The Assistat Software Version 7.7 and its use in the analysis of experimental data. **African Journal of Agricultural Research**, v.11, p.3733-3740, 2016. DOI: https://doi.org/10.5897/AJAR2016.11522.

SOUZA, B.R. de; FREITAS, I.A.S.; LOPES, V. de A.; ROSA, V. do R.; MATOS, F.S. Growth of *Eucalyptus* plants irrigated with saline water. **African Journal of Agricultural Research**, v.10 p.1091-1096, 2015. DOI: https://doi.org/10.5897/AJAR2014.9087.

TAIZ, L.; ZEIGER, E. **Fisiologia vegetal**. 5.ed. Porto Alegre: Artmed, 2013. 890p.

TENHAKEN, R. Cell wall remodeling under abiotic stress. **Frontiers in Plant Science**, v.5, art.771, 2015. DOI: https://doi.org/10.3389/fpls.2014.00771.

VALE, L.S.; SEVERINO, L.S.; BELTRÃO, N.E. de M. Efeito da salinidade da água sobre o pinhão-manso. In: CONGRESSO DA REDE BRASILEIRA DE TECNOLOGIA DO BIODIESEL, 1., 2006, Brasília. **Anais**. Brasília: IBPS, 2006. p.87-90.