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RESEARCH ARTICLE

Salt tolerance of Soft and Hard jackfruit varieties in the seedling stage

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ABSTRACT

The formation of seedlings is an essential step in fruit plant development, playing a fundamental role in successful orchard implantations. This study aimed to evaluate the salinity tolerance through irrigation water in jackfruit varieties at the seedling stage. The study was carried out at the Centro de Ciências Agrárias of the Universidade Federal da Paraíba, Areia, Paraíba, Brazil. The treatments were distributed in randomized blocks, in a 5 × 2 factorial scheme with four replications and three plants per plot, totaling 40 experimental plots and 120 plants to be evaluated. At 85 days after sowing, the plants were collected and separated into root, stem, and leaves and dried to obtain dry matter. The leaf area was measured using the LAI-model 2200 equipment, from which the specific leaf area and leaf area ratio was calculated. Dickson's quality index was calculated with data on the root, shoot and total dry matter, seedling height, and stem diameter. The results of the study showed that the increase in water salinity reduced the leaf area and inhibited plant biomass formation, negatively affecting the quality of the seedlings, especially in the hard jackfruit variety. Seedlings of the Jackfruit soft variety were tolerant to the salinity level of 3.0 dS m^{-1}, whereas the hard variety was tolerant until up to 2.0 dS m^{-1}. In conclusion, the soft jackfruit variety is more tolerant to the salinity of irrigation water than the hard variety.

Keywords: *Artocarpus heterophyllus*; Early growth genetic variability; Salt stress

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus*) is a fruit species cultivated in tropical regions of South Asia, Africa, and America, mainly in Brazil (Khan et al., 2021; Wangchu et al., 2013). It was first introduced in Brazil by Portuguese settlers in the 15th century and is currently present in all country regions (Costa et al., 2013; Madruga et al., 2014). However, most of the jackfruit fruits commercialized in Brazil come from extractive activities due to the lack of technical-scientific knowledge on cultural and commercial management of this species (Oliveira et al., 2018).

This fruit species has significant variability and pulp consistency rich in fiber, calcium, phosphorus, iron, and B-complex vitamins, mainly riboflavins and niacin (Madruga et al., 2014). Jackfruit is classified as a 'hard' and 'soft' variety, referring to larger fruits with firm pulp (hard variety) and smaller fruits with a softer, sweeter pulp (soft variety) (Costa et al., 2013).

The seedling formation is an essential step in fruit species cultivation, playing a fundamental role in successful orchard implantations (Oliveira et al., 2018; Mesquita et al., 2020). In semiarid regions, water scarcity is one of the limiting factors for plant growth and the obtaining of good quality seedlings (Oliveira et al., 2017). In these areas, precipitation occurs in low volume and is concentrated in few months of the year. In addition, due to specific soil formation characteristics, many sources of water used in irrigation have high levels of soluble salts (Leal et al., 2019).

Under salinity stress, plants have reduced water uptake capacity, resulting in low nutrient absorption and nutritional imbalance (Guimarães et al., 2013; Ahmadi and Souri, 2018; Wani et al., 2020). In conditions of prolonged stress, plants absorb toxic ions, mainly sodium and chlorine, causing

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visual toxicity symptoms of chlorosis and leaf necrosis (Ashraf and Orooj, 2006; Acosta-Motos et al., 2017; Machado and Serralheiro, 2017). Under these conditions, fruit species have their growth and yield compromised (Bonifácio et al., 2018). Despite the adverse effects of salinity on plants, there is scientific evidence of genetic variability of species in lower or higher tolerance to salinity due to morphophysiological defense mechanisms (Ayers and Westcot, 1999; Freitas et al., 2014).

Some studies were carried out with jackfruit seedlings irrigated with brackish water, but only evaluating the effect of saline stress attenuators. When irrigating jackfruit var. Soft with water up to 4.0 dS m^{-1}, Oliveira et al., (2017) and Oliveira et al., (2018) found marked reductions in growth, biomass accumulation and seedling quality, but with less intensity when urea was applied as a saline stress attenuator. Similar behaviors were observed by Mesquita et al., (2019) and Mesquita et al., (2020), when they concluded that irrigation with brackish water (4.0 dS m^{-1}) reduced the quality of jackfruit seedlings (var. Mole and var. Hard), however the application of bovine biofertilizer reduced the degenerative effects of salts under the plants.

The salinity tolerance of varieties of the same species changes according to phenological age, exposure time, climate, and environmental conditions (Parihar et al., 2015; Sheldon et al., 2017; Ouda et al., 2018). Quantitatively, the tolerance of plant species to salinity is evaluated, in relative terms, between the absolute values of productivity and/or biomass between plants grown in saline and non-saline conditions, being classified as salt sensitive, moderately sensitive, moderately tolerant, and tolerant (Maas and Hoffman, 1977; Fageria, 1985; Ayers and Westcot, 1999).

The seedling quality loss of fruit species irrigated with saline water, and the proven variability of varieties within the same species towards salt stress, may indicate the selection of promising jackfruit materials for cultivation in salinized areas. Therefore, this study aimed to evaluate the salinity tolerance of jackfruit seedlings varieties irrigated with saline water.

MATERIAL AND METHODS

The experiment was carried out from June to September of 2014, in a protected seedling nursery at the Departamento de Solos e Engenharia Rural (DSER), Centro de Ciências Agrárias (CCA) of the Universidade Federal da Paraíba (UFPB), Areia, Paraíba, Brazil. The area is located in the Microregion of the Brejo Paraibano by the geographic coordinates: 6º58'12" S and 35º42'15" W, 619 m altitude. The climate region is classified as As' type according to Köppen's classification, characterized by a tropical climate with dry summers and rains concentrated in the autumn (Alvares et al., 2013). Average temperature and average relative humidity of 25 ºC and 75% respectively in the warmest months (October, November, and December) and 21.6 ºC and 87% in the coldest months (June, July, and August).

The treatments were distributed in randomized block experimental design, in a 5 × 2 factorial scheme, with four replications and three plants per plot. The sources of variation were the electrical conductivities of irrigation water (ECiw) of 0.3; 1.0; 2.0; 3.0, and 4.0 dS m^{-1} and the two jackfruit seedlings varieties (var.), with a total of 40 experimental plots and 120 plants for evaluation (Fig. 1).

The substrate was composed of soil collected in the first 0.2 m depth. After collection, samples were shade-dried, sieved in a 2 mm mesh, and characterized for physicochemical (Texeira et al., 2017) and salinity attributes (Richards, 1954), as shown in table 1. The soil is classified as Red Yellow Latosol with sandy-clay loam texture (Santos et al., 2018).

Pots of 2 dm^3 capacity were filled with a 2 cm layer of coarse gravel followed by 2 cm of washed sand, covered with a mesh sheet to prevent substrate losses and drainage of possible water volume above the maximum required during irrigations. Then, the pots were filled with a mixture of 1.5 dm^3 of soil and the mineral fertilizer NPK (100, 300, 150 mg kg^{-1} of soil): N (urea - 45% N), P_2O_5 (simple superphosphate - 20% P_2O_5, 20% Ca^{2+} and 12% S) and K_2O (potassium chloride – 60% K_2O), as recommended by Novais et al., (1991).

Seeds of the hard and soft jackfruit varieties were selected based on full physiological maturation, size, and fruit mass, from trees located in Areia county, located in the Microregion of the Brejo Paraibano, Paraíba - Brazil. The

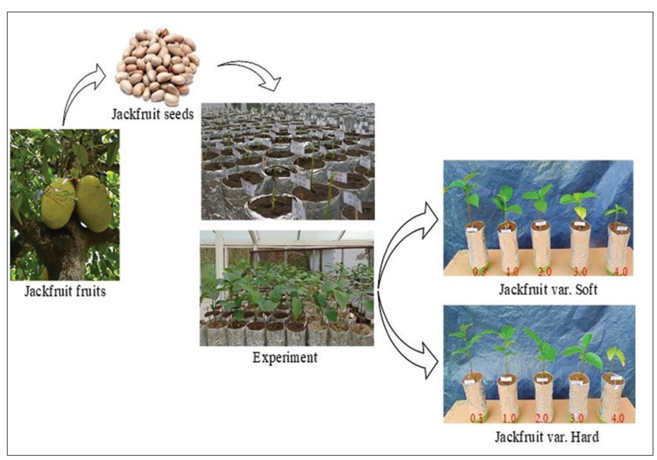

Fig 1. General diagram of the experiment

Table 1: Physicochemical and saline attributes of the soil used as the substrate

Fertility	Value	Physical	Value	Salinity	Value
pH in water (1:2.5)	4.90	Sd (g cm^{-3})	1.11	pHps	5.06
P (mg dm^{-3})	13.50	Pd (g cm^{-3})	2.67	ECs (dS m^{-1})	0.17
K^+ ($cmol_c$ dm^{-3})	0.12	Tp (%)	0.58	K^+ ($mmol_c$ L^{-1})	0.36
Ca^{2+} ($cmol_c$ dm^{-3})	1.58	Sand (g kg^{-1})	552	Ca^{2+} ($mmol_c$ L^{-1})	0.32
Mg^{2+} ($cmol_c$ dm^{-3})	2.36	Silt (g kg^{-1})	101	Mg^{2+} ($mmol_c$ L^{-1})	0.29
Na^+ ($cmol_c$ dm^{-3})	0.09	Clay (g kg^{-1})	347	Na^+ ($mmol_c$ L^{-1})	0.69
SB ($cmol_c$ dm^{-3})	4.15	Cdw (g kg^{-1})	52	SC ($mmol_c$ L^{-1})	1.66
H^+ + Al^{3+} ($cmol_c$ dm^{-3})	7.83	FD (%)	85	Cl^- ($mmol_c$ L^{-1})	1.36
Al^{3+} ($cmol_c$ dm^{-3})	0.80	SDi (%)	15	CO_3^{2-}($mmol_c$ L^{-1})	0.00
CTC ($cmol_c$ dm^{-3})	11.98	SMfc (g kg^{-1})	23	HCO_3^- ($mmol_c$ L^{-1})	0.18
PES (%)	0.75	SMpw (g kg^{-1})	15	SO_4^{2-} ($mmol_c$ L^{-1})	0.22
V (%)	34.64	Aw (g kg^{-1})	8	SA ($mmol_c$ L^{-1})	1.76
OM (g dm^{-3})	17.00	----	---	PES (%)	0.75
Classification	Dystrophic	Class	FAA	Classification	NS

SB = Sum of exchangeable bases (Ca^{2+} + Mg^{2+} + K^+ + Na^+); CTC = Cation Exchange Capacity [SB + (H^+ + Al^{3+})]; PES = Percent exchangeable sodium [(Na+/CTC) × 100]; V = Percentage of soil saturation by exchangeable bases; OM = Organic matter; Sd = Soil density; Pd = Particle Density; Tp= total porosity; Cdw= Clay dissolved in water; FD = Flocculation degree; SDi = soil dispersion index; SMfc = Soil moisture at field capacity (voltage -0.033 Mpa); SMpw = Soil moisture at permanent wilting point (tension -1.500 Mpa); Adi = Available water; FAA = sandy clay loam; Ps = Saturated paste; ECes = electrical conductivity of the saturation extract; SC = Sum of cations; SA = Sum of anions; SAR= Sodium Adsorption Ratio {Na+/[(Ca^{2+}+Mg^{2+})/2]$^{1/2}$}; NS = Not saline.

varieties are distinguished by the production of fruits with hard pulp (var. Hard) and soft pulp (var. Soft), as described by Bezerra et al., (2013). One seed per pot was sown, with seedling emergence starting at 18 DAS and germination stabilization at 31 DAS.

The non-saline water (0.3 dS m^{-1}), used as the control treatment, was provided from the local supply. The remaining treatments were obtained by diluting a saline stock solution of 10.0 dS m^{-1}, prepared by dissolution of sodium chloride [NaCl], calcium chloride [$CaCl_2.2H_2O$], magnesium chloride [$MgCl_2.6H_2O$], and potassium chloride [KCl] in a ratio of 6:2:1:1 in non-saline water (0.3 dS m^{-1}) until reaching the pre-established electrical conductivity. The digital conductivity meter model CDR-860 Instrutherm® was used to adjust the concentrations.

The seedlings were irrigated daily by measuring the evapotranspiration of each pot on a semi-analytical scale, replacing the volume of water every 24 h to maintain the substrate with field capacity moisture level. Considering that the soil moisture was held as close as possible to the field capacity level, the washing fraction was not applied to avoid losses by leaching, mainly of nitrogen and potassium (Fagundes et al., 2015).

The jackfruit seedlings of each treatment were collected at 85 DAS and separated into root and shoot, placed in paper bags, and dried in an oven with air circulation at 65 ºC for a period of 72 h until they reach constant weight. The root (RDM), shoot (MSPA), and total dry matter (MST) were weighed on an analytical scale. Before drying, the leaves were detached and determined the leaf area with the LAI-model 2200 equipment. From the leaf area, the specific leaf area (SLA) and leaf area ratio (LAR), according to the methodology described by Benincasa (2003). Dickson's quality index (DQI) was obtained using the values of the root, shoot and total dry matter, according by Dickson et al., (1960)

The coefficients between leaf area, dry matter of roots, shoot, total, and Dickson quality index under each salinity (1.0; 2.0; 3.0 and 4.0 dS m^{-1}) compared to the control (0.3 dS m^{-1}) was used to assess the salt tolerance based on the genotypes classification on salt tolerance according to dry matter reduction (Fageria, 1985) (Table 2).

Data were submitted to analysis of variance by the F test. The Tukey test ($p < 0.05$) compared the means between the jackfruit varieties, and polynomial regression ($p < 0.05$) was performed to analyze the variables under salinity levels. The statistical software SISVAR 5.6 (Ferreira, 2014) was used.

RESULTS AND DISCUSSION

As observed by the analysis of variance (Table 3), the interaction between the varieties and the salinity levels influenced the leaf area, leaf area ratio, shoot dry matter, total dry matter, and Dickson quality index. The varieties had significant effects on the specific leaf area, while the water salinity affected the root dry matter of the seedlings. The RDM/SDM ratio did not respond to the application of treatments and had a mean value of 0.54.

Oliveira et al., (2017) observed significant effects of irrigation water salinity in jackfruit seedlings var. Soft in the initial growth of plants submitted to saline water irrigation and nitrogen fertilization. The authors concluded that although irrigation with high salinity water (4.0 dS m^{-1})

reduced the quality of jackfruit seedlings, they were suitable for field planting. In jackfruit var. soft, Mesquita et al., (2020) found a significant effect for irrigation water salinity and the application of bovine biofertilizer on seedling growth and quality variables and concluded that water salinity reduces plant growth, but with less intensity in the substrate with the organic input.

The leaf area of jackfruit seedlings responded differently to the salinity increase, and the var. Soft presented greater tolerance (Fig. 2). The leaf area of the var. Soft seedlings were stimulated up the salinity of 1.76 dS m^{-1} (253.1 cm^2), with reductions above this level. Conversely, in seedlings of the hard variety, the leaf area linearly reduced from 214.6 to 141.2 cm^2 among seedlings irrigated with lower and higher salinity water, resulting in losses of 34.2%.

When the leaf area was compared between the varieties, the var. Soft had an increment of 18.1%, even when irrigated with saline water of 1.76 dS m^{-1}. The reduction in leaf area in plants irrigated with strongly saline water (4.0 dS m^{-1}), mainly in the hard variety, reflects the adverse effects of salinity on cell division and elongation, which reduces leaf expansion and light interception used for photoassimilates synthesis (Parihar et al., 2015; Machado and Serralheiro, 2017). Reductions in leaf area of jackfruit seedlings in the var. Soft under saline irrigation water was also reported by Oliveira et al., (2017) and for both varieties by Mesquita et al., (2019).

Table 2: Classification of genotypes according to salt tolerance, based on the dry matter or yield reduction

Dry matter reduction (%)	Classification
0 – 20	Tolerant
21 – 40	Moderately tolerant
41 – 60	Moderately sensitive
> 60	Sensitive

Data were submitted to analysis of variance by the F test. The Tukey test ($p < 0.05$) compared the means between the jackfruit varieties, and polynomial regression ($p < 0.05$) was performed to analyze the variables under salinity levels. The statistical software SISVAR 5.6 (Ferreira, 2014) was used.

The specific leaf area of var. Soft seedlings were 4.97% greater when compared to the var. hard seedlings (Fig. 3). The reduction of SLA in the hard variety is an indication of greater salt tolerance. Lower SLA values represent greater leaf thickness, contributing to lower water losses, allowing a more favorable response to low osmotic potential in the soil (Romero-Munar et al., 2017; Maia Júnior et al., 2019).

When plants are submitted to salt stress, their leaf expansion is compromised, reducing leaf area available for photosynthesis, with accentuated stress effects under prolonged periods (Acosta-Motos et al., 2017; Ouda et al., 2018). In addition, the absorption of toxic ions, especially chloride and sodium, compromises the synthesis and translocation of hormones between roots and shoots, resulting in reduced leaf area, since these are essential for cell metabolism and, consequently, reduced plant dry matter (Parihar et al., 2015; Machado and Serralheiro, 2017; Sheldon et al., 2017). This also reduces specific leaf area, in addition to inhibition of root system growth, delay in apical buds emission, chlorosis, and leaf edges necrosis (Bonifácio et al., 2018; Wani et al., 2020).

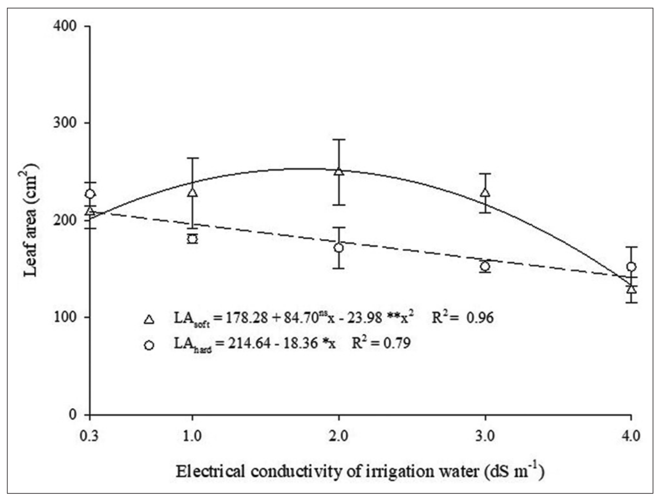

Fig 2. The leaf area of jackfruit seedlings var. Soft (—) and var. Hard (- -) irrigated with saline water

Table 3: Summary of the analysis of variance, by mean square values for leaf area (LA), specific leaf area (SLA), leaf area ratio (LAR), root dry matter (RDM), shoot dry matter (SDM), total dry matter (TDM), root and shoot dry matter ratio (RDM/SDM) and Dickson quality index (IQD) in jackfruit seedlings (V) irrigated with saline water (A)

SV	DF	Mean Square							DQI
		LA	SLA	LAR	RDM	SDM	TDM	RDM/SDM	
Block	3	66849.6^{ns}	8242.9^{ns}	12379.2^{ns}	3.45^{ns}	2.34^{ns}	11.64^{ns}	0.35^{ns}	0.91^{ns}
Var (V)	1	1652747.7**	264306.3*	53100.3*	0.48^{ns}	11.66^{ns}	7.48^{ns}	0.46^{ns}	2.65^{ns}
Wa (W)	4	1169077.2**	50857.6^{ns}	58309.1**	80.66**	241.6**	598.37**	1.16^{ns}	19.64**
V × W	4	515435.9**	91949.1^{ns}	31328.9*	15.74^{ns}	20.41*	67.95**	2.65^{ns}	3.82*
Residue	27	90209.7	38936.9	5492.4	6.16	5.92	14.54	2.25	1.13
Total	39	-	-	-	-	-	-	-	-
CV (%)	-	16.45	12.72	11.02	24.54	13.15	13.33	27.62	19.22
Mean	-	182.57	155.15	67.25	1.02	1.85	2.86	0.54	0.55

**, * and ^{ns} - significant at 1 and 5% probability and not significant by the F test, respectively; SV - Source of variation; DF - Degree of freedom; CV - Coefficient of variation.

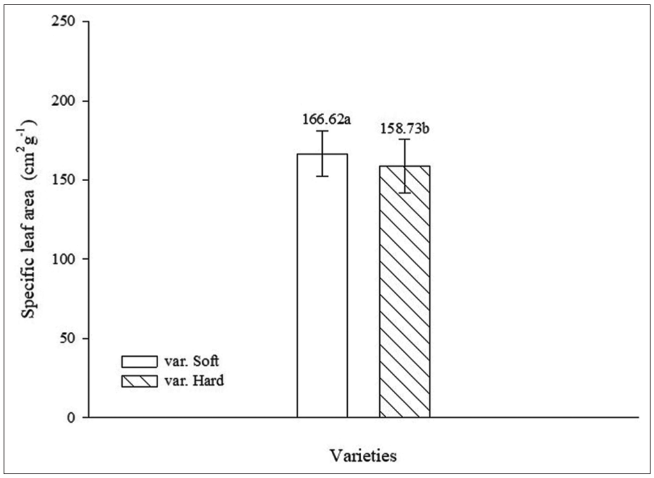

Fig 3. Specific leaf area of jackfruit seedlings varieties

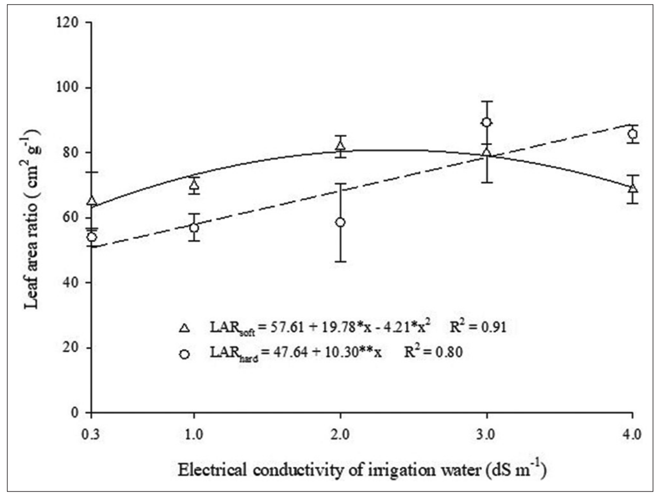

Fig 4. Leaf area ratio of jackfruit seedlings of the var. Soft (—) and var. Hard (- -) irrigated with saline water

The LAR of jackfruit seedlings was high regardless of the genetic material, with higher values for var. Hard (Fig. 4). In the var. Soft, the LAR increased from 57.61 in non-saline water to 80.84 cm^2 g^{-1} in ECiw of 2.34 dS m^{-1}. Whereas in the var. Hard, the leaf area ratio linearly increased from 47.64 to 88.84 cm^2 g^{-1} when increasing the water salinity from 0.3 to 4.0 dS m^{-1}. When these values were compared, it is verified that the higher water salinity increased the leaf area ratio of jackfruit seedlings var. hard by 86.5%.

Despite the higher values observed in the var. Hard irrigated with lower and higher saline water when the LAR mean values were evaluated in the other electrical conductivities, a relative increment of 10.4% in the soft variety was obtained. The lowest LAR values were observed in jackfruit var. Soft under higher saline indicates greater photosynthetic efficiency than the var. Hard since there was greater efficiency use of the photosynthetically active leaf area in the biomass synthesis under these conditions (Freitas et al., 2014; Bonifácio et al., 2018).

The salinity increase linearly inhibited the root biomass of the jackfruit seedlings (Fig. 5). The RDM reduced from 1.31 to 0.72 g among plants irrigated with the lowest and highest saline water, representing a 45% reduction. Frequent irrigation with saline water leads to increased substrate salinity, increasing the osmotic pressure at the root-soil interface, compromising the expansion of the root cell wall (Richards, 1954; Acosta-Motos et al., 2017; Machado and Serralheiro, 2017).

The salinity-plant system relationship starts with the roots, considered the most salt-sensitive organs due to the high metabolic activity required to adjust salt excess in the soil or irrigation water (Guimarães et al., 2013). Under saline stress conditions, generally, the accumulation of root biomass is reduced due to the inhibition of root growth

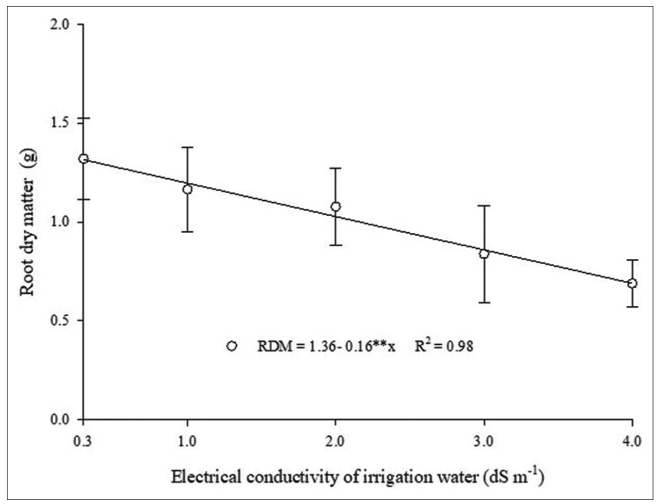

Fig 5. Root dry matter of jackfruit seedlings irrigated with saline water

and the number of secondary roots (Sharif et al., 2019). Similar results were obtained by Oliveira et al., (2018), with reduced root dry matter production in jackfruit seedlings irrigated with saline water.

The salinity increase also reduced the SDM and TDM, with more significant reductions in the var. Hard (Fig. 6). Irrigation with water up to 1.1 and 0.9 dS m $^{-1}$ promoted SDM (2.19 g) and TDM (3.30 g) accumulation in the var. Soft. Under higher salinity, the plants reduced the dry matter due to salt stress (Figure 5A and 5B). The SDM and TDM of the var. Hard linearly reduced from 2.54 to 1.22 g and from 4.04 to 1.92 g, respectively. These reductions represent losses of 52% when compared to plants irrigated with no saline water (Figure 5A and 5B).

The reduction in plant dry matter under salt stress is mainly due to the nutritional imbalance caused by high levels of sodium and chloride in the irrigation water in the root zone,

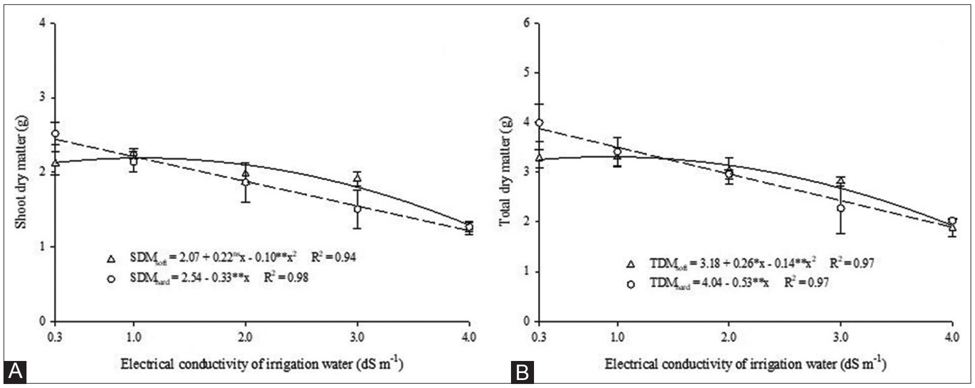

Fig 6. Shoot (A) and total (B) dry matter of seedlings of the soft (—) and hard (- -) jackfruit varieties irrigated with saline water

impairing uptake of essential nutrients, such as potassium and phosphorus (Ahmadi and Souri, 2018; Wani et al., 2020). In addition, excessive sodium and chlorine uptake by plants cause toxicity and visual symptoms, chlorophyll degradation, adverse metabolic changes, and photosynthetic activity (Machado and Serralheiro, 2017; Geilfus, 2018), which reduces the biomass accumulation by the plants.

Similar results were obtained by Oliveira et al., (2018) when the authors verified that the dry matter of seedlings of the soft variety increased under an ECiw of 1.0 dS m^{-1} and reduced under higher salinity levels. In jackfruit seedlings irrigated with water of up to 4.0 dS m^{-1}, the total dry matter of the plants reduced as the salinity increased (Mesquita et al., 2020).

The shoot and total dry matter had more significant reductions than the roots, indicating more sensitivity to salinity. This also indicates that the shoot dry matter is the most suitable parameter for salt tolerance classification in jackfruit seedlings.

According to the Dickson quality index, the salinity increase of the irrigation water affected the quality of the jackfruit seedlings (Fig. 7). The water salinity increase from 0.3 to 4.0 dS m^{-1} reduced the DQI values of seedlings from 0.62 to 0.40 in var. Soft and from 0.79 to 0.38 in var. Hard. These reductions represent 37.5 and 53.6% losses in the two varieties, respectively. The var. Hard seedlings had more significant losses in the DQI parameter under conditions of high salinity.

High DQI values indicate that the robustness and distribution of plant biomass is adequate, increasing the possibility of seedlings surviving in the field after transplanting (Bonifácio et al., 2018). Saline irrigation water is one of the main causes of quality loss in seedlings (Oliveira et al., 2017) due to osmotic, toxic, and/or nutritional effects caused by salt stress, limiting vital processes, such as nitrogen assimilation and protein metabolism (Parihar et al., 2015; Ahmadi and Souri, 2018;).

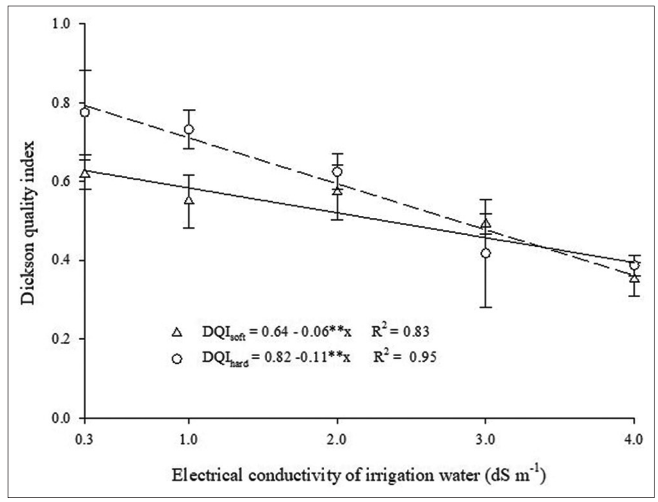

Fig 7. Dickson quality index of jackfruit var. Soft (—) and var. Hard seedlings (- -) irrigated with saline water

There is scarce information in the literature about jackfruit seedlings with no DQI value of reference. However, the observed values are in agreement with Oliveira et al., (2017) and Mesquita et al., (2019), ranging from 0.40 to 0.64 and 0.21 to 0.79, respectively, in jackfruit seedlings irrigated with saline water up to 4.0 dS m^{-1}, indicating the possibility jackfruit seedlings production of quality using water with high salt content.

According to the salt tolerance classification (Table 4), var. Soft seedlings irrigated with salinity water up to 3.0 dS m^{-1} presented less than 21% reduction than the control treatment, therefore classified as tolerant. However, when irrigated with ECiw of 4.0 dS m^{-1}, they presented reductions of 41 to 51%, considered moderately sensitive, except for the leaf area, which reduction was 36%, placing it as moderately tolerant.

The jackfruit seedlings from var. Hard had more significant reductions in the variables evaluated, especially above the ECiw of 2.0 dS m^{-1}, being classified as moderately sensitive to salinity. The most significant relative reduction was

Table 4: Salt tolerance of two jackfruit varieties irrigated with saline water, based on the percentage of leaf area, root dry matter, shoot dry matter, total dry matter, and Dickson quality index reductions

Variety	Percentage of reduction compared to control (ECiw 0.3 dS m^{-1})				
	0.3 dS m^{-1}	1.0 dS m^{-1}	2.0 dS m^{-1}	3.0 dS m^{-1}	4.0 dS m^{-1}
			Leaf area		
Soft	Control	0^{T}	0^{T}	0^{T}	36^{MT}
Hard	Control	6^{T}	24^{MT}	49^{MS}	44^{MT}
			Root dry matter		
Soft	Control	6^{T}	10^{T}	17^{T}	42^{MS}
Hard	Control	0^{T}	16^{T}	54^{MS}	68^{S}
			Shoot dry matter		
Soft	Control	0^{T}	13^{T}	18^{T}	51^{MS}
Hard	Control	0^{T}	21^{MT}	49^{MS}	58^{MS}
			Total dry matter		
Soft	Control	2^{T}	12^{T}	17^{T}	48^{MS}
Hard	Control	0^{T}	19^{T}	51^{MS}	62^{S}
			Dickson quality index		
Soft	Control	6^{T}	14^{T}	20^{T}	41^{MS}
Hard	Control	0^{T}	7^{T}	49^{MS}	59^{MS}

T - Tolerant; MT - Moderately Tolerant; MS - Moderately Sensitive; S - Sensitive

observed in root dry matter of seedlings of the var. Hard, with 54 and 68% reduction when irrigated with water of 3.0 and 4.0 dS m^{-1}, respectively. These reductions are probably due to high Na^{+} and Cl^{-} ions accumulation in the roots (Ashraf and Orooj, 2006, Geilfus, 2018). These are the most salt-sensitive plant organs due to the high metabolic activity required to adjust the salt excess in the soil solution (Guimarães et al., 2013; Sharif et al., 2019).

CONCLUSIONS

The increase in water salinity up to 4.0 dS m^{-1} reduces the leaf area, inhibits the plant biomass accumulation, and negatively affects the quality of jackfruit seedlings, especially in the var. Hard. The root dry matter accumulation of jackfruit seedlings is negatively affected when irrigated with saline water. The jackfruit var. Soft is more tolerant, withstanding salinity until up to 3.0 dS m^{-1}, whereas the var. Hard is tolerant until up to 2.0 dS m^{-1}.

AUTHOR CONTRIBUTIONS

Francisco Ítalo Fernandes de Oliveira: Conducting the experiment, tabulating data and writing the manuscript; Antônio Gustavo de Luna Souto: Statistical analysis, experiment conduction and manuscript correction; Lourival Ferreira Cavalcante: Project coordinator, conducting the experiment and reviewing the manuscript; Flaviano Fernandes de Oliveira: Conducting the experiment and tabulating data; José Adeilson Medeiros do Nascimento: Correction of the manuscript and data analysis; Francisco Thiago Coelho Bezerra: Conducting the experiment and reviewing the manuscript; Ítalo Herbert Lucena Cavalvante: Data analysis and review of the English language.

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