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Attenuating use of biofertilizers and saline waters in jackfruit seedlings biomass

Uso atenuador de biofertilizantes e águas salinas na biomassa de mudas de jaqueiras

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ABSTRACT

The salinity is one of the agriculture main obstacles worldwide, limiting plant growth and development. However, the use of biofertilizers can be a viable alternative to mitigate the effect of salinity. In this way, the aim of this study was to evaluate the effect of irrigation water salinity on two jackfruit varieties seedlings formation under the application of common and enriched bovine biofertilizers, respectively. In that sense, an experiment was carried out in a greenhouse in the period of october/2016 to february/2017, in the Federal University of Paraiba (FUPB), in the county of Areia, Paraiba state, Brazil. The substrate was collected from the 10 cm depht of a Distrophic Regolithic Neossol. The experimental design was completely randomized (DCR), in factorial scheme 5x3x2, with three replications, referring to the electrical conductivity levels of the irrigation water (0.5; 1.0; 2.0; 3.0 and 4.0 dS m^{-1}), two types of biofertilizer (common biofertilizer; enriched biofertilizer; absence of biofertilizer) and two jackfruit varieties (soft and hard jackfruit), packed in black polyethylene bags with a maximum capacity of 3.0 kg, totaling 90 treatments. The biofertilizer was diluted in non-saline water in the proportion of 1:3, it was applied only once to 10% of the volume of substrate, days two before sowing. The studied variables were - leaf area (LR); root area (RA); root diameter (RD); biomass allocation (BA); root dry mass (RDM); dry mass of aerial (AP) part and total dry mass (TDM). Biofertilizers did not inhibit but positively attenuate the harmful effects of excessive salt content in the irrigation water on jackfruit phytomass production. The growth and development of the jacfruits seedlings was positively expressed in the treatments with rich and common biofertilizer, respectively.

Key-words: *Artocarpus heterophyllus. Artocarpus brasiliensis,* organic input, salinization, varieties.

RESUMO

A salinidade é um dos principais entraves em todo mundo, constituindo-se num dos fatores limitantes ao crescimento e desenvolvimento das plantas. No entanto, o uso de biofertilizantes pode ser uma alternativa viável para mitigar o efeito da salinidade. Deste modo, objetivo deste estudo foi avaliar os efeitos da salinidade da água de irrigação sobre a formação de duas variedades de jacas com a utilização de biofertilizantes bovinos comum e enriquecido, respectivamente. Nesse sentido, um experimento foi desenvolvido em casa de vegetação no período de outubro de 2016 a fevereiro de 2017, na Universidade Federal da Paraíba – UFPB, município de Areia-PB, Estado da Paraíba, Brasil. O substrato foi material dos primeiros 10 cm de um Neossolo Regolítico distrófico. O delineamento experimental foi inteiramente casualizado (DIC), no esquema fatorial 5x2x2, com três repetições, referentes aos valores de condutividade elétrica da água de irrigação: 0,5; 1,0; 2,0; 3,0 e 4,0 dS m^{-1}, com dois tipos de biofertilizantes (Biofertilizante comum, enriquecido quimicamente e sem uso de bio) e dois tipos de variedades de jaqueiras (jaca-mole e jaca-dura, respectivamente), acondicionados em sacos de polietileno preto com a capacidade máxima de 3,0 kg, totalizando 90 tratamentos. O biofertilizante foi diluído em água não-salina na razão de 1:3, foi aplicado uma única vez a 10% do volume do substrato, dois dias antes da semeadura. As variáveis estudadas foram: área foliar (AF), área radicular (AR), diâmetro de raiz (DR), alocação de biomassa (AB), biomassa seca de raiz (BSR), matéria seca da parte aérea (MSPA) e matéria seca total (MST). O biofertilizante não inibiu mas atenuou positivamente os efeitos degenerativos do excesso de sais presente na água de irrigação sobre a produção de fitomassa de jaqueiras. O crescimento e desenvolvimento das mudas de jaqueiras se expressou positivamente nos tratamentos com biofertilizante rico e comum, simultaneamente.

Palavras-chave: *Artocarpus heterophyllus. Artocarpus brasiliensis,* insumo orgânico, salinização, variedades.

1 INTRODUCTION

The growing need to increase food production constitutes an urgent scientific and technological challenge and requires the expansion of new agricultural land. However, expanding food production does not depend upon the incorporation of new areas only, but it also relies on the ability to grow crops in places that are currently unsuitable, such as degraded lands, affected by the accumulation of salts within the soil and the presence of low-quality water, with high salts content (RIBEIRO et al., 2017).

The jackfruit (*Artocarpus heterophyllus* Lam.), also known as jack tree, is a species of tree in the family Moraceae native to India. The jackfruit tree is present in all tropical regions of the world and it is considered as an exotic and spontaneous species (SANTOS et al., 2012). It was introduced in Brazil in the middle of the 17th century and because of its expressiveness, is widely cultivated in domestic orchards of all tropical regions of the country, being very popular and extensively consumed (CHOOKLIN et al., 2014). However, there is a challenge when cultivating jack trees, mainly due to difficulties in seedlings production (NUNES et al., 2017).

In the Brazilian semi-arid region, family farming is concentrated in most parts. This operational farming model requires cost reduction and reuse of inputs, such as organic fertilizers, for instance biofertilizers, worm humus, etc. In addition to beneficial nutritional effects, studies have shown biofertilizers to have an attenuating effect on saline stress. According to Nascimento et al. (2016), organic fertilizers mitigate salinity harmful effects to plants due to positive action on the soil physical characteristics and on the rhizosphere.

In the production of good quality seedlings with well-defined agronomic characteristics, efficient and, if possible, low cost methodologies should be adopted (OLIVEIRA et al., 2018). High-quality biological material is one of the limitations in jackfruit cultivation, as well as in others fruit trees. In this phenological phase, and considering that jackfruit seedlings are moderately sensitive to salinity during its first year (AYERS; WESTCOT, 1999), growth may be inhibited by salinity or sodicity and by other limitations such as water shortage in terms of quantity and quality (MEDEIROS et al., 2016).

Saline water has hampered agricultural activity both by the direct effects on the plant and by its ccumulation in the superficial layers of the soil. The damaging effects of salinity are related to the reduction of osmotic potential, which impairs water availability to the plants, the toxic effect of specific ions, such as Na+ and Cl-, and the nutritional effect (CARNEIRO et al., 2017). Therefore, even seedlings that normally do not present tolerance to saline stress, may have high sensitivity in the initial phase of its development (MORAIS et al., 2012). Therefore, in addition to the quality of the water, special attention should also be given to the substrate. The growing substrate should be of good quality, with adequate amounts of nutrients and preferably with mechanisms of controlled release, in order to avoid losses by leaching and volatilization (SIMÕES et al., 2012).

In this context, technologies that might attenuate the deleterious effects of excess salts in irrigation water during the entire growing phase of the crop, especially during emergence and seedling formation, are needed. The use of cattle manure biofertilizers (*humic substances*) under irrigation with saline water, provides greater osmotic adjustment between the roots and the soil solution, alleviating the salts toxic effects on plants (SOUZA; PERES, 2016), thus increasing the efficiency of water and nutriente uptake and, consequently, stimulating plant growth (OLIVEIRA et al., 2017).

Some studies highlight the positive action of biofertilizers in partially attenuating the effects of saline water on seedlings formation of some crops, such as guava (CAVALCANTE et al., 2010), yellow passion fruit (MESQUITA et al., 2012) and oiticica (DINIZ NETO et al., 2014). The mitigating effect is due to the presence of humic substances contained in organic matter, which provides greater osmotic regulation between the roots and soil solution, besides reducing the intensity of the salts toxic effects on plant growth (MELO FILHO et al., 2017).

Thus, the aim of this study was to evaluate the effect of irrigation water salinity on two jackfruit varieties seedlings formation under the application of common and enriched bovine biofertilizers.

2 MATERIAL AND METHODS

The experiment was carried out between october/2016 and february/2017, in a sheltered environment, at the Agricultural Sciences Center, in Department of Soil and Rural Engineering of the Federal University of Paraiba (CCA-FUPB), in city of Areia, Brazil (latitude 6°58'S, longitude 35° 41'W and altitude of 575 m).

According to Köppen's classification, the climate of the region is As' type (warm and humid), with a rainy season from March to July and average annual rainfall of 1.410 mm. The mean air temperature in the region is 24.28 ºC, presenting higher temperatures in February (26.7 ºC) and milder in July (21.6 ºC). The average relative humidity is 78.52% (COSTA et al., 2015).

The mean air temperature at the site of the experiment in the hottest month was around 31.43 °C outside the greenhouse and 42.67 °C inside the shelter; in the coldest month, the values ranged from 26.56 ° C outside and 29.87 ° C inside the sheltered environment. The air relative humidity in the hottest month was 60.25% outside and 49% inside the sheltered environment and in the coldest month 84% outside and 56% inside.

The soil used in the experiment was characterized as a Neolithic Regolithic of sandy texture, not saline (SANTOS et al., 2016), collected in the 20 cm depth. After the soil material was collected the samples were sent to DSER/CCA/UFPB laboratory for processing. The soil samples passed through a 2 mm mesh sieve and then were physically and chemically (fertility) analyzed, following Embrapa (2013) methodology. The electrical conductivity of a saturated paste extract was also estimated, following Richards (1954). The results of the soil analyses performed are shown in Table 1.

Table 1. Chemical, physical and of the soil salinity characterization in depth of 0-20 cm. Areia, PB, 2017.

Physical Attributes	Value	Attributes of fertility	Value	Attributes of Salinity	Value
Sd (g cm^{-3})	1.53	pH in water (1:2.5)	4.93	ECw (dS m^{-1})	0.81
Pd (g cm^{-3})	2.66	OM (g kg^{-1})	4.18	pH	6.08
Tp (m^3 m^{-3})	0.46	P (mg dm^{-3})	6.37	Ca^{2+} ($mmol_c$ L^{-1})	1.63
Sand (g kg^{-1})	869	K^+ (mg dm^{-3})	49.73	Mg^{2+} ($mmol_c$ L^{-1})	1.35
Silte (g kg^{-1})	69	Ca^{+2} ($cmol_c$ dm^{-3})	0.69	Na^+ ($mmol_c$ L^{-1})	3.42
CDw (g kg^{-1})	98	Mg^{+2} ($cmol_c$ dm^{-3})	0.46	K^+ ($mmol_c$ L^{-1})	1.19
Ada (g kg^{-1})	12	Na^+ ($cmol_c$ dm^{-3})	0.16	Cl^- ($mmol_c$ L^{-1})	-
GF (%)	80.45	$H^+ + Al^{+3}$($cmol_c$ dm^{-3})	1.75	CO_3^{2-} ($mmol_c$ L^{-1})	-
ID (%)	12.76	Al^{+3} ($cmol_c$ dm^{-3})	0.20	HCO_3^- ($mmol_c$ L^{-1})	-
U_{cc} (g kg^{-1})	15.43	BS ($cmol_c$ dm^{-3})	2.01	SO_4^{2-} ($mmol_c$ L^{-1})	-
U_{pmp} (g kg^{-1})	3.67	CEC ($cmol_c$ dm^{-3})	3.76	SAR (mmol L^{-1})$^{1/2}$	1.22
Aw (g kg^{-1})	6.37	V (%)	53.45	ESP (%)	90.95

ECW=electrical conductivity of water; BS= base sum (Na++K++Ca2++Mg2+); CEC=Cation exchange capacity= SB+(H++Al3+); V=Saturation value by bases (100xSB/CTC); PES=Percentage of exchangeable sodium (100xNa+/CTC); SD=Soil Density; Dp=Density of particle; Tp=Total porosity; Ucc and Upmp = respectively, soil moisture to the tensions of – 0.01 e -1.5 Mpa; ; DI=Dispersion index; RAR = Sodium Adsorption relation = Na+ x [(Ca2+ + Mg2+)/2]1/2; ESP = Exchangeable sodium percentage (100xNa+/CTC).

The experimental design used was the Randomized Complete Block design in a 5x3x2 factorial scheme, with three replications. The treatments consisted of five salinity levels of the irrigation water (0.5; 1.0; 2.0; 3.0 and 4.0 dS m-1), two types of biofertilizer (common biofertilizer; enriched biofertilizer; absence of biofertilizer) and two jackfruit varieties (Artocarpus heterophyllus and Artocarpus brasiliensis), soft and hard jackfruits, respectively, totaling 90 treatments, aconditioned in bags of black polyethylene with the maximum capacity of 5.0 kg, according to Mesquita et al. (2017).

For obtaining, the value of electrical conductivity levels were obtained by diluting strongly saline water (14.75 dS m-1) in non-saline water (0.5 dS m-1), from the ‘Jacarezinho’ dam located in the municipality of Remigio-PB. In this way, non-saline water of electrical conductivity (0.5 dS m-1) was added as did Mesquita et al. (2015). The salinity of the waters were determined and controlled using a portable conductivity meter (Hanna, model Hi98304). The plants were irrigated daily with each type of water in order to maintain the soil water content always close to field capacity, registering each volume applied. These irrigations were performed with non-saline water (ECw = 0.5 dS m-1) and saline water (ECw = 1.0; 2.0; 3.0 and 4.0 dS m-1).

The common bovine biofertilizer was prepared from the mixture of equal parts of fresh cattle manure and water (non-saline and non-chlorinated), in a biodigester through anaerobic fermentation, during a period of 30 days, according to Mesquita et al. (2015). The enriched biofertilizer was prepared with the same amounts of water and cattle manure from the common biofertilizer, but in addition, 4 L of molasses, 8 L of bovine milk and 4 kg of agricultural gypsum were added weekly, in the following proportion 1:2:1. The agricultural gypsum used contained 26% of CaO, 14.7% of S and 5% moisture (LEITE et al., 2010). The chemical composition of the irrigation waters and biofertilizers in liquid form (Table 2) was performed using the methodologies suggested by Richards (1954) at the Soil Analysis Laboratory of the Federal University of Paraiba /FUPB, Areia-PB.The chemical composition of the irrigation waters and biofertilizers in liquid form (Table 2) was performed using the methodologies suggested by Richards (1954) at the Soil Analysis Laboratory of the Federal University of Paraiba /FUPB, Areia-PB.

Table 2. Characterization of the irrigation water, of the common biofertilizer and enriched with milk, molasses and agricultural gypsum. Areia, PB, 2017.

Components	**Water**	**Biofertilizers**	
		Common	**Enriched**
pH	7.35	6.64	5.96
EC (dS m^{-1})	0.23	4.28	17.41
SAR (mmol $L^{-1})^{1/2}$	1.36	8.20	8.76
Ca^{+2} ($mmol_c$ L^{-1})	1.35	8.03	34.00
Mg^{+2} ($mmol_c$ L^{-1})	0.94	1.81	0.91
Na^{+} ($mmol_c$ L^{-1})	1.46	18.21	36.62
K^{+} ($mmol_c$ L^{-1})	0.13	3.85	11.21
Cl^{-} ($mmol_c$ L^{-1})	0.18	0.00	0.03
HCO^{-}_3 ($mmol_c$ L^{-1})	0.00	0.42	3.31
CO^{-2}_3 ($mmol_c$ L^{-1})	0.01	0.01	0.00
SO^{-2}_4 ($mmol_c$ L^{-1})	0.76	6.23	15.52
Classificação	C_1S_1	C_2S_1	C_3S_1

EC=Electric conductivity; SAR= Sodium adsorption Relationship=Na^{+}x $[(Ca^{+2} + Mg^{+2})/2)]^{-1}$.

For the maintenance of the anaerobic system, which was hermetically sealed, a 4 mm diameter hose was connected at the top of the biodigester to the upper base (Lid), and then the other end of the hose was put out of the biodigestor into a 2.0 liter PET bottle containing water. Two days before sowing, the biofertilizer was diluted with water in a 1: 3, ratio and applied in a volume equivalent to 10% of the substrate volume (5.0 dm^{-3}).

With respect to the sowing process of the two jackfruit varieties, five seeds were placed in each experimental unit that presented viability of 84%. At the 17 days after seedling emergence, thinning was performed, leaving only the two more vigorous ones. Irrigation with each salinity level was performed daily according to the water requirement of the crop, where the volume of water applied to maintain the soil at field capacity, ranged from 150 to 450 mL of water.

At 95 days after the seedlings emergence (DAE), the following morphological parameters were evaluated: leaf (LA) and root (RA) area, estimated according to the leaf disc weighing method proposed by Mielke et al. (1995) and Nascimento et al. (2011), where leaf discs with known area (1.0 cm^2) were cut from the basal, median and apical portions of the leaf blade. The main root diameter was measured using a digital caliper (model 6"150 mm DC-60 Western) with an accuracy of 0.002 mm.

After the characterization, the phytomass production data passed through the drying process in a forced air circulation oven at 65 ºC until reaching constant weight, the jackfruit seedlings organs (leaves, stems and roots) were quantified then separated and packed in paper bags for statistical analysis. After this process, biomass allocations for leaves (ABF), stem (ABC) and roots (ABR) were calculated and the root/shoot ratio (R/PA) was determined, using the formulas below (BENINCASA, 2003): ABF = MSF/MST; ABC = MSC/MST; ABR = MSR/MST and the ratio R/PA = MSR/(MSF+MSC). Where: MSF = leaf dry matter, MSC= stem dry matter, MSR= root dry matter and MST= total dry matter.

The results were submitted to analysis of variance by the F test, and when significant the water salinity levels were submitted to Polynomial Regression analysis, while the biofertilizers and the jackfruit varieties were compared by the Tukey test ($p < 0.05$). The 5.6 SISVAR software, Build 86 - DEX-UFL Alivre (FERREIRA, 2011) was used for data processing.

3 RESULTS AND DISCUSSION

The leaf area of the jackfruit seedlings was significantly, affected by biofertilizers and varieties. It was verified that the "hard" jackfruit variety was statistically outstanding in all treatments evaluated. For the "hard" jackfruit variety, the use of enriched biofertilizer (B3) provided a larger leaf area compared to the common biofertilizer (B2) and the treatment without biofertilization (B1), which presented the lowest values.

In the same way, for the "soft" jackfruit, the use of both biofertilizers (B2 and B3) provided greater leaf expansion when compared to the treatment that did not receive the fermented organic compound (Figure 1A).

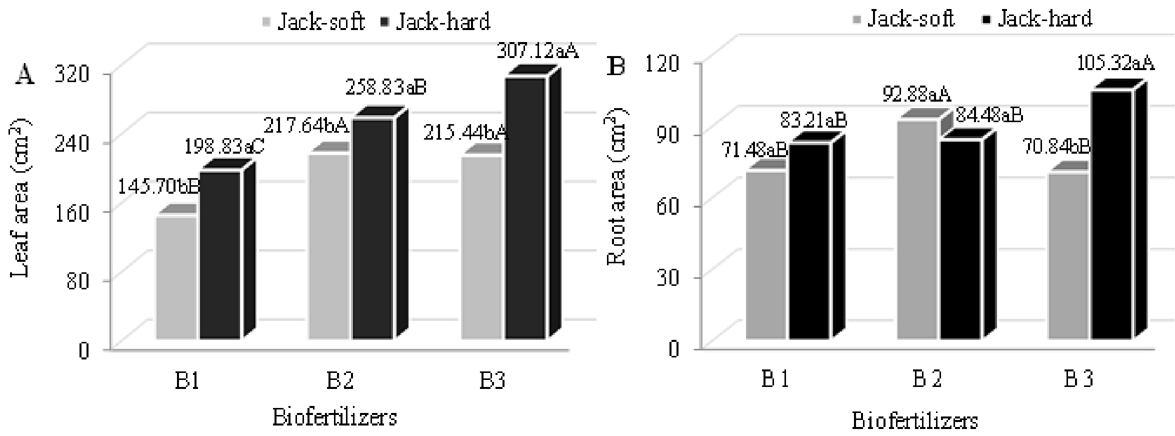

Figure 1. Leaf area (A) and root area (B) of jackfruit seedlings grown in substrate without biofertilizer, with a common biofertilizer and with a enriched biofertilizer, evaluated at 95 DAE. Areia, PB, 2017.

Similar results were reported by Cavalcante et al. (2010), in guava seedlings, where the use of biofertilizer improved growth by increasing stem height and diameter. Organic fertilizers provide several benefits to the soil, such as improvements in physical, chemical and biological properties, thus increasing the nutrient supply to the plants (SANTANA et al., 2012). Furthermore, the greater results provided by the enriched biofertilizer on the leaf area, especially of hard jackfruits variety, may be due to the calcium content present in this input, which favors a better structuring of the plants cell wall, as reported by Sousa et al. (2018).

Regarding the root area (Figure 1B), the hard jackfruits variety was superior to the soft jackfruits variety only under biofertilizer rich, with a 32.73% increase in root area, whilst in the other treatments, no significant differences were observed between the two varieties. In relation to the use of organic fertilizers, the rich biofertilizer was superior in the hard jackfruits variety and the common biofertilizer (—) in the soft jackfruits variety. Based on this Figure, Cavalcante et al. (2010) also observed increased root growth with the application of biofertilizer in guava seedlings. The superiority of the biofertilizer rich (-·-) may be due to a higher concentration of nutrients, such as calcium, magnesium and potassium, in its chemical composition (RODRIGUES et al., 2017).

In the same way, when analyzing the root diameter of the jackfruit varieties (Figure 2A), it was interfered by the interaction (varieties x biofertilizers) with higher and lower increases in the DC when using the organic compounds (humic acids present in the biofertilizers), respectively, in both varieties. The varieties differed significantly only in B1, with a higher average for the "hard" jackfruit, possibly because this cultivar has superior

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potential compared to the other. Thus, it´s can be inferred that the use of biofertilizer, especially the enriched one, favors jackfruit root expansion, regardless of the variety.

Similar results were reported by Sousa et al. (2018) when evaluating sorghum genotypes under salinity, which found that the application of biofertilizer, even with saline water, increased the stem diameter values of sorghum plants by 50%, compared to treatments without organic compounds.

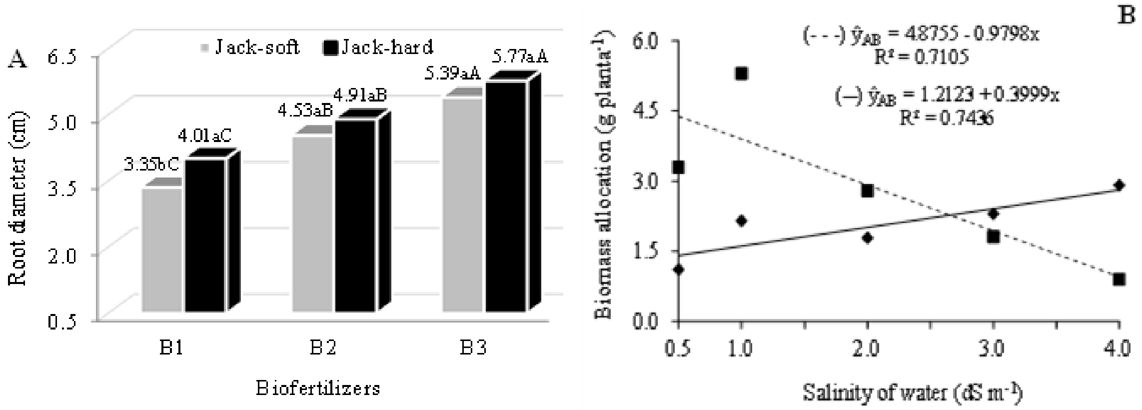

Figure 2 - Root diameter (A) and Biomass allocation (B) of jackfruit seedlings on grown in substrate without biofertilizer, with a common biofertilizer and with an enriched biofertilizer to the detriment of the salinity of irrigation water. Areia, PB, 2017.

The biomass allocation was significant for the saline waters and jackfruit varieties. It was verified that with increasing salt levels in the irrigation water there was a reduction of 78.19% in the soft jackfruit variety when comparing the highest (4.0 dS m^{-1}) and lowest (0.5 dS m^{-1}) salinity levels. However, the "hard" jackfruit variety increased 99.10% in the same salinity range (Figure 2B). Salinity stress reduces plant growth due to the osmotic effect or water deficit caused by high salt concentrations, which impairs water absorption. Also, excess of ions causes leaf damages, reducing plant growth and, consequently, biomass allocation (LIMA NETO et al., 2016). These effects were observed mainly in the "soft" jackfruit variety. Oliveira et al. (2018), when evaluating the biomass of "soft" jackfruit seedlings submitted to saline water, verified that the increase in salinity from 0.3 to 4.0 dS m^{-1} promoted decreases of 7.10% and 46.81% in root and shoot dry mass accumulation, respectively.

The increase of the biomass allocation in the "hard" jackfruit (Figure 2B), may be an adaptation to the saline conditions imposed, since there is variability between varieties of the same species (PEREIRA et al., 2017; SÁ et al., 2017). As a defense mechanism, some varieties maintain high levels of potassium (K^+) and calcium (Ca^{2+}) and low sodium content (Na^+) in its tissues, thus absorbing higher amounts of K^++ and Ca^{+2}, in order to maintain high K^+/Na^+ and Ca^{2+}/Na^+ ratios, so their biomass are not reduced even under saline conditions (GALDINO et al., 2017).

It can be observed in Figure 3A, that the shoot dry mass accumulation was significant for the interaction between biofertilizers x salinity. It´s was verified that the treatment without biofertilizer did not fit in any mathematical model, presenting an estimated mean of 1.71 g. However, the application of common and enriched biofertilizer in the seedlings provided a quadratic behavior, with increments of 2.71 and 2.14 g, respectively, at salinity levels of the irrigation water of 1.7 and 2.1 dS m^{-1}. These results indicate that the use of biofertilizers, especially the common biofertilizer, favors the accumulation of biomass in the shoot system of jack trees. In a study carried out with oiticica seedlings under salinity conditions, Diniz Neto et al. (2014) observed that the use of biofertilizer attenuated the effect of the salt on the shoot dry mass, when compared to the treatment without biofertilizer.

Similarly, the use of biofertilizer attenuated the salinity effects on seedlings, improving the plants biomass production (CAVALCANTE et al., 2010). These positive results might be due to the greater amount of nitrogen in the substrate. Nitrogen increases plant growth, reducing the salinity harmful effects, as it is a core component of several organic solutes that boost the plants osmotic adjustment capacity (LIMA NETO et al., 2016). In addition, the effect of bovine biofertilizer on plant characteristics may be due to its composition, as well as to the fact that it favors numerous microbiological processes related to mineralization and nutrient release to plants (SOUSA et al., 2018).

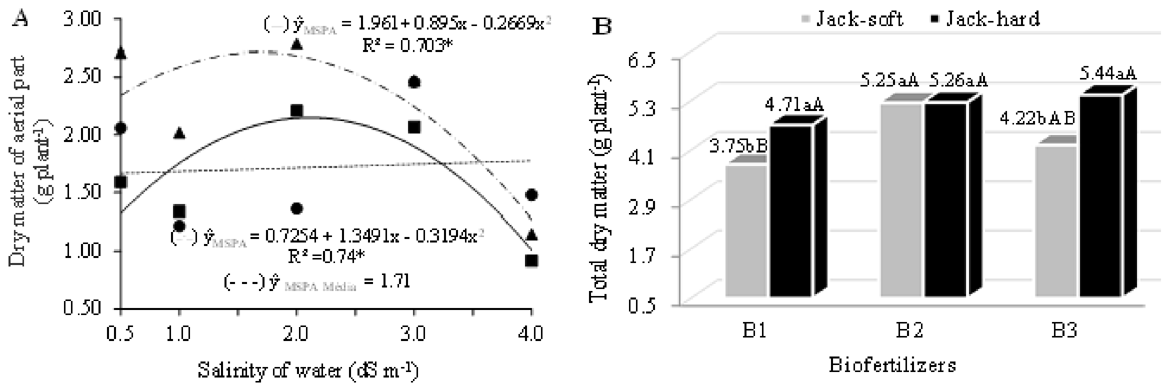

Figure 3 - Shoot dry matter (A) and total dry biomass (B) of jackfruit seedlings on grown in substrate without biofertilizer (- - -), with common biofertilizer (—) and with enriched biofertilizer (—.—), as a function of the salinity of irrigation water. Areia, PB, 2017.

The varieties presented significant differences in the total dry mass with the use of biofertilizers, with the hard jackfruits variety showing superiority in all evaluated treatments (Figure 3B). However, with the use of common biofertilizer (—), the soft jackfruits variety presented high accumulation of dry mass, similar to the hard jackfruits. Probably, this result is due to the lower electrical conductivity in the saturation extract of the common biofertilizer (3.59 dS m^{-1}) in relation to biofertilizer rich (6.28 dS m^{-1}), thus soft jackfruit seedlings, which are more sensitive to salinity, presented lower total dry mass under biofertilizer rich (-·-). According to Rodrigues et al. (2017), although biofertilizers increase the electrical conductivity of substrates, it also increase plant growth and biomass production.

According to Taiz et al. (2017), growth impairment caused by salinity is mainly due to the osmotic effect, which promotes physiological drought, as well as the toxic effect, resulting from the high ion concentration in the protoplasm. Plant tolerance to salinity, although relatively scarce in most cultivated species, can occur with great genetic variability not only among species, but also among cultivars within the same species, as it can be observed in the present study (PONTE et al., 2011). These authors also state that root system inhibition occurs as a plant strategy to avoid contact with the salt present in the substrate. Most fruit trees present a detrimental effect on root growth with increased salt levels in the irrigation water, such as lemon (SÁ et al., 2017), papaya (LIMA NETO et al., 2016) and guava (OLIVEIRA et al., 2018).

4 CONCLUSIONS

Biofertilizers did not inhibit but positively attenuate the harmful effects of excessive salt content in the irrigation water on jackfruit phytomass production.

The statistical superiority of all variables studied indicates a positive action of the biofertilizers in reducing the harmful effects of saline irrigation water to the plants.

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