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PHYSICOCHEMICAL QUALITY OF FRUITS OF WEST INDIAN CHERRY UNDER SALINE WATER IRRIGATION AND PHOSPHATE FERTILIZATION[1]

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ABSTRACT - In the semiarid region of Northeastern Brazil due to the qualitative and quantitative scarcity of water resources, the use of saline water should be considered as an alternative to expand irrigated agriculture. However, the use of waters with high levels of salts depends on management practices that minimize deleterious effects on plants. In this context, the objective of this study was to evaluate the effects of irrigation with water of increasing salinity and fertilization with phosphorus on the postharvest physicochemical composition of fresh fruits of West Indian cherry, cv. 'BRS 366 Jaburu'. The research was carried out in a protected environment, in lysimeters with *Neossolo Regolítico Psamitico Típico* (Entisol) of clay loam texture, using a randomized block design, in a 5x2 factorial scheme with three replicates and one plant per plot, relative to five levels of irrigation water electrical conductivity (0.6; 1.4; 2.2; 3.0 and 3.8 dS m^{-1}) and two phosphorus doses [100 and 140% of the recommendation of Musser. Increase in water salinity reduced fruit size and fresh mass formation, but increased soluble solids contents and titratable acidity in the pulp of West Indian cherry fruits. Phosphate fertilization, regardless of dose, stimulated the formation of fresh mass of West Indian cherry fruits. Water salinity inhibited the formation of ascorbic acid in West Indian cherry fruits, and the highest value was observed in plants irrigated with 0.6 dS m^{-1} water and fertilized with a dose of 100% of the recommendation of P_2O_5.

Key words: *Malpighia emarginata*. Irrigation, Salinity. Mineral nutrition.

QUALIDADE FISICO-QUIMICA DE FRUTOS DE ACEROLEIRA IRRIGADO COM ÁGUAS SALINAS E ADUBAÇÃO FOSFATADA

RESUMO - No semiárido do Nordeste brasileiro devido à escassez qualitativa e quantitativa dos recursos hidricos o uso de água salina deve ser considerado como uma alternativa para expandir a agricultura irrigada**.** Contudo, a utilização de águas com níveis elevados de sais depende de práticas de manejo que minimizem os efeitos deletérios sobre as plantas**.** Neste contexto, objetivou-se avaliar os efeitos da irrigação com água de salinidade crescente e adubação com fósforo na composição físico-química pós-colheita dos frutos *in natura* de aceroleira 'BRS 366 Jaburu'. A pesquisa foi realizada em ambiente protegido, em lisímetros com Neossolo Regolítico Psamitico Típico de textura franco-argilosa, utilizando-se o delineamento de blocos casualizados, em esquema fatorial 5x2 com três repetições e uma planta por parcela, relativo aos cinco níveis de condutividade elétrica da água de irrigação de 0,6; 1,4; 2,2; 3,0 e 3,8 dS m^{-1} e duas doses de fósforo de 100 e 140% da recomendação de Musser. O aumento da salinidade das águas reduziu o tamanho dos frutos e a formação de massa fresca, mas aumentou os teores de sólidos solúveis e acidez titulável da polpa dos frutos de aceroleira. A adubação fosfatada, independente da dose estimulou a formação de massa fresca de frutos de aceroleira. A salinidade das águas inibiu a formação de ácido ascórbico dos frutos de aceroleira sendo maior valor observado nas plantas irrigadas com água de 0,6 dS m^{-1} adubadas com dose de 100% da recomendação de P_2O_5.

Palavras-chave: *Malpighia emarginata*. Irrigação, Salinidade. Nutrição mineral.

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INTRODUCTION

West Indian cherry (*Malpighia emarginata* DC.) stands out due to its economic and nutritional potential, considered for its ascorbic acid contents, being rich in bioactive compounds such as carotenoids, thiamine, riboflavin and niacin, and standing out in the field of functional foods, which adds a great potential for the consumption of its fruit either fresh or industrialized (SEGTOWICK; BRUNELLI; VENTURINI FILHO, 2013). It is marketed fresh, frozen, in the form of frozen pulp and in other food products, such as nectar, tropical juice, concentrated juice, liquor, and can be used in powder, as medicinal capsules of vitamin E and C, jams and sweets (YAMASHITA et al., 2003).

The occurrence of waters with high concentrations of salts is particularly evident in the semiarid region of Northeastern Brazil, due to the low rainfall levels and high evaporation rates that occur in most of the year. Due to the water scarcity that occurs in this region, both quantitatively and qualitatively, the practice of irrigation is the only means to safely ensure crop production (DALCHIAVON; NEVES; HAGA, 2016).

The use of saline water in the production of fruit crops, including West Indian cherry, can promote increased osmotic pressure, changes in ionic homeostasis resulting mainly from ionic toxicity due to excessive absorption of Na^+ and Cl^- and to the nutritional imbalance caused by disturbances in the absorption or distribution of nutrients (ACOSTA-MOTOS et al., 2017), losses in the permeability of cell membranes and in the quantum efficiency of photosystem II, and ionic balance, which lead to a reduction in plant development, regardless of the nature of the salts (SILVA et al., 2014; LIMA et al., 2015).

Losses in fruit yield and postharvest quality in plants grown under salt stress result from the negative effect of the osmotic potential of the soil solution, since the stress reduces water potential, reducing the absorption of water and nutrients by plants, as well as their photosynthetic capacity, due to factors such as dehydration of cell membranes, salt toxicity, reduction in CO_2 supply (closure of stomata), salinity-induced senescence and changes in enzymatic activity (TERCEIRO NETO et al., 2013).

However, the salinity level that causes changes in physicochemical composition and plant yield varies among species and cultivars, which exhibit different physiological behavior regarding the effects of salinity in soil and in the irrigation water. The effects of salt stress on the crop depend on its phenological stage, duration of exposure to salt stress, salts present in the medium, environmental conditions, soil properties, type and intensity of soil and crop managements (DIAS et al., 2011; COSTA et al., 2013).

The information in the literature on irrigation with saline waters in the cultivation of West Indian cherry is limited to the effects of salt stress on growth, gas exchange, photochemical efficiency and photosynthetic pigments in the post-grafting phase of the plants (LIMA et al., 2018; DIAS et al., 2018; ALVARENGA et al., 2019). Given the importance of this crop for the semiarid region of Northeastern Brazil, conducting studies aiming to monitor changes in the physicochemical composition of West Indian cherry fruits, cv. 'BRS 366 Jaburu', is extremely important for the industrialization of the juice, the main product obtained from this fruit crop.

Mineral nutrition, especially fertilization with phosphorus, is an alternative to mitigate the effects of irrigation water salinity, as it performs important functions in plant metabolism, with emphasis on the capacity to store energy. Thus, studies with phosphate fertilization in plants under salt stress are still incipient compared to those with nitrogen fertilization, but some studies have reported the mitigating action of phosphorus in plants under salt stress conditions (OLIVEIRA et al., 2010; SÁ, 2016).

In view of the above, the objective of this study was to evaluate the effects of irrigation with waters of increasing salinity and fertilization with phosphorus on the physicochemical composition of fresh fruits of West Indian cherry, cv. 'BRS 366 Jaburu'.

MATERIAL AND METHODS

The experiment was carried out between July 2017 and March 2018 in a greenhouse of the Center of Technology and Natural Resources of the Federal University of Campina Grande, Campina Grande, Paraíba, Brazil, located at the geographic coordinates 7°15'18" South latitude, 35°52'28" West longitude and Mean altitude of 550 m.

The treatments were distributed in randomized blocks, with three replicates and one plant per plot, using a 5 x 2 factorial arrangement, relative to five levels of irrigation water electrical conductivity - ECw of 0.6; 1.4; 2.2; 3.0 and 3.8 dS m^{-1} and two phosphorus doses of 100 and 140% of the recommendation of Musser (1995), corresponding to 45.0 and 63.0 g of P_2O_5 $plant^{-1}$ $year^{-1}$.

Seedlings of West Indian cherry, cultivar 'BRS 366-Jaburu', aged 240 days, were produced by grafting on a heirloom rootstock from the seed garden of EMBRAPA Tropical Agroindustry, in Pacajus-CE. After sowing during 240 days the seedlings of rootstock were irrigated with low-salinity water (0.6 dS m^{-1}). The seedlings were transplanted to lysimeters and acclimatized for a period of 30 days before irrigation with waters of increasing salinity.

West Indian cherry was grown in 250-dm^3 lysimeters, filled with 235 kg of air dried soil. Before filling the lysimeters, Bidim® geotextile and a 0.5-kg layer of crushed stone were placed at the bottom of each of the two drains to avoid clogging. The soil used to fill the lysimeters was classified as *Neossolo Regolítico Psamitico Típico* (Entisol) of clay loam texture (0-30 cm depth), coming from the municipality of Lagoa seca, PB. After being pounded to break up clods, the soil was characterized as to the physicochemical attributes (Table 1) according to methodologies proposed by Teixeira et al. (2017).

Table 1. Physical-hydraulic characteristics of the soil used in the experiment.

Chemical characteristics									
pH (H_2O) (1:2.5)	OM (dag kg^{-1})	P (mg kg^{-1})	K^+	Na^+	Ca^{2+}	Mg^{2+}	Al^{3+}	H^++Al^{3+}	ECse (dS m^{-1})
			..........($cmol_c$ kg^{-1})..........						
5.63	1.83	18.20	0.21	0.17	3.49	2.99	0.00	5.81	0.61

Physical characteristics									
Size fraction (g kg^{-1})			Textural class	Water content (kPa)		AW	Total porosity	BD	DP
Sand	Silt	Clay		33.42	1519.5				
				....	(dag kg^{-1})	....	(m^3 m^{-3})	------(kg dm^{-3})----	
572.7	100.7	326.6	CL	12.68	4.98	7.70	0.57	1.13	2.65

OM - Organic matter: Walkley-Black Wet Digestion; Ca^{2+} and Mg^{2+} extracted with 1 M KCl at pH 7.0; Na^+ and K^+ extracted using 1 M NH_4OAc at pH 7.0; Al^{3+} and H^+ extracted using 0.5 M CaOAc at pH 7.0; ECse - electrical conductivity of the soil saturation extract; CL - Clay Loam; AW - Available water; BD - Bulk density; DP - Particle density.

The waters with lower electrical conductivity (ECw) (0.6 and 1.4 dS m^{-1}) were obtained from the dilution of public-supply water (ECw = 1.78 dS m^{-1}) with rainwater, and the other ECw levels (2.2; 3.0 and 3.8 dS m^{-1}) were obtained by adding NaCl, $CaCl_2.2H_2O$ and $MgSO_4.7H_2O$ to public-supply water in the equivalent proportion of 7:2:1, respectively, which represents the average composition of ion contents present in the waters used for irrigation in the semiarid region of Northeastern Brazil.

Irrigation with the different levels of water electrical conductivity was performed by adopting a 3-day interval, applying in each lysimeter a volume of water sufficient to keep soil moisture close to the soil water retention capacity (33.42 kPa). The volume to be applied in each irrigation was determined according to the water requirement of the plants based on the water balance in the root zone, obtained by the difference between the volume applied minus the volume drained in the previous irrigation. In order to maintain low accumulation of salts in the root zone, an irrigation depth with a leaching fraction of 0.10 was applied every 45 days (AYERS; WESTCOT, 1999).

Fertilization with P was performed according to the pre-established treatments using single superphosphate (18% P_2O_5, 18% Ca^{2+}, 12% S) as phosphorus source. Potassium application followed the recommendation of Musser (1995), applying 22.2 g of K_2O $plant^{-1}$ using potassium chloride (60% K_2O). Phosphorus was supplied as basal fertilization. Urea was used as nitrogen source, and its applications were split into 24 equal portions, at 15-day intervals along the year, applying 2.21 g of N per plant per month.

Potassium fertilization was split into 12 equal portions, applied monthly, at dose of 1.85 g of K_2O $plant^{-1}$ $month^{-1}$, and both fertilizations began in the acclimatization period (15 DAT). At 150 days after the application of saline treatments, monthly foliar fertilizations were performed with micronutrients, following the manufacturer's recommendation. Along the experiment, Cultural and phytosanitary practices were performed as recommended for the crop, by monitoring the occurrence of pests and diseases and adopting control measures when necessary.

West Indian cherry fruits were harvested when they showed a red color, and harvest began at 525 days after transplantation. After harvest, a pre-cleaning was performed in order to remove decayed fruits and impurities. Subsequently, all fruits were washed three times in running water and sanitized in chlorinated solution (1%) for 20 min. After this stage, their pulp was extracted manually. The determinations of the physicochemical composition of West Indian cherry fruits were performed in triplicate in all experimental plots to characterize the fruits of each treatment studied.

Physical characterization of the fruit was made through the equatorial diameter (FED), polar diameter (FPD) and fruit fresh mass (FFM), while the physicochemical composition was measured through soluble solids (ºBrix), hydrogen potential (pH), titratable total acidity (TTA), and ascorbic acid content (AA). FED and FPD were measured immediately after harvest, with the aid of digital caliper. FFM was obtained by weighing all fruits collected per plant, using a scale with precision of 0.01 g. Soluble solids content (SS) was determined by direct reading in refractometer, according to the methodology of the Association of Official Analytical Chemists International (AOAC, 1995).

Titratable acidity was determined by the volumetric titration method, whose principle is based on the reaction of neutralization of acids with standardized solution of alkali (sodium hydroxide at

0.1 N) and alcoholic solution of phenolphthalein at 0.5%. After preparation, the sample was titrated until reaching the equivalence point or "turning point", pink color (IAL, 2008). Acidity was expressed in mL of 1 N NaOH solution 100 g^{-1} of West Indian cherry pulp.

The ascorbic acid content of the natural pulp was determined shortly after preparation by the Tillmans method (titrimetric), which is based on the reduction of 2-6-dichlorophenol-indophenol (DCPIP) by ascorbic acid. DCPIP is blue in basic or neutral medium, pink in acid medium, and its reduced form is colorless. The end point of titration is detected by turning of the solution from colorless to pink, when the first drop of DCPIP solution is introduced into the system, with all the ascorbic acid already consumed. This methodology was proposed by the Adolf Lutz Institute (IAL, 2008), using homogenized samples. The results were expressed in mg of ascorbic acid per 100 g of West Indian cherry pulp.

The data were subjected to analysis of variance by F test at 0.05 probability level. Linear and quadratic polynomial regression analyses were performed for the salinity levels factor, while the means comparison test was performed (Tukey) for phosphorus doses, using the statistical software SISVAR for data processing (FERREIRA, 2011).

RESULTS AND DISCUSSION

According to the summary of analysis of variance (Table 2), the interaction between water salinity and phosphate fertilization did not exert significant effects on any of the variables analyzed. There was single significant effect of water salinity levels on fruit equatorial diameter (FED), fruit polar diameter (FPD) and fruit fresh mass (FFM). Phosphorus doses caused significant effect ($p<0.05$) only in fruit fresh mass. Lima et al. (2018), when evaluating the production of West Indian cherry cv. 'BRS 366 Jaburu' as a function of irrigation with waters of different salinities (ECw of 0.8 and 3.8 dS m^{-1}) and potassium fertilization, found that the interaction between the salinity levels and K_2O doses caused significant effect only on the fruit fresh mass.

Table 2. Summary of the analysis of variance for fruit equatorial diameter (FED), fruit polar diameter (FPD) and fruit fresh mass (FFM) of grafted West Indian cherry, cv. 'BRS 366 Jaburu', irrigated with waters of different salinities and phosphorus doses.

Source of variation	DF	Mean squares		
		FED	FPD	FFM
Salinity levels (SL)	4	33.27^{**}	27.41^{**}	1722580.74^{*}
Linear regression	1	131.42^{**}	101.73^{**}	6883142.68^{**}
Quadratic regression	1	0.42^{ns}	6.40^{ns}	65.36^{ns}
Doses phosphorus (DP)	1	0.14^{ns}	0.09^{ns}	3960747.54^{*}
Interaction (SL*DP)	4	0.61^{ns}	4.39^{ns}	306537.17^{ns}
Blocks	2	4.24^{ns}	2.49^{ns}	1188706.67^{ns}
Residual	18	4.05	3.13	356752.59
CV (%)		9.39	10.43	20.66

ns, **, * respectively not significant, significant at $p < 0.01$ and significant at $p < 0.05$; DF - Degree of freedom; CV – Coefficient of variation.

The equatorial and polar diameters of West Indian cherry fruits were negatively affected by the increase in irrigation water salinity and, according to the regression equations (Figure 1A and 1B), there were reductions of 7.25 and 7.91%, respectively, in FED and FPD. By comparing the values of plants irrigated with 3.8 dS m^{-1} water to those of plants subjected to water electrical conductivity of 0.6 dS m^{-1}, it was possible to note reductions of 24.26 and 26.59%, respectively. The reduction in the size of West Indian cherry fruits (Figure 1A and 1B) may be a consequence of the high concentration of salts in irrigation water, which caused an increase in soluble ions and a decrease in the osmotic potential in the root zone, making water absorption difficult (DUARTE; SOUZA, 2016).

Due to salt stress, the plant produces a large number of reactive oxygen species (ROS) in various cell compartments, such as chloroplasts, mitochondria and peroxisomes (HUANG et al., 2019), resulting in photooxidative damage to DNA, protein denaturation and removal of hydrogen atoms from methylene groups of polyunsaturated fatty acids, initiating lipid peroxidation (TRIPATHY; OELMULLER, 2012) and finally leading to the formation of fruits with smaller diameter.

Evaluating the postharvest quality of West Indian cherry fruits, Sá (2018) found that under conditions of high water salinity (3.8 dS m^{-1}), there was a reduction in fruit diameter as the salinity levels of irrigation water increased. In a study with guava, Bezerra et al. (2019) evaluated the physicochemical composition of fruits of 'Paluma' guava irrigated with salinity waters (ECw from 0.3 to 3.5 dS m^{-1}) and found reductions in fruit polar diameter of 7.08 and 7.43%, per unit increase of ECw, respectively, in the first and second years of cultivation.

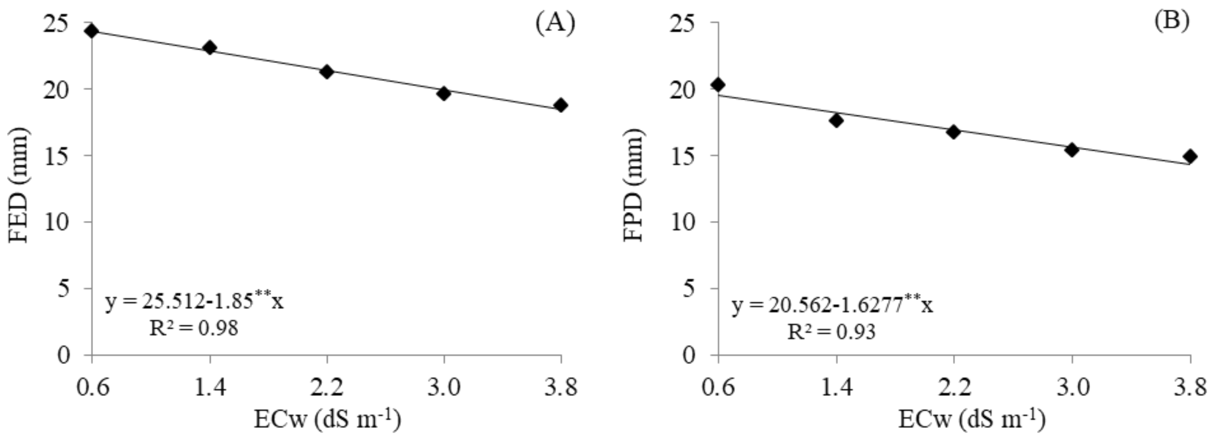
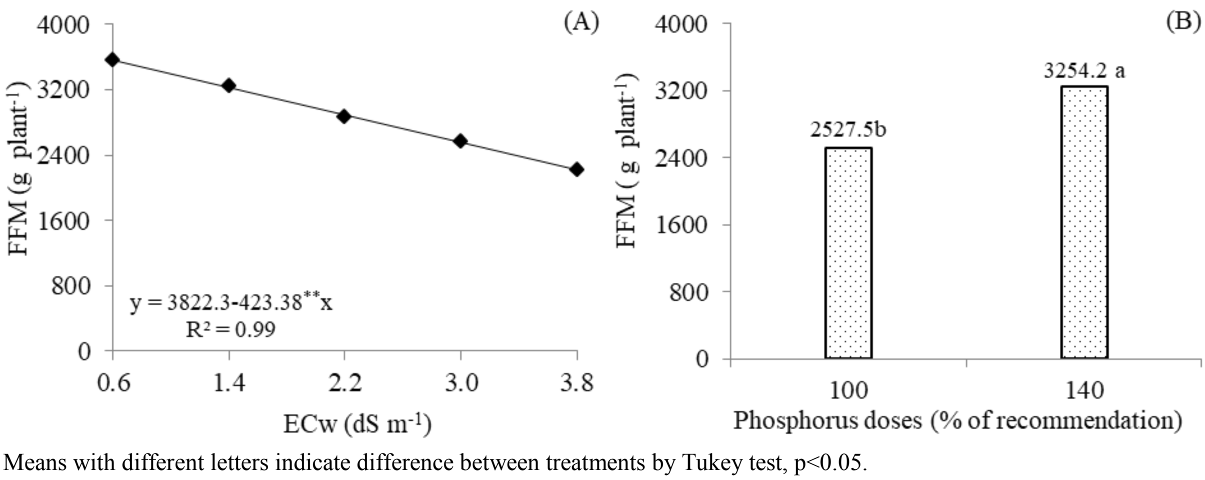


Figure 1. Equatorial diameter - FED (A) and polar diameter - FPD (B) of West Indian cherry fruits 'BRS 366 Jaburu', as a function of irrigation water salinity.

The fresh mass of West Indian cherry fruits decreased linearly with the increase in the levels of irrigation water salinity (Figure 2A), with loss of 11.07% per unit increment in ECw, resulting in a reduction of 37.96% (1354.81 g plant^{-1}) in the FFM of plants irrigated with 3.8 dS m^{-1} water, compared to those subjected to salinity of 0.6 dS m^{-1}. Reduction in fruit fresh mass may be a consequence of the reduction in the number and size of fruits. Additionally, excess salts in irrigation water requires greater energy effort for plants to absorb water and nutrients as a consequence of changes that occur in the osmotic potential of the soil solution, resulting in a decrease in photosynthetic rate, limiting plant production (OLIVEIRA et al., 2019). This situation promotes a reduction in fruit fresh mass as a result of physiological and biochemical changes to maintain cellular homeostasis. Similar results were reported by Lima et al. (2018), who evaluated the production of West Indian cherry cv. 'BRS 366 Jaburu' irrigated using waters with salinity levels of 0.8 and 3.8 dS m^{-1} and potassium fertilization, and also found reduction in the fresh mass of West Indian cherry fruits, and the greatest effect was observed in plants cultivated with the highest salinity level (3.8 dS m).



Means with different letters indicate difference between treatments by Tukey test, $p<0.05$.

Figure 2. Fruit fresh mass - FFM of West Indian cherry, cv. 'BRS 366 Jaburu', as a function of irrigation water salinity (A) and phosphorus doses (B).

The increase of phosphorus in the soil stimulated the fresh mass of West Indian cherry fruits (Figure 2B) by 22.33% or 726.7 g plant^{-1} between plants fertilized with 100 and 140% of the recommended dose. Such increase is related to the functions performed by phosphorus in metabolism, with emphasis on the storage capacity and energy transfer of the cell, respiration and photosynthesis, being a basic constituent of adenosine triphosphate (ATP) molecules, participating in the donation of electrons to maintain the biochemical phase of photosynthesis and acting as a constituent of structural phospholipids in cell membranes (TAIZ et al., 2015). Therefore, there is an increase in photosynthetic activity, which allows an increase in the flow of solutes inside the plant, facilitating the expression of mechanisms of plant tolerance to salt stress (SÁ et al., 2015).

The salinity × phosphate fertilization interaction, despite not interfering with pH and soluble solids content (ºBrix), which responded to the single action of water salinity, exerted significant effects on titratable acidity and ascorbic acid content in the pulp of West Indian cherry fruits (Table 3). Bezerra et al. (2019), in a study evaluating the post-harvest quality of 'Paluma' guava cultivated with saline waters (ECw from 0.3 to 3.5 dS m^{-1}) and nitrogen doses, also found that there was a significant single effect on soluble solids, titratable acidity and ascorbic acid.

Table 3. Summary of the analysis of variance for hydrogen potential (pH), soluble solids (SS), total titratable acidity (TTA) and ascorbic acid content (AA) of the pulp of fruits of grafted West Indian cherry, cv. 'BRS 366 Jaburu', irrigated with waters of different salinities and phosphorus doses.

Source of variation	DF	Mean squares			
		pH	SS	TTA	AA
Salinity levels (SL)	4	0.13^{**}	18.83^{**}	0.42^{**}	454.72^{**}
Linear regression	1	0.50^{**}	71.78^{**}	1.55^{**}	1251.17^{**}
Quadratic regression	1	0.00^{ns}	1.21^{ns}	0.08^{*}	425.92^{**}
Doses phosphorus (DP)	1	0.00^{ns}	0.11^{ns}	0.01^{ns}	55.97^{**}
Interaction (SL*DP)	4	0.01^{ns}	0.39^{ns}	0.04^{*}	9.85^{*}
Blocks	2	0.01^{ns}	0.17^{ns}	0.006^{ns}	2.63^{ns}
Residual	18	0.01	0.09	0.006	1.96
CV (%)		3.27	2.59	5.39	11.91

ns, **, * respectively not significant, significant at $p < 0.01$ and significant at $p < 0.05$; DF - Degree of freedom; CV – Coefficient of variation.

The hydrogen potential of the pulp decreased with the increase in water salinity levels (Figure 3A), resulting in a 3.02% reduction per unit increase in water electrical conductivity, causing losses of 9.86% between plants subjected to ECw of 0.6 and 3.8 dS m^{-1}. This situation shows that excess salts in irrigation water causes reduction of pH in West Indian cherry juice, increasing the acid aspect of the fruits. The pH provides an indication of the degree of deterioration of fruit pulps (NASSER; ZONTA, 2014). It is worth pointing out that the pH value obtained in this study is within the ideal range recommended by the Ministry of Livestock, Agriculture and Food Supply (BRASIL, 2000) for fruit pulp quality, because a pH lower than 4.5 is desirable to prevent the proliferation of microorganisms and pH values higher than 4.5 require longer periods of sterilization of the raw material in a thermal processing, causing higher energy consumption and higher processing cost (MONTEIRO et al., 2008). Dias et al. (2011), studying the effects of irrigation water salinity (ECw from 0.5 to 4.5 dS m^{-1}) on the chemical quality of yellow passion fruit, also observed a linear reduction in the pH of yellow passion fruit juice.

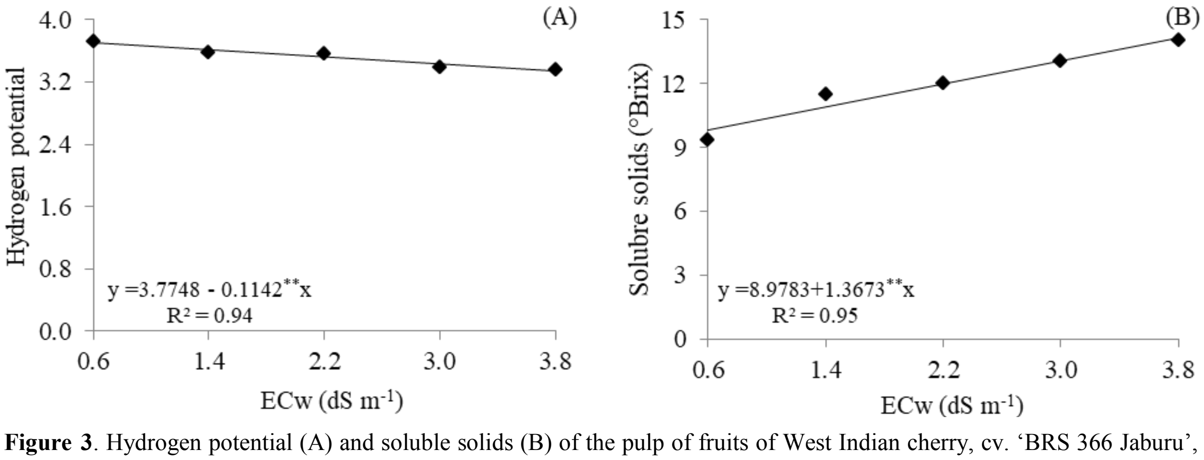


Figure 3. Hydrogen potential (A) and soluble solids (B) of the pulp of fruits of West Indian cherry, cv. 'BRS 366 Jaburu', as a function of irrigation water salinity.

The soluble solids content – SS of the pulp increased as a function of the electrical conductivity of irrigation water (Figure 3B) by 15.22% per unit increase in ECw. Comparatively, West Indian cherry plants subjected to irrigation using water with the highest salinity level (3.8 dS m^{-1}) produced fruits with 44.65% more SS in comparison to those irrigated with 0.6 dS m^{-1} water. The increase in the levels of irrigation water salinity led to an increment in the soluble solids content of West Indian cherry fruit pulp, which is considered extremely important for products that are marketed fresh, because the increase in the concentration of soluble solids is positively correlated with the contents of sugars and organic acids (CANUTO et al., 2010). Zhang, Senge and Dai (2016) concluded that high levels of NaCl in water promoted an increment in the soluble solids contents of tomato fruits. The results obtained in this study are in agreement with those reported by Freire et al. (2014), who found that the increase in water salinity levels of 0.5 and 4.5 dS m^{-1} promoted significant increase in the soluble solids contents of yellow passion fruit.

According to Figure 4A, the data of plants grown under phosphorus doses of 100 and 140% of recommendation of Musser (1995) increased linearly with the increment in irrigation water salinity. In fruits of plants fertilized with 100% P_2O_5, titratable acidity increased by 16.67%, i.e., a 48.48% increase between plants irrigated using water of lowest (0.6 dS m^{-1}) and highest (3.8 dS m^{-1}) levels of salinity.

The fruits of plants fertilized with 140% P_2O_5 also showed an increase in titratable acidity, equal to 21.15% per unit increase in ECw, that is, when plants were irrigated with 3.8 dS m^{-1} water, the values were 60.06% higher than those found in plants cultivated with 0.6 dS m^{-1} water. It can be verified through the respective figure that the plants fertilized with 140% P_2O_5 had a slight tendency of increase in titratable acidity compared to those that were fertilized with 100% P_2O_5, but in both situations the maximum value obtained corresponded to the highest dose of P_2O_5 (140%) in plants irrigated using water with the highest salt concentration.

According to the results, the titratable acidity of the pulp of West Indian cherry fruits was classified as acidic, pointed as appropriate for the processing of concentrated juice of yellow passion fruit (FREIRE et al., 2010). In addition, as West Indian cherry fruits are more intended for consumption in the form of pulp, the increase in titratable acidity reduces the need for adding acidifiers, ensuring food safety for consumers while maintaining organoleptic quality as found for yellow passion fruit (NASCIMENTO et al., 2015), reducing processing costs and increasing the shelf life of the juice (DIAS et al., 2011). In a study with 'Paluma' guava under irrigation with saline water (ECw from 0.3 to 3.5 dS m^{-1}) and nitrogen fertilization, Bezerra et al. (2019) obtained fruits with titratable acidity ranging from 4.1 to 4.59%, that is, values well lower than that of West Indian cherry.

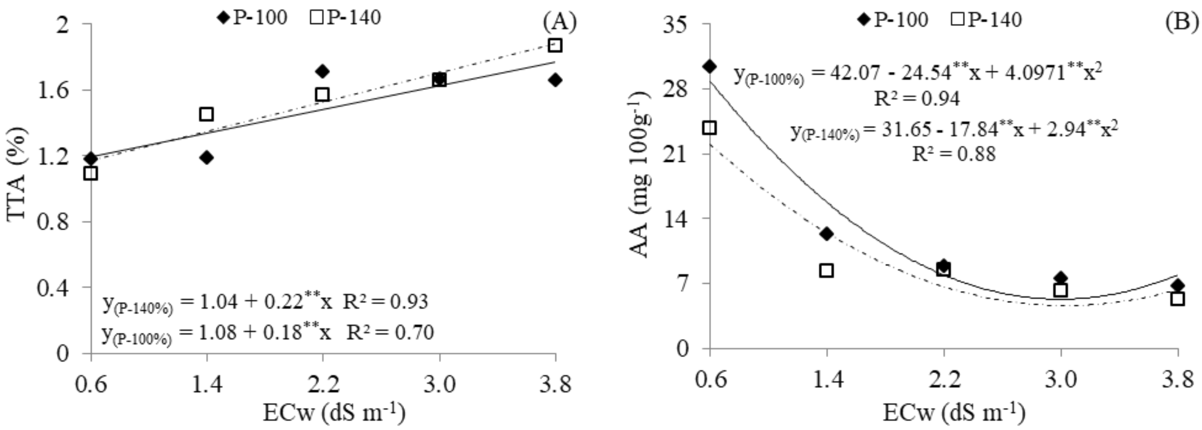


Figure 4. Total titratable acidity - TTA (A) and ascorbic acid content - AA (B) of the pulp of fruits of West Indian cherry, cv. 'BRS 366 Jaburu', as a function of the interaction between irrigation water salinity and phosphorus doses.

For the ascorbic acid content of the pulp of West Indian cherry fruits (Figure 4B), it is seen that plants fertilized with P doses of 100% obtained the highest value (28.82 mg 100 g^{-1}) when subjected to water salinity of 0.6 dS m^{-1}. There was a reduction of 20.84 mg 100 g^{-1} in the AA contents between plants grown with ECw of 3.8 dS m^{-1} and those subjected to the lowest level of salinity (0.6 dS m^{-1}).

When using 140% of the P recommendation, the maximum estimated value for AA was 15.65 mg 100 g^{-1} when plants were irrigated with 0.6 dS m^{-1} water. Moreover, as the salinity levels increased, there were reductions in AA content, and a value of 6.34 mg 100 g^{-1} was obtained when West Indian cherry plants were irrigated using water with ECw of 3.8 dS m^{-1}. Despite the decrease in AA content as a function of the increase in water salinity, plants cultivated with the highest salinity level (3.8 dS m^{-1}) had the lowest reduction in this variable.

The decrease in ascorbic acid content (AA) may be related to changes in the translocation of photoassimilates due to the stress caused by excess salts in irrigation water. Dias et al. (2011) also found that the increase in irrigation water salinity (ECw from 0.5 to 4.5 dS m^{-1}) led to reduction in vitamin C (ascorbic acid) content in yellow passion fruit. These authors classified the decrease in ascorbic acid content as a consequence of the reduction in the synthesis of hexose sugars, originally D-glucose or D -galactose.

CONCLUSIONS

Increase in water salinity reduces fruit size, evaluated by diameter and fresh mass formation, but increases the soluble solids contents and titratable acidity of the pulp of fruits of West Indian cherry, cv. 'BRS 366 Jaburu'.

Phosphate fertilization, regardless of dose, stimulates the formation of fresh mass in West Indian cherry fruits.

Water salinity inhibits the formation of ascorbic acid in West Indian cherry fruits, with highest value in plants irrigated using 0.6 dS m^{-1} water and fertilized with a dose of 100% P_2O_5.

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