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PRODUÇÃO E QUALIDADE PÓS-COLHEITA DO MARACUJAZEIRO-AZEDO IRRIGADO COM ÁGUAS SALINAS E APLICAÇÃO EXÓGENA DE H_2O_2

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1 RESUMO

O Nordeste brasileiro é caracterizado tanto pela indisponibilidade hídrica em termos quantitativos como qualitativos. Para assegurar a produção de alimentos nesta região é necessário o uso de fontes hídricas com elevada salinidade. Assim torna-se necessário buscar estratégias que amenizem o efeito do estresse salino nas plantas irrigadas com águas salinas. Neste contexto, objetivou-se com este estudo avaliar a produção e a qualidade pós-colheita do maracujazeiro-azedo 'BRS Rubi do Cerrado' irrigado com águas salinas e aplicação foliar de peróxido de hidrogênio - H_2O_2. O experimento foi desenvolvido em lisímetros de drenagem sob condições de casa de vegetação em Campina Grande – PB. O delineamento foi inteiramente casualizados em parcelas subdivididas, sendo cinco níveis de condutividade elétrica da água - CEa (0,6; 1,2; 1,8; 2,4 e 3,0 dS m^{-1}) consideradas as parcelas e quatro concentrações de H_2O_2 (0, 15, 30 e 45 μM) as subparcelas, com três repetições. A aplicação exógena de H_2O_2 na concentração de 30 μM amenizou os efeitos deletérios do estresse salino sobre o número de frutos e espessura da casca do maracujazeiro-azedo. O H_2O_2 exógeno no cultivo do maracujazeiro azedo atua como elicitor dos efeitos negativos da irrigação com águas salinas no diâmetro polar, rendimento e massa da polpa.

Palavras-chave: *Passiflora edulis* Sims, peróxido de hidrogênio, estresse oxidativo, homeostase redox.

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YIELD AND POST-HARVEST QUALITY OF SOUR PASSION FRUIT UNDER SALINE WATERS AND EXOGENOUS APPLICATION OF H_2O_2

2 ABSTRACT

The brazilian northeast is characterized by limited water unavailability, both in quantitative and qualitative terms. Therefore, high salt waters are applied to assure food production in the region. Thus, some strategies need to be adopted to mitigate the salt effect on grown plants. In this context, this study aimed to evaluate the yield and post-harvest quality of sour passion fruit 'BRS Rubi do Cerrado' under saline waters and H_2O_2 application on leaves. The experiment

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was carried out using drainage lysimeters under greenhouse conditions in the municipality of Campina Grande (state of Paraiba in Brazil). The design was completely randomized in split-plot plots, with water salinity levels ECw (0.6, 1.2, 1.8, 2.4, and 3.0 dS m^{-1}) considered the plots and concentrations of H_2O_2 (0, 15, 30, and 45 µM) considered the subplots, with three replicates. Exogenous application of H_2O_2 at 30 µM mitigated the adverse effects of salt on the number of fruits and shell thickness of sour passion fruit. The exogenous application of H_2O_2 on sour passion fruit production mitigates the negative effects caused by saline water on polar diameter, slurry yield, and weight.

Keywords: *Passiflora edulis* Sims, hydrogen peroxide, oxidative stress, redox homeostasis.

3 INTRODUCTION

Brazil is the world's largest producer and consumer of passion fruit, producing approximately 1 million tons (FALEIRO; JUNQUEIRA, 2016). According to data obtained by the IBGE, in 2020, the Northeast Region was the largest producer, with a production of 491,326 tons. Ceará stood out as the largest national producer, accounting for 28.93% of the total production, and in the national ranking, Paraíba was in 12th place, with a production of 10,076 tons and an average yield of 9,605 kg ha- ^{1} (IBGE, 2022).

The Northeast Region of Brazil has edaphoclimatic conditions that favor passion fruit cultivation; however, the high temporal and spatial variability of rainfall (LIMA *et al.*, 2016; BEZERRA *et al.*, 2018), associated with high evapotranspiration, results in water deficit for plants as well as a reduction in the quality of water available for irrigation, which commonly results in high concentrations of soluble salts (FREIRE *et al.*, 2014; LIMA *et al.*, 2020a; LIMA *et al.*, 2021).

Salinity can cause osmotic and ionic effects, limiting the production of carbohydrates and proteins. Among these osmoprotectants, proline is a stress-related metabolite that aids in osmoregulation and increases tolerance to certain levels of water and salt stress (SANTOS *et al.*, 2016; SALAZAR *et al.*, 2017; LIMA *et al.*, 2020b). Excess salts in irrigation water can also cause changes in cell membrane permeability and plant physiological functions due to osmotic stress, disturbances in water relations, and changes in ionic homeostasis (LIMA *et al.*, 2014; LIMA *et al.*, 2015). Silva *et al.* (2019), when investigating the gas exchange and growth of yellow passion fruit seedlings irrigated with saline water (0.7; 1.4; 2.1 and 2.8 dS m $^{-1}$) and foliar application of hydrogen peroxide (0; 25; 50 and 75 µM), reported that the crop can be classified as sensitive to salt stress, with a threshold salinity of irrigation water of 0.7 dS m $^{-1}$.

Thus, the search for strategies that allow the use of saline waters in agricultural production has been a challenge for several researchers. In this context, the use of hydrogen peroxide $_{(H2O2)}$ applied via foliar application has been studied with the aim of mitigating the deleterious effects of excess salts on plants (BAGHERI; GHOLAMI; BANISAB, 2019; QIAO *et al.*, 2021; SILVA *et al.*, 2019).

OH $_2$ O2 is a reactive oxygen species that is naturally produced in mitochondria, chloroplasts, and peroxisomes and diffuses through cells and tissues to initiate immediate cellular effects, such as changes in cell shape; the onset of abiotic stress; the signaling of cellular damage; and the activation of antioxidant enzymes that mitigate damage related to the action of external agents such as salinity, temperature, and water deficit (SIES, 2017).

Pretreatment with exogenous H_2O_2 decreases lipid peroxidation induced by salt stress while increasing the proline content in the roots so that the increased accumulation of proline in the presence of NaCl is significantly suppressed by diphenylene iodonium (DPI), an NADPH oxidase inhibitor, and dimethylthiourea, an H_2O_2 scavenger; thus, hydrogen peroxide, which is mediated by the action of the enzyme NADPH oxidase, alleviates the oxidative damage induced by salt stress through the regulation of proline biosynthesis (LIU; HUANG; SUN, 2020).

The use of reactive oxygen species can improve lipid accumulation through the upregulation of genes related to lipid biosynthesis, mediating the accumulation of molecules essential for lipid metabolism (ZHANG *et al.*, 2020; SILVA *et al.*, 2021). Furthermore, lipid accumulation in plants under salt stress may be an adaptive mechanism, allowing them to respond to increased osmotic pressure and maintain cell membrane fluidity and integrity (JI *et al.*, 2018).

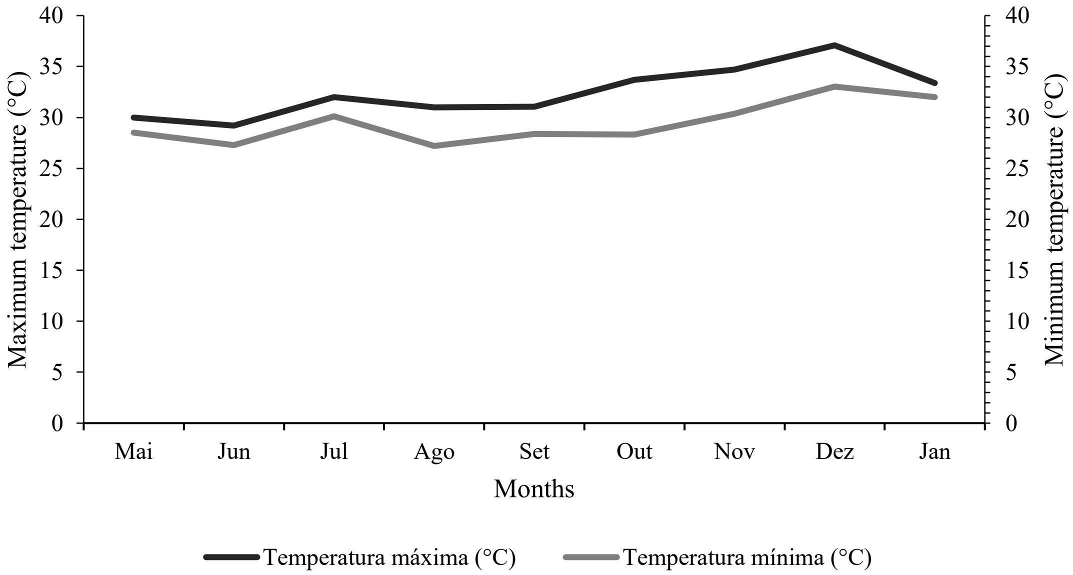
Given the above, the objective of this study was to evaluate the production and postharvest quality of 'BRS Rubi do Cerrado' passion fruit irrigated with saltwater and foliar application of hydrogen peroxide.

4 MATERIALS AND METHODS

The experiment was conducted between May 2019 and January 2020 in an arch-type greenhouse with a 150-micron low-density polyethylene cover, belonging to the Academic Unit of Agricultural Engineering - UAEAg at the Federal University of Campina Grande, in Campina Grande - UFCG, state of Paraíba, Brazil (7°15'18" S, 35°52'28" W and average altitude of 550 m).

Maximum and minimum temperature data were collected throughout the experimental period via a digital thermometer (Figure 1).

Figure 1. Maximum and minimum temperature data inside the greenhouse throughout the experiment.



The treatments resulted from the combination of five levels of electrical conductivity of irrigation water, ECw (0.6, 1.2, 1.8, 2.4 and 3.0 dS m $^{-1}$), and four concentrations of hydrogen peroxide, H_2O_2 (0, 15, 30 and 40 μM). The design was completely randomized in subdivided plots, with three replicates. The electrical conductivity levels of irrigation water were considered as a plot, and the hydrogen peroxide concentrations were considered subplots. The H_2O_2 concentrations and ECw levels were established on the basis of a study developed by Andrade *et al.* (2019).

Seeds of the sour passion fruit 'BRS Rubi do Cerrado' obtained from the orchard of the Instituto Federal da Paraíba-IFPB, Sousa campus, were used. The fruits of this cultivar are predominantly red, purplish, or yellowish skin, weigh on average 170 g, and are rounded, with an average soluble solids content of 14° Brix, a pulp yield of approximately 35%, greater resistance to transport, a strong yellow pulp color (higher amount of vitamin C), and resistance to diseases such as viruses and bacteria (EMBRAPA, 2014).

To prepare the seedlings, 3 kg plastic bags were used, which were filled with substrate at a proportion of 84:15:1 (by volume) for the soil, washed sand and organic matter (worm castings) by mass. The moisture content of the substrate was raised to the level corresponding to field capacity, and then four seeds were sown per bag. Irrigation was performed daily via the weighing lysimetry method (BERNARDO; SOARES; MANTOVANI, 2008).

Ten days after emergence, thinning was carried out, leaving one plant per bag. Seventy days after emergence, when the plants tended to grow, the seedlings were transplanted into pots adapted as drainage lysimeters.

The vessels adapted as drainage lysimeters had a capacity of 250 L (70 cm high, 57 cm bottom diameter, and 57 cm top opening). Each lysimeter was perforated at the base and fitted with a drain. A nonwoven geotextile blanket (Bidim) was placed over each drain to prevent clogging. A plastic container was attached to the outer end of each drain to collect the drained water and estimate the plant's water consumption.

The lysimeters were filled with a layer of 0.5 kg of gravel followed by 250 kg of soil representative of the semiarid region in Alagoa Nova, PB, and were classified as chromic Luvisol (EMBRAPA, 2018). Before starting the experiment, chemical and physical-hydric attributes were characterized (Table 1) according to the methodology of Teixeira *et al.* (2017).

Table 1. Chemical and physical–hydraulic characteristics of the soil used in the experiment

Chemical characteristics								
pH	MO	P	K^+	In the +	Ca^{2+}	Mg 2+	Al^{3+} + H +	CEes
-	dag kg $^{-1}$	(mg kg $^{-1}$)	..........................(cmol $_c$ kg $^{-1}$)					(dS m $^{-1}$)
5.90	1.3	6.8	0.2	0.1	2.6	3.6	1.9	1.0

Physical-water characteristics									
Granulometric fraction (dag kg $^{-1}$)			CL	Humidity (kPa)		AD	PT	FRO	DP
Sand	Silt	Clay		33.42	1519.5 dag kg $^{-1}$	....	%	(kg dm $^{-3}$)	
73.2	14.2	12.5	FA N	11.9	4.3	7.6	47.7	1.39	2.6

MO – Organic matter: Walkley-Black Wet Digestion; Ca^{2+} and Mg^{2+} extracted with 1 M KCl pH 7.0; Na^+ and K^+ extracted using 1 M NH_4OAc pH 7.0; Al^{3+} and H^+ extracted using 0.5 M CaOAc pH 7.0; CL – Extural class; FA – Sandy loam; PT – Total porosity; AD – Available water; DA - Apparent density; DP - Particle density.

The spacing used was 2.20 m between rows and 1.50 m between plants; the vertical easing system with smooth wire no. 14 was installed inside the greenhouse, 2.40 m from the floor and 1.60 m from the lysimeter soil.

When the plants reached 10 cm above the espalier, the apical bud was pruned to stimulate the emission of secondary branches, which were conducted one to each side until a length of 1.10 m, where a new pruning was performed to emission tertiary branches and consequently the formation of curtains and stimulation of inflorescences. Pruning was performed 30 cm from the ground of the tertiary branches to avoid contact with the soil. Throughout the pruning process, a Bordeaux mixture was applied to promote the healing of injuries, as indicated by Mezzonato-Pires; Salimena; Bernacci (2013).

Foundation fertilization was carried out as recommended by São José (2000), applying 250 g of simple superphosphate (18.9% P_2O_2) and 100 g of potassium chloride (60% K_2O) monthly until the beginning of flowering; after the beginning of this stage, fertilization with nitrogen and potassium was carried out monthly, according to the recommendation of Santos (2001), using urea (45.9% N) as the nitrogen source and potassium chloride (60% K_2O) as the potassium source.

In the vegetative phase, a ratio of 1 N:1K was used, with 10 g of nitrogen used as a reference; from the beginning of flowering, the N dose was increased to 20 g and K to 30 g, and the N:K ratio was increased to 1:1.5. Micronutrient fertilization was carried out according to Embrapa (2010) at 15-day intervals after transplanting. The plants were sprayed on the adaxial and abaxial surfaces of leaves with a solution containing 2.5 g/L commercial fertilizer with the following composition: N (15%); P_2O_5 (15%); K_2O (15%); Ca (1%); Mg (1.4%); S (2.7%); Zn (0.5%); B (0.05%); Fe (0.5%); Mn (0.05%); Cu (0.5%) and Mo (0.02%).

The electrical conductivity levels of the irrigation water were prepared to have an equivalent ratio of 7:2:1 in terms of the relationship between Na:Ca:Mg and the salts NaCl, $CaCl_2.2H_2O$ and $MgCl_2.6H_2O$, adjusting them to the concentrations of the available water supply, which is the proportion of salts commonly found in water bodies of the semiarid region (MEDEIROS, 1992). In the preparation of the irrigation water, the relationship between ECa and the salt concentration extracted from Richards (1954) was considered, according to Eq. 1:

$$C = 10 \times CEa \quad (1)$$

where:

C = Concentration of salts to be applied (mmol $_c$ L $^{-1}$);

CEa = electrical conductivity of water (dS m $^{-1}$).

Irrigation with saline water began 15 days after transplanting; during this period, the plants were irrigated with water with low electrical conductivity (0.6 dS m $^{-1}$).

After transplanting, irrigation was carried out daily, and the volume corresponding to that obtained via the water balance was applied to each container; the volume of water to be applied to the plants was determined via Eq. 2:

$$VI = \frac{(Va - Vd)}{(1 - FL)} \quad (2)$$

where:

VI = Volume of water to be used in the next irrigation event (mL);

Va = volume applied in the previous irrigation event (mL);

Vd = Drained volume (mL) and

FL = leaching fraction of 0.15 (AYERS; WESTCOT, 1999).

H2O2) concentrations were prepared in deionized water for each application, as H2O2 degrades rapidly in the presence of light. The volume used per treatment was quantified at the end of each application. During the crop development period until the beginning of flowering, each plant received an average of 63.75 mL of hydrogen peroxide solution per application. To prevent drift of the H2O2 solution, the plants in each treatment were isolated via plastic curtains.

Hydrogen peroxide was applied via foliar spray on the adaxial and abaxial surfaces at 15-day intervals, beginning 15 days after the start of irrigation with salinized water until the flowering stage. A manual sprayer for a PET bottle with an adjustable 1 cm conical metal nozzle, an operating pressure of 300 psi, and a flow rate of 1.1 L min $^{-1}$ was used for this purpose. Applications were made after 5:00 p.m. because of the lower incidence of light.

At 240 days after transplanting (DAT), the number of fruits per plant (NF) and fresh fruit mass (MFF) were measured. The following physical characteristics of the fruits were also evaluated: equatorial (DE) and polar diameter (DP), peel thickness (EC), pulp mass (MP), and internal attributes: pulp yield (RP) and the ratio of pulp mass to fresh fruit mass. The soluble solids content (°Brix) and pulp density (Dens) were determined via an Adago analog refractometer. Fruits with a completely yellow or reddish skin color that were spontaneously detached from the plant were considered the ideal ripening stage.

The Shapiro–Wilk test and the homoscedasticity test were applied to the data to verify the assumption of normality. They were then subjected to analysis of variance via the F test at $p \leq 0.05$, and when significant, linear and quadratic polynomial regression analyses were performed via SISVAR ESAL statistical software (FERREIRA, 2019). When heterogeneity occurred in the data, which was verified through the coefficient of variation values, exploratory data analysis was performed, with square root transformation.

5 RESULTS AND DISCUSSION

The interaction between the factors (NS × H_2O_2) significantly affected all the analyzed variables, except for fresh fruit mass (Table 2). Water salinity levels significantly influenced all the measured variables. H2O2 concentrations significantly affected the polar (DP) and equatorial (ED) diameters, peel thickness (EC) and number of fruits (NF) of sour passion fruit 240 days after transplanting.

Table 2. Summary of the F test results for the polar (PD) and equatorial (ED) diameter, peel thickness (EC), number of fruits (NF) and fresh fruit mass (MFF) of sour passion fruit 'BRS Rubi do Cerrado' irrigated with saltwater and foliar application of hydrogen peroxide (H_2O_2)

Source of variation	F Test				
	DP	OF	EC	NF	MFF
Saline Levels (SL)	**	**	**	**	**
Linear regression	**	**	*	**	**
Quadratic regression	ns	*	**	**	ns
Hydrogen peroxide (H_2O_2)	* *	ns	**	**	ns
Linear regression	**	*	ns	*	ns
Quadratic regression	ns	ns	**	*	ns
Interaction (NS × H_2O_2)	**	**	**	**	ns
CV 1 (%)	2.17	5.11	6.83	6:30	10.14
CV 2 (%)	2.94	3.21	5.78	5.89	15,15

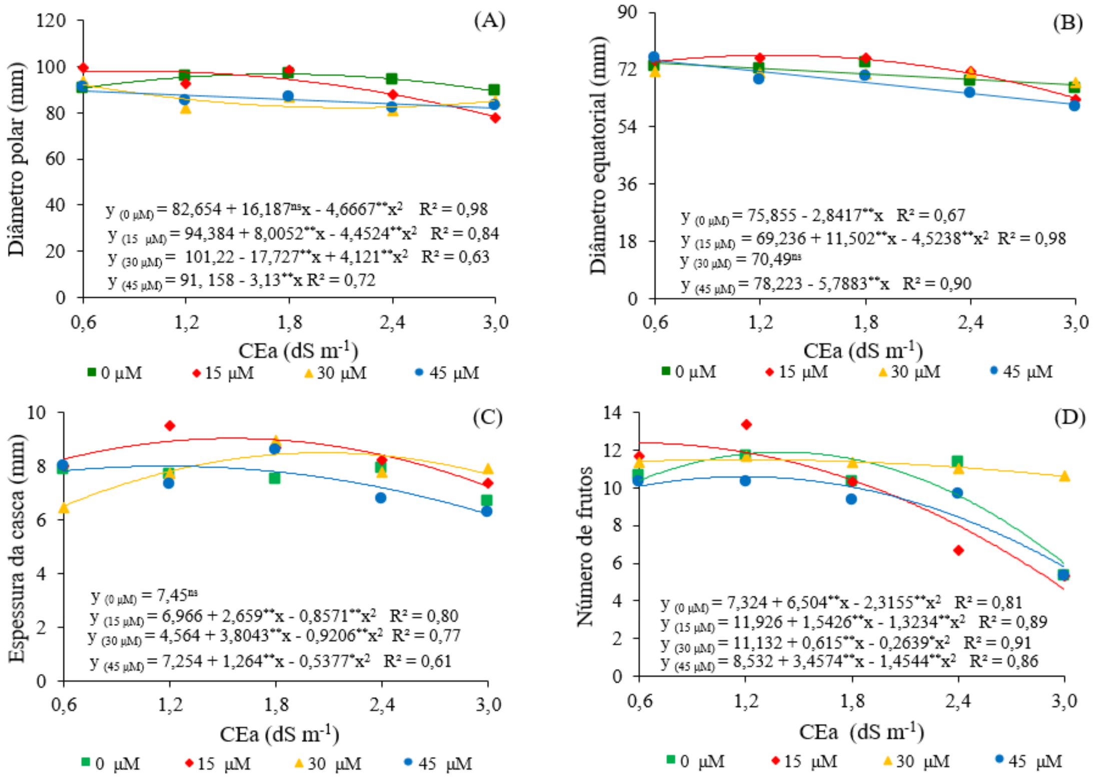
^{ns} Not significant; *, ** significant at 0.05 and 0.01, respectively; CV - coefficient of variation.

The polar diameter of the 'BRS Rubi do Cerrado' sour passion fruit plants that received concentrations of 0, 15 and 30 µM H2O2 fit the quadratic regression model (Figure 2A), which yielded maximum estimated values of 96.69, 97.98 and 92.07 mm when they were irrigated with ECw values of 1.7, 0.9, and 0.6 dS m $^{-1}$, respectively. When 45 µM H2O2 was applied, the data were fitted with a linear regression model, with a decrease of 3.43 mm in the DP of the fruits per unit increase in the salinity of the irrigation water. When the values obtained at the lowest salinity level (0.6 dS m $^{-1}$) were compared with those at the highest salinity level (3.0 dS m $^{-1}$) and a concentration of 45 µM H2O2, a reduction of 8.41% (7.51 mm) in the DP of the sour passion fruit was noted at 240 DAP.

Thus, it can be inferred that exogenously applied hydrogen peroxide at certain concentrations can mitigate the deleterious effects of saline water irrigation. However, at high concentrations, this reactive oxygen species can be toxic, increasing the action of endogenous oxidative enzymes. Notably, plants also have the ability to acclimate, to a certain extent, to stress conditions through physiological processes common in glycophytic plants, such as osmotic adjustment.

Pinheiro *et al.* (2023), evaluating potassium fertilization (60 and 100% of the K_2O recommendation) and different management strategies for the use of saline water (1.3 and 4.0 dS m $^{-1}$), also reported a reduction in the morphological parameters of sour passion fruit when the plants were irrigated with 4.0 dS m $^{-1}$ water throughout the cultivation cycle, in the vegetative phase and in the flowering phase.

Figure 2. Polar (A) and equatorial (B) diameter, peel thickness (C) and number of fruits (D) of the sour passion fruit 'BRS Rubi do Cerrado' as a function of the interaction between the electrical conductivity of the irrigation water (CEa) and the hydrogen peroxide (H_2O_2) concentration 240 days after transplanting.



The increase in the electrical conductivity of the irrigation water reduced the equatorial diameter (ED) of the sour passion fruit 'BRS Rubi do Cerrado' regardless of the foliar application of hydrogen peroxide. According to the linear regression equations (Figure 2B), a decrease per unit increase in irrigation EWc corresponding to 3.74 and 7.40 mm in the EWc of the sour passion fruit was observed when concentrations of 0 and 45 µM H_2O_2 were used. For the respective concentrations (0 and 45 µM), when the average values obtained at the lowest EWc (0.3 dS m^{-1}) were compared with those obtained at the highest EWc (3.0 dS m^{-1}), equivalent reductions of 9.20% (6.82 mm) and 15.58% (13.89 mm) were observed. At a concentration of 15 µM, the data were fitted with a polynomial equation, with the highest estimated value being 76.54 mm at a salinity of 1.3 dS m^{-1}. Moreover, there was no significant effect of 30 µM H_2O_2 on the ED of passion fruit.

The foliar application of H_2O_2 at concentrations of 15 and 45 µM did not mitigate saline stress on the equatorial diameter (ED), suggesting that at this concentration, the plant is conditioned to improve its physiological apparatus to acclimate to saline stress conditions and the action of reactive oxygen species through intracellular signals to increase the production of osmoprotective complexes (proline, glycine betaine) and other antioxidant enzymes to ensure the integrity of its cells (REIS; LIMA; SOUZA, 2012).

However, the effects of H_2O_2 in biological systems depend on the concentration of H_2O_2, the physiological conditions and the specificities of the processes affected by H_2O_2. Thus, clearly distinguishing between the beneficial (signaling) and deleterious (causes damage) roles of H_2O_2 is challenging (WOJTYLA *et al.*, 2016).

The peel thickness (EC) of the fruits was also influenced by foliar application of hydrogen peroxide and irrigation with saltwater (Figure 2C). For cultivated plants subjected to foliar applications of 15, 30, and 45 µM H_2O_2, the data fit the quadratic equation, with maximum estimated values of 9.03, 8.49, and 8.00 mm, respectively, when irrigated with ECw values of 1.6, 2.1, and 1.2 dS m $^{-1}$, respectively. Notably, the concentration of 0 µM H_2O_2 did not significantly influence the EC of passion fruit irrigated with saltwater.

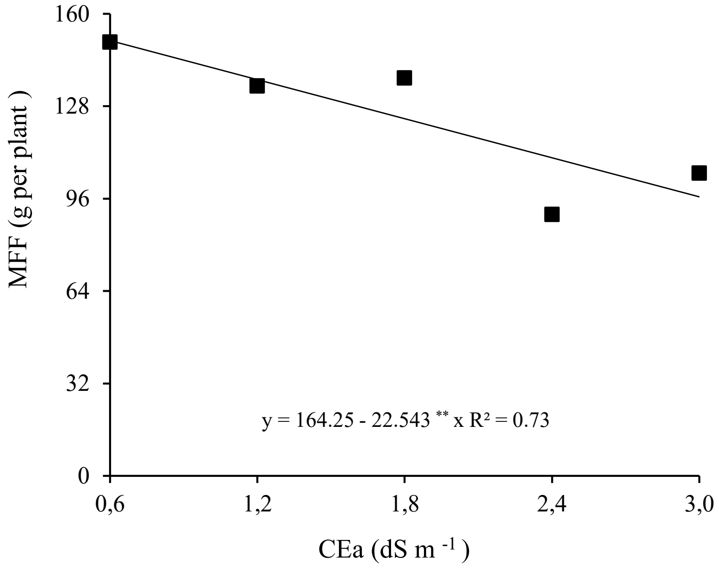
In general, regardless of the H_2O_2 concentration, a reduction in EC occurred under conditions of high water salinity. At low concentrations, hydrogen peroxide can induce acclimation responses in plants under salt stress conditions, inducing changes in their biochemical antioxidant defense functions through the action of antioxidant enzymes to achieve redox homeostasis (CAVERSAN; CASASSOLA; BRAMMER, 2016).

The number of fruits (NF) was influenced by the interaction between the factors (NS × H_2O_2). The plants subjected to H_2O_2 concentrations of 0, 15, 30 and 45 µM reached maximum values of 11.89, 12.38, 11.49 and 10.59 fruits, respectively, under irrigation, with ECw values estimated at 1.4, 0.6, 1.2 and 1.2 dS m $^{-1}$, respectively (Figure 2D). The NF of the plants cultivated with 0, 15, 30 and 45 µM H_2O_2 decreased by 42.30, 62.48, 7.05 and 42.33% (4.40, 7.73, 0.8 and 4.27 fruits), respectively, among the plants irrigated with an ECw of 3.0 dS m $^{-1}$ in relation to the lowest water salinity (0.6 dS m $^{-1}$).

Regardless of the H_2O_2 concentration, there was a reduction in the number of fruits due to the increase in the ECa. Under conditions of salinity stress, there is a reduction in photosynthetic activity and nutrient absorption, transport, assimilation and distribution, as well as an increase in the accumulation of reactive oxygen species (ROS), which can be attributed to the osmotic and ionic effects caused by high salinity, thus reducing the productive yield of plants (HUANG, 2018).

The fresh mass of the passion fruit 'BRS Rubi do Cerrado' decreased linearly with increasing water salinity level (Figure 3), with a reduction of 13.72% per unit increase in ECw and a 35.9% reduction (54.1 g per plant) in the MFF of plants subjected to an ECw of 3.0 dS m $^{-1}$ in relation to those irrigated with 0.6 dS m $^{-1}$ water. The decrease in fresh mass of the fruits reflects the changes caused by excess salts resulting from the decrease in osmotic potential, hindering the absorption of water and nutrients by the plants. In research with passion fruit 'Guinezinho' under conditions of water salinity (0.7 to 2.8 dS m $^{-1}$) and exogenous application of H_2O_2 (0 to 60 µM), Andrade *et al.* (2019) also reported a linear reduction in the number of fruits per plant, with a decrease of 26.8% per unit increase in ECa.

Figure 3. Fresh fruit mass – MFF of the sour passion fruit 'BRS Rubi do Cerrado' as a function of the interaction between the electrical conductivity of the irrigation water and the CEa 240 days after transplanting.



The levels significantly interfered ($p<0.05$) with the hydrogen peroxide concentrations and the interaction effect (NS × H_2O_2) on all the variables analyzed, except for the pulp density (Dens) of sour passion fruit 'BRS Rubi do Cerrado' at 240 days after transplanting (Table 3).

Table 3. Summary of the F test results for pulp yield (RP), pulp mass (MP), soluble solids (°Brix) and pulp density (Dens) of the sour passion fruit 'BRS Rubi do Cerrado' irrigated with saltwater and foliar application of hydrogen peroxide (H_2O_2) 240 days after transplanting

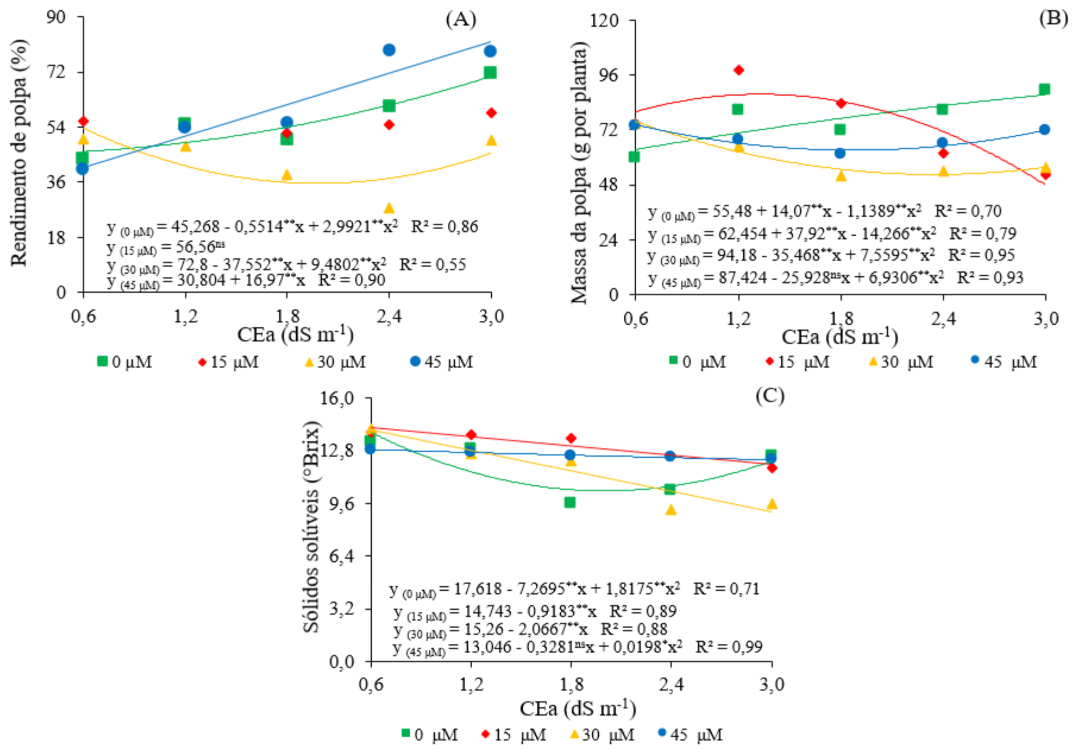
Source of variation	F Test			
	PR	**MP**	**°Brix**	**Dens**
Saline Levels (SL)	**	**	**	ns
Linear regression	**	**	**	ns
Quadratic regression	**	**	**	ns
Hydrogen peroxide (H_2O_2)	**	**	**	ns
Linear regression	*	**	ns	ns
Quadratic regression	**	**	**	ns
Interaction (NS × H_2O_2)	**	**	**	ns
CV 1 (%)	7.31	1.78	5.46	0.57
CV 2 (%)	5.62	4.55	5.02	0.66

^{ns} Not significant; *, ** significant at 0.05 and 0.01, respectively; CV - coefficient of variation.

The pulp yield (RP) of sour passion fruit was significantly affected by the interaction between irrigation water salinity and foliar application of H_2O_2 (Figure 4A). When the plants were subjected to concentrations of 0 and 30 µM H2O2, the data were fitted with a quadratic regression model, with maximum estimated values of 70.54 and 53.68% under ECw values of 3.0 and 0.6 dS m $^{-1}$, respectively. When subjected to a concentration of 45 µM H_2O_2, a linear increase in the pulp yield of sour passion fruit was observed, with an increase of 55.09% per unit increase in the ECw. A 49.84% reduction in fruit pulp yield was observed when the highest CEa (3.0 dS m $^{-1}$) was compared with the lowest level (0.3 dS m $^{-1}$). The concentration of 15 µM H_2O_2 did not significantly influence the RP when the plants were subjected to different salinity levels of the irrigation water (Figure 4A).

The foliar application of H2O2 promoted the salinity of the irrigation water, with an electrical conductivity of 3.0 dS m $^{-1}$. This increase in the pulp yield of passion fruit irrigated with an ECw of 3.0 dS m -1 and exogenous application of 45 µM H2O is possibly due to the increase in the pulp yield of passion fruit irrigated with an ECw of 3.0 dS m $^{-1}$ and exogenous application of 45 µM H2O because H2O2 at low concentrations can cooperate with changes in the response of antioxidant enzymes, acting as a protector and contributing to increased plant tolerance to saline stress (SILVA *et al.*, 2016; ANDRADE *et al.*, 2022).

Figure 4. Yield (A) and pulp mass (B) and soluble solids (C) of the sour passion fruit 'BRS Rubi do Cerrado' as a function of the interaction between the electrical conductivity of the irrigation water (CEa) and the hydrogen peroxide (H_2O_2) concentration 240 days after transplanting.



The pulp mass of the sour passion fruit 'BRS Rubi do Cerrado' was significantly influenced by the interaction between the factors (NS × H_2O_2). For all concentrations, the results were fitted with a quadratic regression model (Figure 4B). When concentrations of 0, 15, 30 and 45 µM H_2O_2 were applied, the highest estimated values corresponded to 87.44, 87.64, 80.82 and 74.36 g, respectively, under irrigation water salinity levels of 3.0, 1.3, 0.6 and 0.6 dS m $^{-1}$, respectively.

Hydrogen peroxide applied exogenously and at low concentrations can promote genetic changes in plants under stress conditions, regulating proteins involved in posttranslational processes that act in nitrogen assimilation and lipid biosynthesis (ROSENWASSER *et al.*, 2014). The increase in pulp mass in plants treated with 0 and 15 μM $_{H2O2}$ may be associated with the accumulation of osmoprotectants, such as proline and glycine betaine, as an acclimative mechanism used to adjust their osmotic potential (HASEGAWA, 2013; DANTAS *et al.*, 2022).

The total soluble solids of sour passion fruit (°Brix) were significantly affected by the interaction between the factors (NS × H_2O_2). In general, increasing ECa levels reduced the total soluble solids contents of sour passion fruit (Figure 4C). When 0 and 45 μM $_{H2O2}$ were applied, the data were fitted with a polynomial regression model, with maximum values estimated at 13.91 and 12.86 °Brix, respectively. When subjected to concentrations of 15 and 30 μM, a decreasing linear reduction was observed, with reductions of 6.23 and 13.54 °Brix per unit increase in irrigation water salinity. At concentrations of 15 and 30 μM, reductions equivalent to 15.53% (2.20 °Brix) and 35.38% (4.96 °Brix) were observed, respectively, when the lowest salinity level (3.0 dS m^{-1}) was compared with the highest level (3.0 dS m^{-1}).

Similarly, Dias *et al.* (2011), who investigated the effects of irrigation with saline water (0.5 to 4.5 dS m^{-1}) on the cultivation of yellow passion fruit in soil fertilized with bovine biofertilizer on different dates, reported a reduction in the content of soluble solids with increasing ECw, with an average reduction of 0.74°Brix per unit increase in ECw.

According to the Ministry of Agriculture, Livestock and Supply/Secretariat of Agricultural Defense, Normative Instruction No. 37 of October 8, 2018 (BRAZIL, 2018), the minimum amount of soluble solids with commercial potential in passion fruit pulp is 11 °Brix at 20 °C. Thus, on average, the soluble solids found in this study (12.63 Brix) are within the commercial standard range and can be marketed on the basis of this parameter, except when hydrogen peroxide is not used.

6 CONCLUSIONS

Irrigation with saline water compromises the production and postharvest quality of the sour passion fruit 'BRS Rubi do Cerrado';

The exogenous application of hydrogen peroxide at a concentration of 30 μM mitigated the deleterious effects of saline stress on the number of fruits and skin thickness, and at 45 μM, it promoted a greater yield of sour passion fruit pulp.

Exogenous hydrogen peroxide in the cultivation of sour passion fruit 'BRS Rubi do Cerrado' acts as an elicitor of the negative effects of irrigation with saline water on the polar diameter, pulp yield and pulp mass.

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