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ORIGINAL ARTICLE

Do moderate salinity and harvest stages interfere with gas exchange and quality of yellow melon fruits?[1]

Salinidade moderada e época de colheita interferem nas trocas gasosas e na qualidade dos frutos de melão amarelo?

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HIGHLIGHTS:

The gas exchange of 'Goldex' melon is not affected by moderate salinity, but it tends to decrease throughout the cycle.
Electrical conductivity of irrigation water of 4.0 dS m^{-1} reduces the fruit mass of 'Goldex' yellow melon.
The quality of 'Goldex' yellow melon fruits is not affected by moderate water salinity.

ABSTRACT: Salinity is one of the most limiting factors for agricultural productivity, as it affects both gas exchange and plant metabolism. However, with population growth and the constant search for alternatives to increase productivity, irrigation with water of moderate salinity appears to be feasible to enhance fruit cultivation in Brazil, especially in semi-arid regions, where most waters have high salt concentration and are the only available source for the producer. In this context, the objective of this study was to evaluate the effects of irrigation water salinity and harvest stages on gas exchange and post-harvest fruit quality of 'Goldex' yellow melon (*Cucumis melo* L.). The treatments consisted of two electrical conductivities of irrigation water (ECw - 0.8 and 4.0 dS m^{-1}) and eight harvest stages (54, 56, 58, 60, 62, 64, 66, and 68 days after transplanting), arranged in a 2 × 8 factorial scheme and a completely randomized design. Under the salinity conditions imposed during the evaluation stages, the 'Goldex' yellow melon maintained its basic gas exchanges stable. The mass and number of fruits per plant were reduced by the salinity of the irrigation water, but the fruits continued to be classified as marketable, which makes irrigation with saline water up to 4.0 dS m^{-1} a viable alternative for the production of yellow melon, especially in regions where there is low availability of good quality water, which can enhance fruit growing in the semi-arid region.

Key words: *Cucumis melo* L., plant physiology, saline water irrigation, post-harvest

RESUMO: A salinidade é um dos fatores mais limitantes para a produtividade agrícola, pois afeta tanto as trocas gasosas quanto o metabolismo das plantas. Porém, com o crescimento populacional e a busca constante por alternativas para aumentar a produtividade, a irrigação com águas de salinidade moderada parece ser viável para potencializar a fruticultura no Brasil, especialmente nas regiões semiáridas, onde a maioria das águas tem alta concentração de sal e são as únicas fontes disponíveis para o produtor. Neste contexto, o objetivo deste estudo foi avaliar os efeitos da salinidade da água de irrigação nas trocas gasosas e na qualidade pós-colheita dos frutos do melão amarelo 'Goldex' (*Cucumis melo* L.) nas fases de colheita. Os tratamentos consistiram de duas condutividades elétricas da água de irrigação (CEa - 0,8 e 4,0 dS m^{-1}) e oito etapas de colheita (54, 56, 58, 60, 62, 64, 66 e 68 dias após o transplantio), dispostas em forma de esquema fatorial 2 × 8 e delineamento inteiramente casualizado. Nas condições de salinidade impostas durante as etapas de avaliação, o melão amarelo 'Goldex' manteve estáveis suas trocas gasosas básicas. A massa e o número de frutos por planta foram reduzidos pela salinidade da água de irrigação, mas os frutos continuaram classificados como comercializáveis, o que torna a irrigação com água salina até 4,0 dS m^{-1} uma alternativa viável para a produção de melão amarelo, principalmente em regiões onde há baixa disponibilidade de água de boa qualidade, o que pode potencializar a fruticultura no semiárido.

Palavras-chave: *Cucumis melo* L., fisiologia de planta, irrigação salina, pós-colheita

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Introduction

In 2021, Brazil produced over 600 thousand tons of melon (*Cucumis melo* L.) in an area of 23,000 hectares, achieving an average yield of 25 t ha^{-1}, with the Northeast region accounting for about 90% of the melon planted area, highlighting the regional and national relevance of the crop (IBGE, 2023). However, in the Brazilian melon production area, there is a restriction on water quantity and quality, since most wells have water with high electrical conductivity (Akrami & Arzani, 2019).

About one billion hectares of saline soils are present in coastal and continental areas around the world, with an annual increase of approximately one million hectares, mainly in arid and semi-arid regions (Hopmans et al., 2021). Given this scenario, saline water in agriculture can be a promising solution for using these brackish waters and salt-affected soils in rural areas, covering a range of salinity levels (Gheyi et al., 2023). Although most studies carried out on cucurbits relating the effect of salinity take into account a specific phase of plant development, the study of salinity in the stages of plant development and the evolution of fruit maturation becomes relevant since salt stress may affect these stages differently and can contribute to the development of management strategies that can minimize salt stress at critical moments for plants and fruits (Sarabi et al., 2019).

Melon is classified as moderately sensitive to water salinity (2.2 dS m^{-1}), and reductions in yield have already been observed with increased salinity in irrigation water (Akrami & Arzani, 2019), as well as reduction in gas exchange (Sousa et al., 2021), growth inhibition and reduction in dry matter (Sousa et al., 2019). In this context, the objective of this study was to evaluate the effects of irrigation water salinity on gas exchange and post-harvest quality of 'Goldex' yellow melon (*Cucumis melo* L.) fruits at the harvest stage.

Material and Methods

The experiment was conducted in the field between October and December 2021, at the Experimental Farm of Pacajus, belonging to Embrapa Agroindústria Tropical, headquartered in Pacajus, Ceará, Brazil. The geographic coordinates are 4° 10' S and 38° 27' W, at an altitude of 60 m, and the soil is classified as *Neossolo Quartzarênico* (Quartzipsamment - United States) (Santos et al., 2018), whose characteristics are presented in Table 1.

The design adopted was completely randomized in a split-plot scheme. The plot consisted of two electrical conductivities of water (ECw 0.8 dS m^{-1} - control and with addition of NaCl - 4.0 dS m^{-1}), and subplots consisted of eight harvests over time (54, 56, 58, 60, 62, 64, 66, and 68 days after transplanting – DAT). The plants were arranged in a random scheme with eight crop rows and two border rows, totaling 10 rows. The spacing was 2 m between rows and 0.8 m between plants. Each cultivation row (treatment) contained 26 plants, of which one plant was randomly harvested during the eight harvests evaluated, making a total of 64 experimental units.

The seeds of 'Goldex' yellow melon (F1 hybrid of the yellow type) were acquired from Agristar Ltda's TOPSEED premium line, Lot: 065119, with a germination rate of 90% and purity of 99%. The seedlings were obtained through sowing in polypropylene trays each containing 200 cells. The substrate used for seedling production comprised coconut fiber, peat, and humus in a 1:1:1 ratio (volume basis). Upon the emergence of the first true leaf on the seedlings (13 days after sowing), they were transplanted to the definitive experimental field. Irrigation with saline water began at four days after transplanting - DAT (Araújo et al., 2024).

The level of 4.0 dS m^{-1} of electrical conductivity of water was obtained by adding adequate amounts of NaCl to water available at the Pacajus experimental farm, coming from a deep well (ECw = 0.8 dS m^{-1}), and the quantity was determined considering the relationship between ECw and salt concentration (Richards, 1954). The ratio used to obtain the salinity level was 10 mM of NaCl for every 1 dS m^{-1}. Adjustments were performed after measurement with a portable conductivity meter. The solutions were prepared in 5000 L water tanks and pumped to the plants by a 0.5 hp motor pump set through PVC pipes with diameter of ¾" for main lines and 16 mm for drip lines. Irrigation was applied using a drip system, with one line of drippers per row, which was covered with double-sided plastic mulching: black side facing down and silver side facing up.

Plant irrigation was based on estimated crop evapotranspiration ($ETc = ET_0 \times Kc \times Kr$). Reference evapotranspiration (ET_0) was calculated according to the FAO-Penman-Monteith method (Allen et al., 1998), using meteorological data obtained from a meteorological station located close to the orchard. The crop coefficients (Kc) applied for all melon development stages were used following the recommendation of Miranda et al. (2001). The irrigation lines had Katif pressure-compensating drippers from Revulis® (Minas Gerais, BR) with flow rate of 4 L h^{-1} spaced 0.8 m apart, corresponding to one dripper per plant. Irrigation began to be applied whenever there was no rainfall event ≥ 10 mm in the last seven days and stopped when a rainfall event ≥ 10 mm occurred. The daily means of maximum and minimum temperatures and relative humidity observed during the experimental period are shown in Figure 1.

Before sowing, the 0.0625-hectare area received the initial application of fertilizers based on soil analysis. Bovine manure (500 kg), urea (2.2 kg), triple superphosphate (29.3 kg), and potassium chloride (3.1 kg) were used. The entire fertilization process was carried out through fertigation, applied three times per week. Nutrient solution was prepared using a 20 L container, and the solution was applied through a Venturi

Table 1. Physical-chemical characteristics of the soil of the experimental area

Layer	P	O.M	pH	K^+	Ca^{2+}	Mg^{2+}	Na^+	H+Al	Al^{3+}	SB	CEC	V	m
(cm)	(mg dm^{-3})	(g kg^{-1})	(H_2O)	($mmol_c$ dm^{-3})								(%)	
0-20	88	9	5.7	7.1	19	10	5	17	0	41	57	71	0

O.M - Organic matter; SB - Sum of exchangeable bases; CEC - Cation exchange capacity; V - Base saturation percentage; m - Aluminum saturation percentage

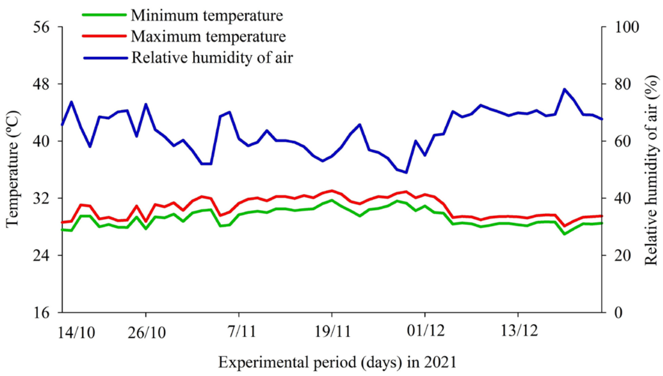


Figure 1. Daily means of maximum and minimum temperatures and relative humidity of air during the experimental period (October to December 2021)

injector in a bypass system. Throughout the crop cycle, 16.7 kg of urea (44% N), 32.6 kg of MAP (10% N, 50% $P_2 0_5$), and 32.3 kg of potassium chloride (60% K_2O) were used, divided and applied over nine weeks. The distribution of nutrients followed the guidelines of the Embrapa Melon Production System (Salviano et al., 2017).

During cultivation, cultural practices were adopted, including the use of black mulching as a cover, to control pest and disease infestations. Delegate® products (Registration Nº. 14414 at the Ministry of Agriculture and Livestock) were applied to control leafminer larva (*Liriomyza trifolii*), and Trifmine (Registration Nº. 2993 at the Ministry of Agriculture and Livestock) was applied before and during planting to prevent the occurrence of *Didymella bryoniae*. The doses were established following the recommendations of each product for the crop. Micronutrients were not applied to the soil. Fruit thinning was not carried out to observe the fruit production potential of the crop under the imposed conditions.

Net CO_2 assimilation rate (A – μmol CO_2 m^{-2} s^{-1}), stomatal conductance (gs – mol H_2O m^{-2} s^{-1}), intercellular CO_2 concentration (Ci – μmol CO_2 mol^{-1} air), transpiration rate (E – mmol H_2O m^{-2} s^{-1}), water use efficiency (WUE – A/E), and intrinsic carboxylation efficiency (iCE = A/Ci) were determined. Gas exchange readings were performed on mature, fully expanded leaves exposed to sunlight. An infrared gas analyzer (IRGA- model LCi by ADC BioScientific, England) was used between 08:00 and 10:00 a.m., with a radiation source of 1500 μmol m^{-2} s^{-1} (value above the saturation point of C3 plants and below a value that may cause photo-inhibition), considering atmospheric CO_2 concentration, temperature, ambient humidity, and the camera had an area of 6.25 cm^2.

The growth and post-harvest variables fruit mass (FM - g) and total soluble solids (TSS - °Brix) were evaluated throughout eight stages of fruit maturation (54, 56, 58, 60, 62, 64, 66, and 68 days after transplanting). At each harvest, the number of fruits per plant (NF), fruit mass (FM - g), and total soluble solids content (TSS - °Brix) of the pulp were determined.

Analysis of variance (ANOVA) of the data was performed using the F test. The significant means of the salt stress treatments were compared using the Tukey test ($p \leq 0.05$), and the regression analysis for the harvest time was performed using of the SISVAR computer program (Ferreira, 2019). The graphs were constructed using the SigmaPlot® program version 11.0 (Systat Software Inc., 2008). Multivariate statistical analysis of plant growth and fruit quality data was performed using principal component analysis (PCA). Analyses were performed using the statistical software R® (R Core Team, 2021).

Results and Discussion

The analysis of variance presented in Table 2 shows that there was significant effect only for the individual factors: water salinity and evaluation times. For the salinity factor, only the variable internal CO_2 concentration (Ci) was significantly influenced ($p \leq 0.05$). As for the harvest times factor, all variables showed a significant effect.

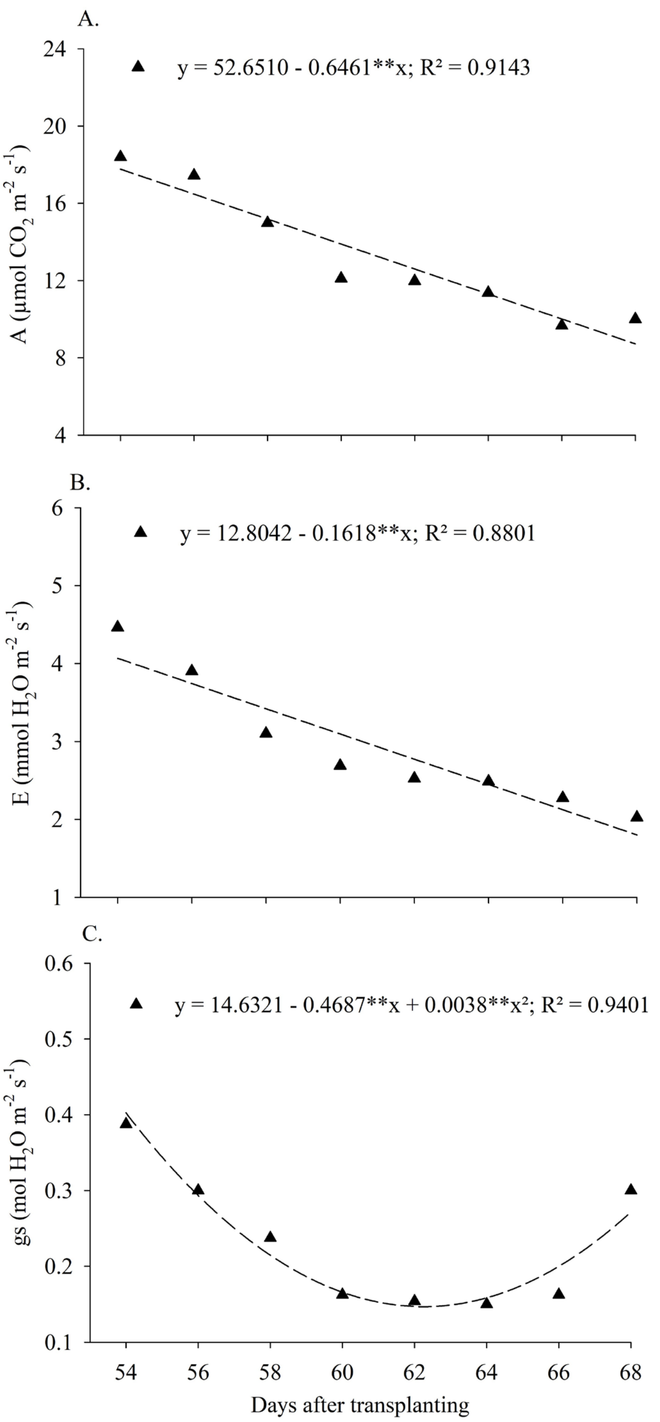
The variables A (Figure 2A) and E (Figure 2B) showed similar trends, in which the data were described by decreasing linear equations as a function of the evaluation times, with net photosynthesis decreasing by 50.9% and transpiration rate decreasing by 55.7% when comparing the first with the last evaluation time. As for gs, the data were described by a quadratic equation with a decreasing trend until the evaluation time of 62 DAT, reaching the minimum point of 0.18 mol H_2O m^{-2} s^{-1}. When comparing gs at 54 and 62 DAT (minimum point), a reduction of 55.3% is observed; however, from 64 DAT onwards there was a recovery in stomatal conductance rates, with no statistical distinction between the data at 54 DAT (Figure 2C).

Transpiration through stomatal pores accounts for 70% of total water loss, highlighting its significance in water management. Stomatal opening is influenced by both plant

Table 2. Analysis of variance of net photosynthesis (A), transpiration (E), stomatal conductance (gs), internal CO_2 concentration (Ci), instantaneous carboxylation efficiency (iCE), and instantaneous water use efficiency (WUE) of melon (*Cucumis melo* L.) under two levels of electrical conductivity of irrigation water - ECw (0.8 and 4.0 dS m^{-1}) and eight harvesting times (54, 56, 58, 60, 62, 64, 66 and 68 DAT)

Sources of variation	DF	Mean squares					
		A	E	gs	Ci	iCE	WUE
ECw	1	1.18^{ns}	1.29^{ns}	0.030^{ns}	10175.76**	0.0001^{ns}	3.80^{ns}
Error 1	6	6.91	1.04	0.01	936.16	0.001	1.07
Harvesting time	7	89.96**	4.45**	0.064**	6614.10**	0.001**	3.58**
Harvesting time x ECw	7	12.56 ^{ns}	0.43 ^{ns}	0.007^{ns}	1486.94^{ns}	0.001^{ns}	0.61^{ns}
Error 2	42	10.77	0.65	0.01	1383.17	0.002	0.84
Corrected total	63	1236.27	69.53	1.057	133275.35	0.13	75.30
CV 1 (%)	-	19.97	32.31	41.17	13.46	57.15	24.25
CV 2 (%)	-	25.58	25.62	45.53	16.36	57.15	21.48

DF - Degrees of freedom; CV- Coefficient of variation; ** - Significant at 0.01 probability level and ns - Not significant.



** Significant at 0.01 probability level by F test

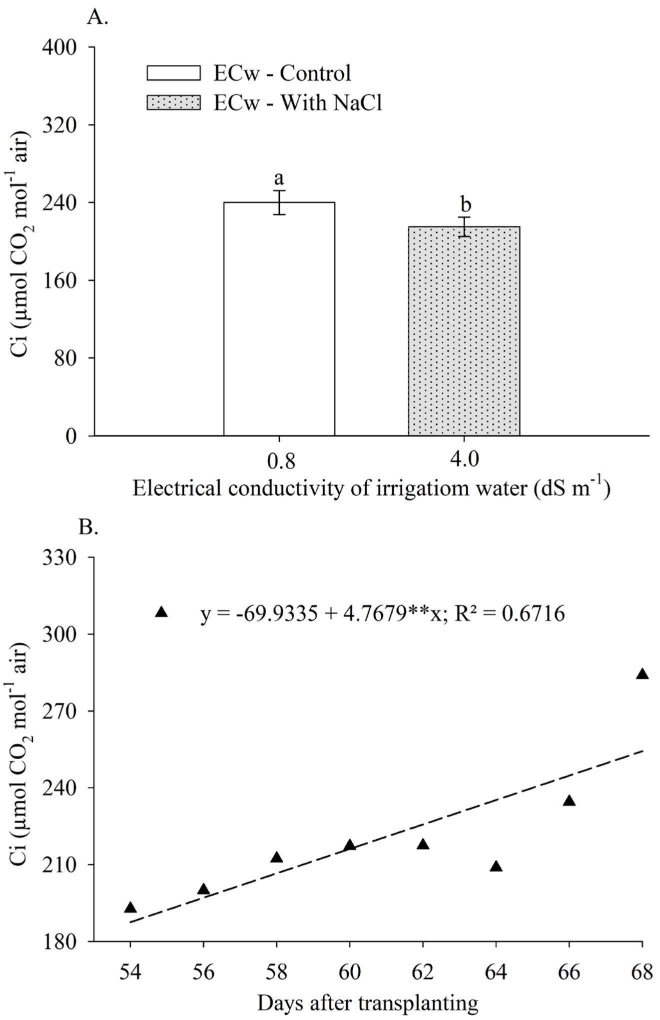
Figure 2. Photosynthesis (A), transpiration (B), and stomatal conductance (C) of melon (*Cucumis melo*) as a function of harvesting times

and environmental factors. When exposed to saline conditions, plant cells lose water and reduce cell elongation to adapt quickly, subsequently accumulating NaCl intracellularly over time (Liu et al., 2017). Pan et al. (2020) assert that in the presence of NaCl, plants undergo osmotic changes in leaf tissues that, in summary, affect CO_2 concentration and stomatal closure.

In a study conducted by Silva et al. (2019) with watermelon, it was observed that during the vegetative phase, the application of saline water increased the values of stomatal conductance. However, during the fruit maturation phase, stomatal conductance showed a 35% reduction compared to plants irrigated with low ECw (0.8 dS m^{-1}) throughout the cycle. This reduction was also observed in leaf transpiration, which results from stomatal limitation due to the difficulty of water absorption, resulting from the reduction of soil water potential (Silva et al., 2019).

According to Dias et al. (2019), the closure of stomata in plants is a mechanism that aims to prevent the loss of water into the atmosphere, preserving the water potential of the leaves and preventing the dehydration of guard cells. In this context, the reduction in photosynthesis, stomatal conductance, and transpiration throughout the evaluation times are related to the higher respiration rate because, when reaching the end of the cycle, plants tend to reduce gas exchange and increase respiration, due to the action of senescence (Woo et al., 2018).

With regard to internal CO_2 concentration, it was observed that ECw of 4.0 dS m^{-1} reduced this variable by 11.63% (Figure 3A). Regarding the evaluation times, the data were described by the increasing linear model, reaching a maximum point of 254.28 μmol CO_2 mol^{-1} air at 68 DAT, and when comparing the value obtained at the first evaluation time (187.5 μmol CO_2 mol^{-1} air) with that obtained at the last, an increase of 35.6% was observed in the internal CO_2 concentration (Figure 3B).



** Significant at 0.01 probability by F test. Different letters differ by Tukey test ($p \leq 0.05$)

Figure 3. Internal CO_2 concentrations of melon (*Cucumis melo*) as a function of the electrical conductivity of irrigation water (A) and harvesting times (B)

Similar results were found by Sarabi et al. (2019), who observed that most plants under salt stress conditions show a reduction in CO_2 absorption through the leaves compared to those that are not subject to this stress. According to Moinuddin et al. (2017), these effects occur due to limited water uptake and imposed osmotic stress, interference with the absorption of essential elements and modification of ionic balance, as well as the accumulation of salt in the cytoplasm of photosynthetic cells.

For iCE, there was a significant linear decrease as a function of the evaluation times, and when comparing the values obtained in the first (54 DAT) and in the last (68 DAT) evaluations, a reduction of 60.9% was observed in the iCE of melon plants (Figure 4A).

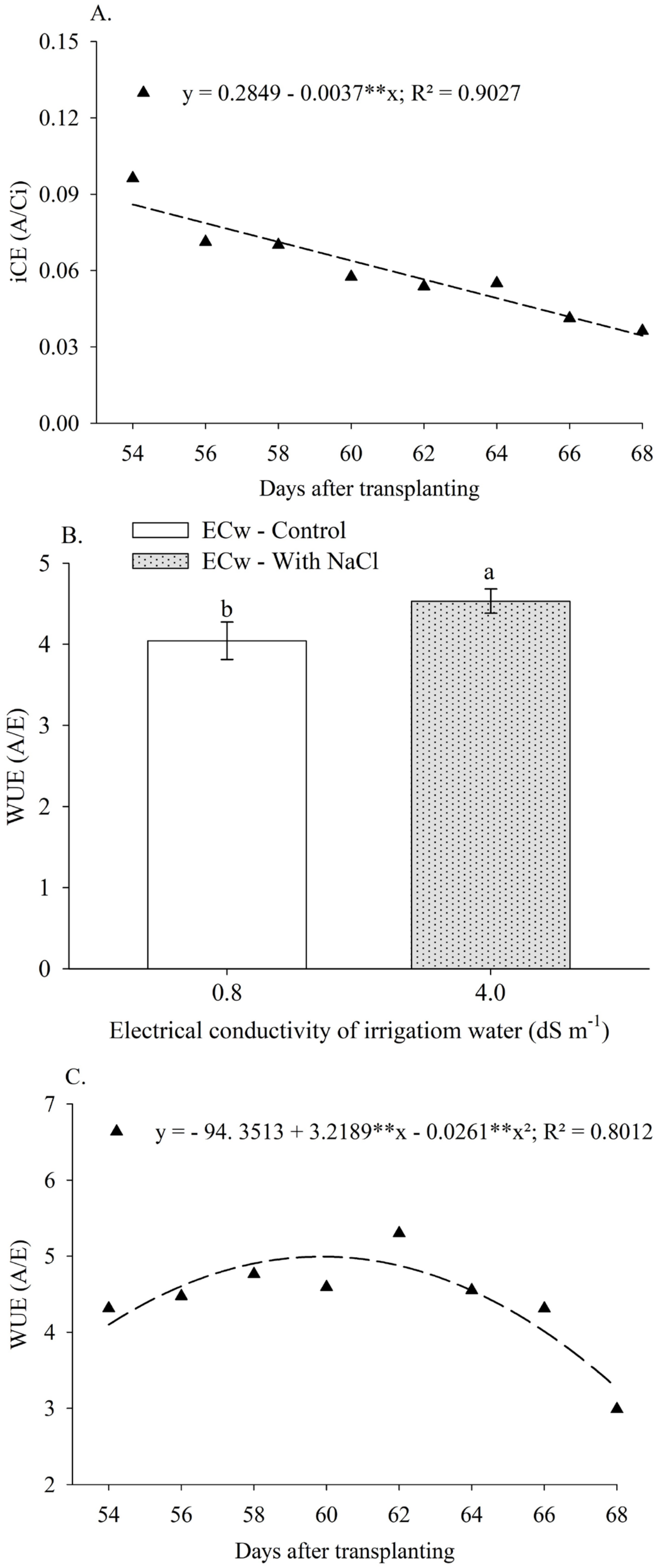
WUE was increased by approximately 12.1% by ECw of 4.0 dS m^{-1} (Figure 4B), while the evaluation times promoted an increase in WUE only up to 62 DAT, where the maximum point of 4.89 (A/E) was found; from then on there was a decrease until the last assessment moment (Figure 4C). According to Nemera et al. (2021), the increase in the intrinsic or instantaneous water use efficiency is commonly directly related to stomatal closure and reduced photosynthesis. This was observed in the present study, in which a reduction in the rates of net photosynthesis, stomatal conductance, and transpiration was observed at 62 DAT (Figure 2A, Figure 2B, and Figure 2C), the latter being responsible for reducing the loss of water from the plant to the atmosphere. At the same time that stomatal conductance was reduced, WUE increased (Figure 4C).

For the analysis of variance of fruit mass, number of fruits, and total soluble solids, it was found that the individual factor ECw (4.0 dS m^{-1}) interfered only with fruit mass, while the individual factor harvesting time provoked significant responses in all variables evaluated. Regarding the interaction between ECw and evaluation times, only the number of fruits was significantly influenced (Table 3).

Fruit mass averaged 1,374 g for fruits under low electrical conductivity (0.4 dS m^{-1}) and 1,139 g when ECw of 4.0 dS m^{-1} was imposed, with a 17.1% reduction under saline conditions (Figure 5A). With regard to the effect of evaluation times, there was a linear increase in fruit mass throughout the harvesting times (54 to 68 DAT), with this increase being greater than 40.8% (Figure 5B).

The salinity of the soil or irrigation water can affect the development of plants as it limits agricultural production and reduces crop yield, reaching unfavorable economic levels, especially in arid and semi-arid regions. Therefore, the influence of salinity in irrigation water is widely recognized as a crucial factor to be considered as its use can trigger adverse effects on the interactions between soil, water, and plants (Hussain et al., 2020). This scenario reinforces the need for careful management of salinity in irrigation water in order to preserve the health and yield of cultivated plants (Dias et al., 2019).

Plants' behavior is affected by the salinity of irrigation water differently depending on their stage of development. Given this, when evaluating the use of brackish water in melon irrigation during plant development stages, Dias et al. (2010) found a linear reduction in growth and fruit mass when plants were subjected to nutrient solution with electrical conductivity above 1.1 dS m^{-1}. The authors also observed that there were melon plants that suffered stress only at the fruiting stage (51 to 70 DAT), recording lower biomass gains due to an increase in electrical conductivity, which made the plants more tolerant to salinity.



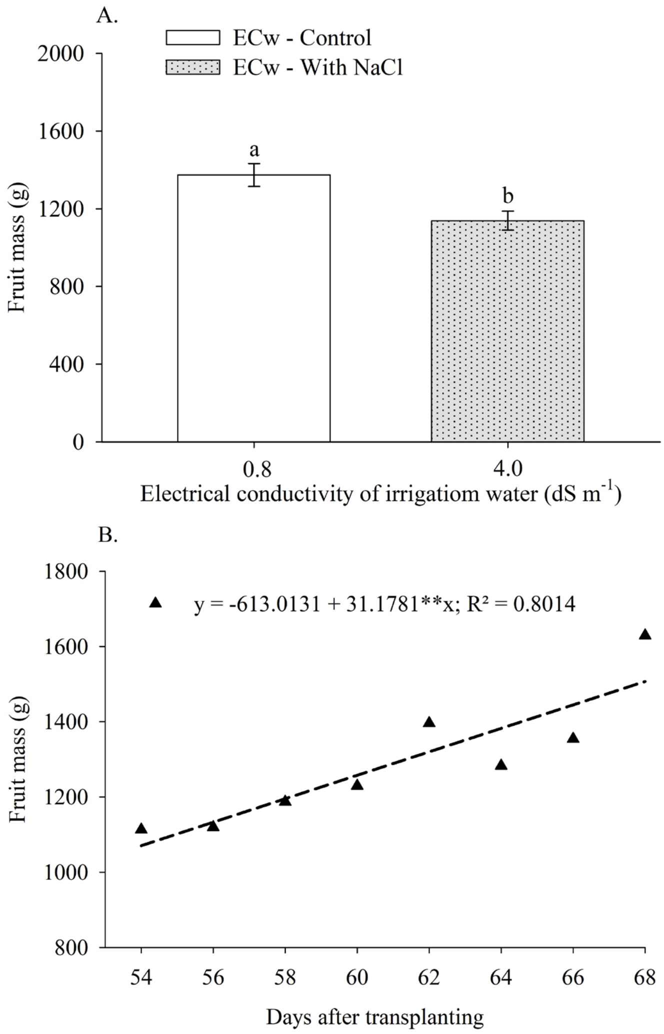
** Significant at 0.01 probability level by F test. Means followed by different letters differ by Tukey test (p ≤ 0.05)

Figure 4. Instantaneous carboxylation efficiency as a function of harvesting times (A) and instantaneous water use efficiency of melon (*Cucumis melo*) as a function of the electrical conductivity of irrigation water (B) and harvesting times (C)

Table 3. Analysis of variance of fruit mass (FM), number of fruits (NF), and total soluble solids (TSS) in melon (*Cucumis melo*) irrigated under two levels of water electrical conductivity (ECw - 0.8 and 4.0 dS m^{-1}) and at eight harvesting times (54, 56, 58, 60, 62, 64, 66, and 68 DAT)

Sources of variation	DF	Mean squares		
		FM	NF	TSS
ECw	1	576194.85*	0.015^{ns}	0.180^{ns}
Error 1	6	17155.22	1.01	1.60
Harvesting time	7	251619.55*	4.05*	5.75**
Harvesting time x ECw	7	123118.23^{ns}	3.47*	1.40^{ns}
Error 2	42	92577.87	1.38	1.13
Corrected total	63	7190561.59	116.98	107.63
CV 1 (%)	-	10.28	25.29	12.67
CV 2 (%)	-	23.88	29.53	10.64

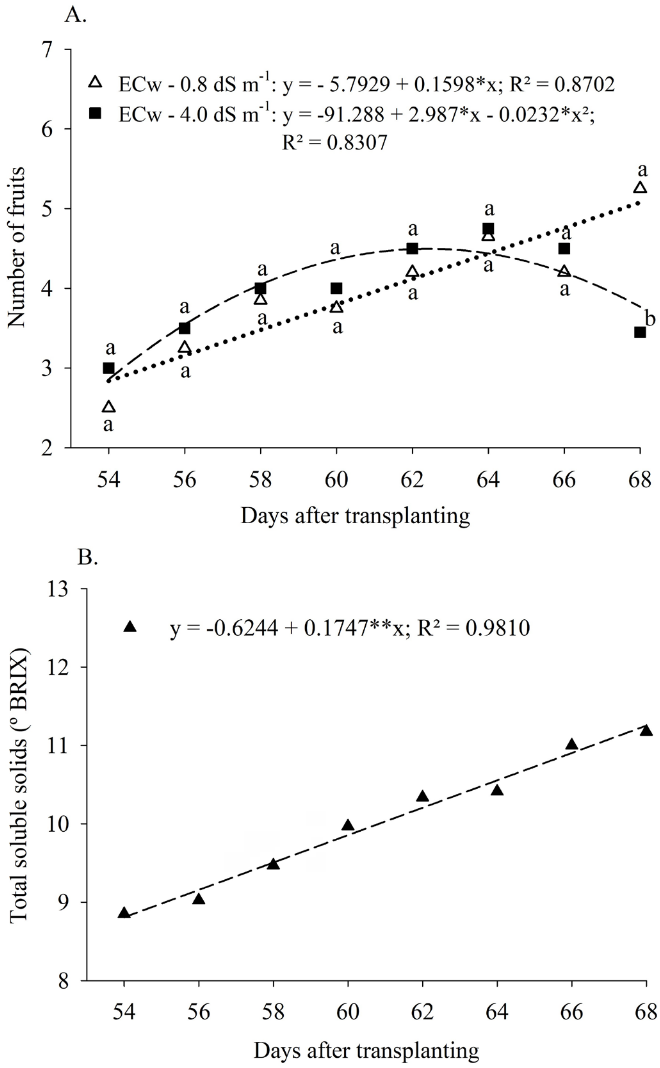
DF - Degrees of freedom; CV - Coefficient of variation; * - Significant at 0.05 probability level; ** - Significant at 0.05 probability level and ns - Not significant



** Significant at 0.01 probability by F test. Means followed by different letters differ by Tukey test ($p \leq 0.05$)

Figure 5. Fruit mass of melon (*Cucumis melo*) as a function of the electrical conductivity of irrigation water (A) and harvesting times (B)

For the number of fruits per plant, the data were described by two equations; the low ECw (0.8 dS m^{-1}) was described by a positive linear equation, reaching the value of 5 fruits per plant at the evaluation time of 68 DAT, and when comparing this result with the value obtained at 54 DAT (3 fruits per plant), an increase of 66.7% was observed (Figure 6A). In



*Significant at 0.05 probability level; ** Significant at 0.01 probability level by F test. Means followed by different letters differ by Tukey test ($p \leq 0.05$)

Figure 6. Number of fruits (A) of melon (*Cucumis melo*) as a function of the electrical conductivity of irrigation water and harvesting times and content of total soluble solids (B) as a function of harvesting time

relation to the level of 4.0 dS m^{-1}, the data were described by a quadratic equation, with the maximum point of 4.85 at 64 DAT, followed by a reduction from that time onwards (Figure 6A).

At 64 DAT, the number of fruits remained constant in both treatments of water salinity. In the treatment of ECw = 4 dS m^{-1}, the plants had an average of 4.5 fruits per plant, with only two of these fruits being viable for commercialization in terms of size and maturity stage. In general, irrigation water salinity can reduce fruit production in salt-sensitive crops such as melon (Lima et al., 2020). However, what occurred was an adaptation of the plants to the imposed water salinity conditions (4.0 dS m^{-1}), where they invested less in vegetative growth and managed to maintain fruit production. Results obtained by Terceiro Neto et al. (2021) for the 'Sancho' cultivar also showed no negative effect on the number of fruits of plants grown under ECw conditions of 4.3 dS m^{-1}.

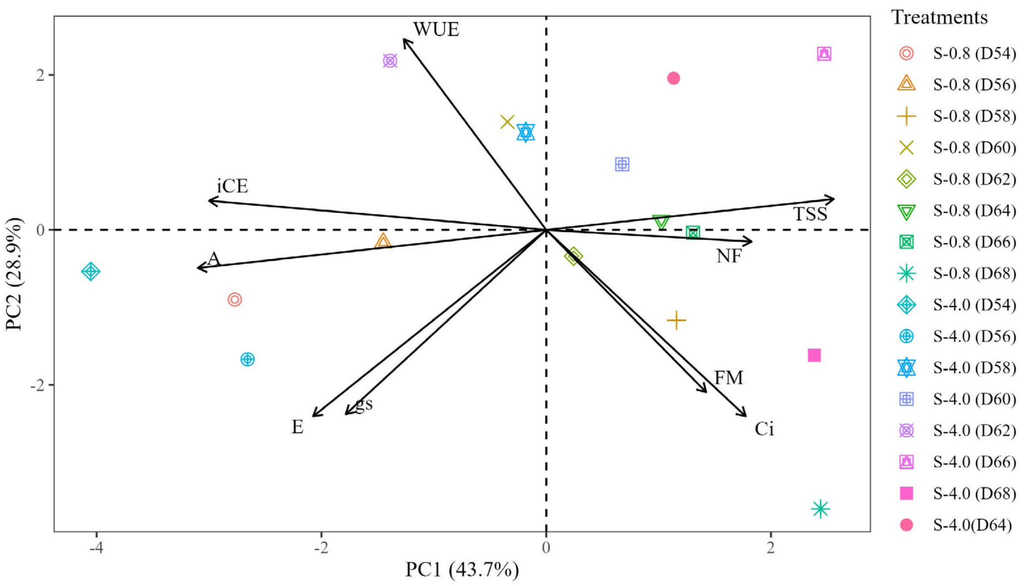
Water management strategies using waters with salinities of 0.57 and 4.33 dS m^{-1} did not affect the number of fruits per plant, fruit production, total soluble solids content, and fruit weight per plant of "Toad Skin" melon (cv. Sancho) in a study conducted by Terceiro Neto et al. (2021). These results corroborate those obtained in the present study, where no significant effect ($p \leq 0.05$) of salinity on the variables number of fruits per plant and total soluble solids was found.

For the total soluble solids content (TSS), it was found that this variable increased throughout the evaluation times. When comparing the values obtained at 54 DAT (8.81 °Brix) with the values of the last evaluation time, 68 DAT (11.25 °Brix), a superiority of 27.7% is observed (Figure 6B). Lima et al. (2020), when evaluating quality parameters of cantaloupe melon fruits, found an increase in the total soluble solids content of the fruits and associated it with the effect of nutrient concentration, given the low supply of water to the fruit, caused by the osmotic effect arising from salinity.

The principal component analysis (PCA) applied to our dataset provided an insightful view of the underlying structure of the analyzed variables. The PCA plot reveals the distribution of observations along the two principal components, representing 72.60% (PC1 and PC2), a significant portion of the total variation (Figure 7). When analyzing the loadings of the principal components, it is observed that principal component 1 (PC1) is strongly influenced by the variables number of fruits - NF, fruit mass - FM, and intercellular CO_2 concentration - Ci, while principal component 2 (PC2) is primarily influenced by the variables water use efficiency - WUE and intrinsic carboxylation efficiency - iCE. The substantial magnitude of the loadings for these variables indicates that they play crucial roles in the variation captured by the components. Gas exchange, photosynthesis - A, leaf transpiration - E, and stomatal conductance - gs were negatively influenced by salinity, indicating an increase in their values over the harvesting times. On the other hand, the variables NF, FM, and Ci showed positive scores for PC1, indicating a higher number and weight of fruits under non-saline conditions (control) (Figure 7).

The biplot (Figure 7) showed that axis 1 (PC1) was negatively correlated with WUE and iCE (under both saline and non-saline conditions). In practical terms, this means that WUE did not increase under conditions of increased electrical conductivity of water (ECw) for the studied 'Goldex' yellow melon variety. In this context, the results observed in Figure 7 can be associated with the negative effect of salinity on plants, especially those that accumulate a large amount of water in their fruits, as in the case of melon, because when they detect saline conditions through their roots, they inhibit the capture of atmospheric CO_2, through stomatal closure, and as a consequence there is a reduction in photosynthesis, since these variables are highly correlated (Figure 7). Results similar to those found in this study were observed by Sarabi & Ghashghaie (2022), who evaluated the physiological and biochemical responses of melon plants under salt stress by NaCl and verified through multivariate analysis that gas exchange was negatively influenced by the increase in salinity, so that plants avoided losing water to the atmosphere in response to stress.

TSS did not show a positive correlation with gas exchange variables (Figure 7). The increase in sugar content was due to the progression of fruit ripening throughout the harvest, where there was no significant effect of the increase in the electrical conductivity of the water. Sucrose, along with major hexoses like glucose and fructose, plays crucial roles in signaling and regulating plant development (Durán-Soria et al., 2020). These sugars have direct or indirect control over various processes such as photosynthesis, nitrogen uptake, defense mechanisms, hormonal balance, secondary metabolism, and ripening (Nookaraju et al., 2010).



S - Salinity; D - Day; A - Photosynthesis; E - Transpiration; gs - Stomatal conductance; Ci - Internal CO_2 concentrations; iCE - Instantaneous carboxylation efficiency; WUE - Instantaneous water use efficiency; FM - Fruit mass, NF - Number of fruits; TSS - Total soluble solids

Figure 7. Principal component analysis (PCA) scatterplot for the growth and gas exchange variables of 'Goldex' melon (*Cucumis melo*) fruits grown under different electrical conductivity of water and harvesting times

Conclusions

1. 'Goldex' yellow melon (*Cucumis melo*) maintains its water status and its basic gas exchange stable under electrical conductivity of 4.0 dS m^{-1}.

2. Electrical conductivity of irrigation water of 4.0 dS m^{-1} caused a reduction in the number of fruits and fruit mass of 'Goldex' yellow melon, but had no effect on the main post-harvest quality variable, the total soluble solids content of 'Goldex' yellow melon pulp, indicating that the plants are capable of maintaining soluble solids concentrations at acceptable levels for commercialization and consumption.

3. Irrigation with electrical conductivity of water up to 4.0 dS m^{-1} under the conditions imposed proved to be a viable alternative for the production of yellow melon as it did not cause any damage to the post-harvest quality of the fruits.

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