Revista Ciência Agronômica, v. 54, e20207586, 2023
Centro de Ciências Agrárias - Universidade Federal do Ceará, Fortaleza, CE
www.ccarevista.ufc.br

Scientific Article
ISSN 1806-6690

Salt stress and K/Ca ratios of the nutrient solution in the production and quality of the melon[1]

Renata Ramayane Torquato Oliveira[2], Francisco de Assis de Oliveira[2]*, Helena Maria de Morais Neta Góis[2], Paulo Victor de Menezes[3], Sandy Thomaz dos Santos[2], Edna Maria Mendes Aroucha[4], José Gustavo Lima de Almeida

ABSTRACT - Melon cultivation under saline conditions is a challenge, as the plants can suffer a reduction in fruit production and quality. The aim of this study was to evaluate the production and quality of noble melon fruit fertigated with different saline solutions and K/Ca ratios. The experimental design was of randomised blocks, with treatments arranged in a 3 x 6 factorial scheme, using three melon cultivars (Bazuca, McLaren, County) fertigated with six nutrient solutions [S1 – standard nutrient solution (SNS); S2 – SNS + NaCl (5.0 dS m^{-1}); S3 – S2 enriched with K (50%); S4 – S2 enriched with K (100%); S5 – S2 enriched with Ca (50%); S6 – S2 enriched with Ca (100%)]. At the end of each cultivar cycle, the fruit was harvested and assessed for the following parameters: fresh fruit weight, fruit diameter, internal cavity, pulp thickness, pulp firmness, soluble solids content, titratable acidity, soluble solids/titratable acidity ratio, and vitamin C. Salt stress impaired the physical characteristics of the fruit of the three noble melon cultivars. The nutrient solution enriched with 50% K (S3) did not reduce the effect of salt stress on fresh weight or fruit size in the melon, but afforded an increase in fruit quality.

Key words: *Cucumis melo* L. Salinity. Fertigation.

DOI: 10.5935/1806-6690.20230052
Editor-in-Article: Prof. Alek Sandro Dutra - alekdutra@ufc.br
*Author for correspondence
Received for publication on 27/08/2020; approved on 17/03/2023
[1]Extracted from the dissertation of the first author, presented to the Graduate Program in Soil and Water Management of the Universidade Federal Rural do Semi-Árido, Mossoró-RN, Brazil. This study was financed by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Brasil)
[2]Graduate Program in Soil and Water Management of the Universidade Federal Rural do Semi-Árido (UFERSA), Mossoró-RN, Brasil, renataramayanet@gmail.com (ORCID ID 0000-0002-7365-8271), thikaoamigao@ufersa.edu.br (ORCID ID 0000-0002-6895-7736), helena_morais13@hotmail.com (ORCID ID 0000-0002-9210-6296), sandy_thomaz@hotmail.com (ORCID ID 0000-0001-6487-555X)
[3]Undergraduate in Agronomy, Universidade Federal Rural do Semi-Árido (UFERSA), Mossoró-RN, Brasil, paulo_escoteiro39@hotmail.com (ORCID ID 0000-0002-4913-9279)
[4]Department of Engineering and Ambiental Sciences, Universidade Federal Rural do Semi-Árido (UFERSA), Mossoró-RN, Brasil, aroucha@ufersa.edu.br (ORCID ID 0000-0003-1530-4114), guga@ufersa.edu.br (ORCID ID 0000-0001-9601-2046)

INTRODUCTION

The melon is one of the most exported fruits in Brazil, especially to European countries, with around 40% of total production being sent abroad (ANUÁRIO BRASILEIRO DE HORTI E FRUTI, 2022). In 2021, the mean domestic yield was 25,444 kg ha^{-1}, with 95% of this production concentrated in the northeast of the country, particularly the states of Rio Grande do Norte, Ceará and Bahia (IBGE, 2021).

In recent years, the states of Rio Grande do Norte and Ceará have expanded the production of melons of the 'noble' group. Among the fruits of the varieties belonging to this group, are the Cantaloupe, Gália and Orange, which are highly appreciated on the international market as they have more taste and high nutritional value (COSTA, 2017).

Although the semi-arid region of the northeast of Brazil is a major producer of the melon, salinisation of the irrigation water is one of the biggest obstacles, due to the climate conditions in the region that contribute to the processes of salinisation (ALVES *et al*., 2021). The high concentration of salts affects plants through osmotic stress, causing water deficit, and through the accumulation of toxic ions, which interferes with nutrient absorption and causes cytotoxicity (TAIZ *et al*., 2017).

The accumulation of toxic ions, such as Na^+, has an antagonistic effect on the absorption of essential nutrients, especially K^+ and Ca^{2+}, resulting in a higher Na^+/K^+ and Na^+/Ca^2 ratio (MUKAMI *et al*., 2020). A high sodium content mainly affects plant absorption of the nutrients potassium and calcium, so correct calcium and potassium nutrition can reduce the Na^+/Ca^2 and Na^+/K^+ ratio, increasing plant tolerance to salt stress.

The increase in plant tolerance from potassium fertilisation is related to the osmotic adjustment caused by K^+ improving the ionic balance (CHAKRABORTY *et al*., 2016). In addition, an adequate supply of potassium affords better fruit quality by increasing the levels of soluble solids and vitamin C (SANTOS *et al*., 2018; SILVA *et al*., 2014).

Calcium acts by inhibiting Na^+ influx and K^+ leakage, reducing the effects of salt stress on the plant (RAHMAN *et al*., 2016), and resulting in an increase in fresh fruit weight and greater pulp firmness, even under saline conditions (SANGTARASHANI; TABTAABAEI; BOLANDNAZAR, 2013).

In the melon, the proper replacement of nutrients, such as calcium and potassium, is a highly important management practice, as it affords gains in productivity and fruit quality (SILVA *et al*., 2014). However, it is important to determine which ratio of these nutrients reduces the effects of salt stress.

Therefore, the aim of the present study was to evaluate the production and quality of noble melon fruit fertigated with different saline solutions and K/Ca ratios.

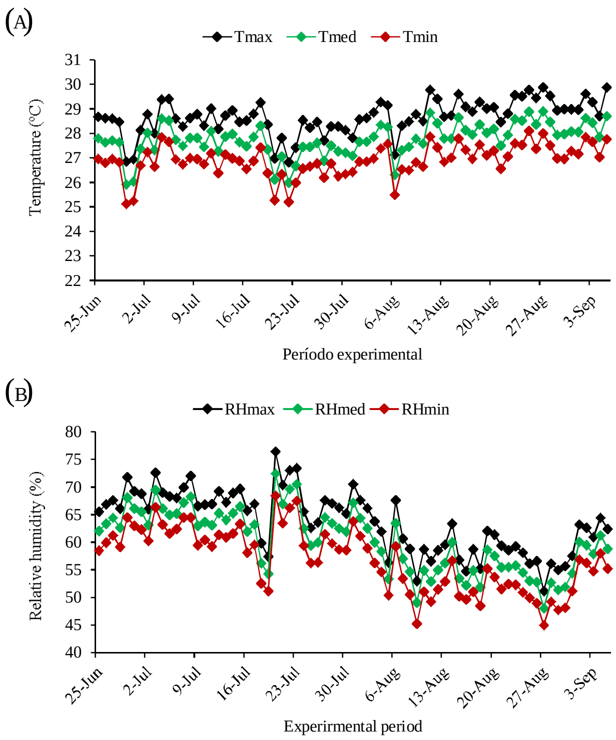
MATERIAL AND METHODS

The experiment was conducted from 25 June 2019 to 3 September 2019 in a greenhouse of the Department of Agronomic and Forestry Science of the Universidade Federal Rural do Semiárido (UFERSA), in Mossoró, Rio Grande do Norte.

During the experiment, daily data were collected on the maximum (Tmax), mean (Tmean) and minimum (Tmin) temperature (Figure 1A), and maximum (RHmax), mean (RHmean) and minimum (RHmin) relative humidity (Figure 1B), using an automatic weather station (Campbell Scientific Inc, model CR1000), installed inside the greenhouse. The temperature varied from 25.0 °C to 28.0 °C for Tmin, 26.0 °C to 29.0 °C for Tmean and 27.0 °C to 30.0 °C for Tmax; the relative humidity varied from 44% to 68% for RHmin, 48% to 72% for RHmean and 51% to 76% for RHmax.

The experimental design was of randomised blocks, with treatments arranged in a 3x6 factorial scheme, with six repetitions, using three melon genotypes

Figure 1 - Climate data for temperature (A) and relative humidity (B) during the experiment



(Cantaloupe – Bazuca hybrid, Gália – McLaren hybrid, and Orange – County hybrid) and six nutrient solutions (Table 1).

The saline nutrient solutions (S2, S3, S4, S5 and S6) were prepared using the UFERSA water supply (Table 2), adding commercial sodium chloride with no iodine until an electrical conductivity of 5.0 dS m^{-1} was reached. To supply the macronutrients, the following fertilisers were used: calcium nitrate, potassium nitrate, calcium chloride, potassium chloride, potassium sulphate, magnesium sulphate and monoammonium phosphate (MAP). Rexolin® was used for the micronutrients, at a dose of 30 g $1000L^{-1}$ in the following concentration: 11.6% potassium oxide (K_2O), 1.28% sulphur, 0.86% magnesium, 2.1% boron, 2.66% iron, 0.36% copper, 2.48% manganese, 0.036% molybdenum and 3.38% zinc.

A drip irrigation system was adopted, using an independent system for each nutrient solution consisting of a reservoir (water tank with a capacity of 310 L), a motor pump, hoses (16 mm) and spaghetti-type microtubes (internal diameter 1.5 mm, length 0.5 m). Irrigation was controlled by digital timer (time) to activate the system, with a sufficient volume of nutrient solution applied in each irrigation to give a leaching fraction of 10%. The nutrient solutions in the reservoirs were discarded and replaced when their level fell below the suction of the pump.

The seedlings were produced by sowing in expanded polystyrene trays of 200 cells using a commercial substrate suitable for vegetables. Transplanting was carried out 12 days after sowing in plastic pots containing a substrate of coconut fibre (Golden Mix Granulate).

One plant was placed in each pot, which were then arranged in the greenhouse to leave 1.2 m between rows and 0.5 m between plants. As an aid in growing and training the plants, wooden posts were installed parallel to the plant row, with wires stretched between the ends of each post.

The fruit of the three cultivars were harvested when they showed a uniform skin colour. In addition, the Cantaloupe fruit were harvested when a change in colour was seen near the insertion point of the peduncle. After harvesting, the fruit were weighed on an analytical balance to determine the fresh weight. The transverse equatorial diameter of the fruit was then determined using a digital calliper. Finally, the fruit were divided longitudinally into two parts, and the dimensions of the internal cavity and pulp thickness were determined, again using a digital calliper.

Pulp firmness was determined in the equatorial region of the pulp by analogue penetrometer (McCormick, model FT 327) with an 8-mm diameter tip. The soluble solids content, titratable acidity and vitamin C were determined from the juice obtained after processing

Table 1 – Nutrient concentration and electrical conductivity of the nutrient solutions used in the experiment

Solution	EC dS m^{-1}	N	P	K	Ca	Mg	S
		mg L^{-1}					
S1 - K/Ca = 1.5:1*	0.5	170	39	226	153	25	32
S2 - K/Ca = 1.5:1*	5.0	170	39	226	153	25	32
S3 - K/Ca = 2.2:1	5.0	170	39	339	153	26	32
S4 - K/Ca = 3:1	5.0	170	39	452	153	25	32
S5 - K/Ca = 1:1	5.0	170	39	226	203	25	32
S6 - K/Ca = 1:1.4	5.0	170	39	226	306	25	32

*Nutrient solutions S1 and S2 present the recommended nutrient concentration for the melon under NFT hydroponic cultivation (CASTELLANE; ARAÚJO, 1995). EC: Electrical Conductivity. S1 – standard nutrient solution (SNS); S2 – SNS + NaCl (5.0 dS m^{-1}); S3 – S2 enriched with K (50%); S4 – S2 enriched with K (100%); S5 – S2 enriched with Ca (50%); S6 – S2 enriched with Ca (100%)

Table 2 - Chemical characterisation of the water used in preparing the nutrient solutions

EC (dS m^{-1})	pH	Ca^{2+}	Mg^{2+}	K^+	Na^+	Cl^-	CO_3^{2}	HCO_{3-}
		mmol m^{-3}						
0.5	8.3	3.1	1.1	0.3	2.3	1.8	0.2	3.8

EC – Electrical Conductivity; pH – Hydrogen potential; Ca^{2+} – Calcium; Mg^{2+} – Magnesium; Na^+ – Sodium; Cl^- – Chlorine; CO_3^{2-} – Carbonate; HCO_3 – Bicarbonate the fruit in a multiprocessor. The soluble solids content was determined using a digital refractometer, titratable acidity by titration with sodium hydroxide (0.1 N), and vitamin C by titration with DFI (2,6 diclo-phenolindofen).

The data obtained for the variables under analysis were submitted to the Shapiro-Wilk test of normality. An analysis of variance was carried out by F-test, and mean values that showed a significant response were analysed using Tukey's test ($p \leq 0.05$). The statistical analyses were carried out using the Sisvar v5.3 statistical software (FERREIRA, 2014).

RESULTS AND DISCUSSION

The interaction between the factors cultivar (C) and nutrient solution (S) had a significant effect on the variables fruit fresh weight (FFW) and transverse diameter (TD) at a level of 5%, as well as on internal cavity (CAV), pulp firmness (FIRM), soluble solids (SS), titratable acidity (TA) and the SS/TA ratio ($p < 0.01$). On the other hand, there was a significant response for pulp thickness (PT) only for the isolated factors cultivar (C) and nutrient solution ($p < 0.01$) (Table 3).

FFW differed statistically between cultivars only when they were fertigated with the standard nutrient solution (S1), for which the highest values occurred in the Bazuca (1.46 kg fruit^{-1}) and County (1.54 kg fruit^{-1}) cultivars, both statistically superior to the McLaren cultivar (1.1 kg fruit^{-1}). For the effect of the nutrient solutions, it was found that solution S1 promoted fruit with higher fresh weight in all three cultivars. Whereas, when they were submitted to the S2 saline nutrient solution, lower FFW values were obtained, of 0.50 kg fruit^{-1} (Bazuka), 0.54 kg fruit^{-1} (McLaren) and 0.59 kg fruit^{-1} (County), with a reduction of 65%, 51% and 61%, for the Bazuca, McLaren and County cultivars, respectively, compared to the standard nutrient solution (S1). Furthermore, there was no effect from adding extra potassium (S3 and S4) or calcium (S5 and S6) on FFW under saline conditions (Figure 2A).

A reduction in the fresh weight of melon fruit subjected to salt stress has been seen by other authors (DIAS *et al*., 2018; OLIVEIRA *et al*., 2021a). This reduction can be attributed to the decrease in water availability caused by the osmotic effect resulting from the salinity interfering with the absorption of water and nutrients (TAIZ *et al*., 2017).

These results corroborate those of Oliveira *et al*. (2021a), working with salt stress and potassium fertilisation in two melon cultivars, McLaren and SV1044MF. The authors also found no effect from potassium fertilisation in reducing salt stress. On the other hand, other authors working with calcium and potassium fertigation in other crops under salt stress, such as studies with the tomato (OLIVEIRA *et al*., 2021b), pepper (SILVA *et al*., 2020a) and mini watermelon (ALVES *et al*., 2023), found a positive effect from potassium and calcium on FFW. In addition to the species, this difference can be attributed to the sources of K and Ca used (KCl and $CaCl_2$), which also provide Cl^-, a toxic ion.

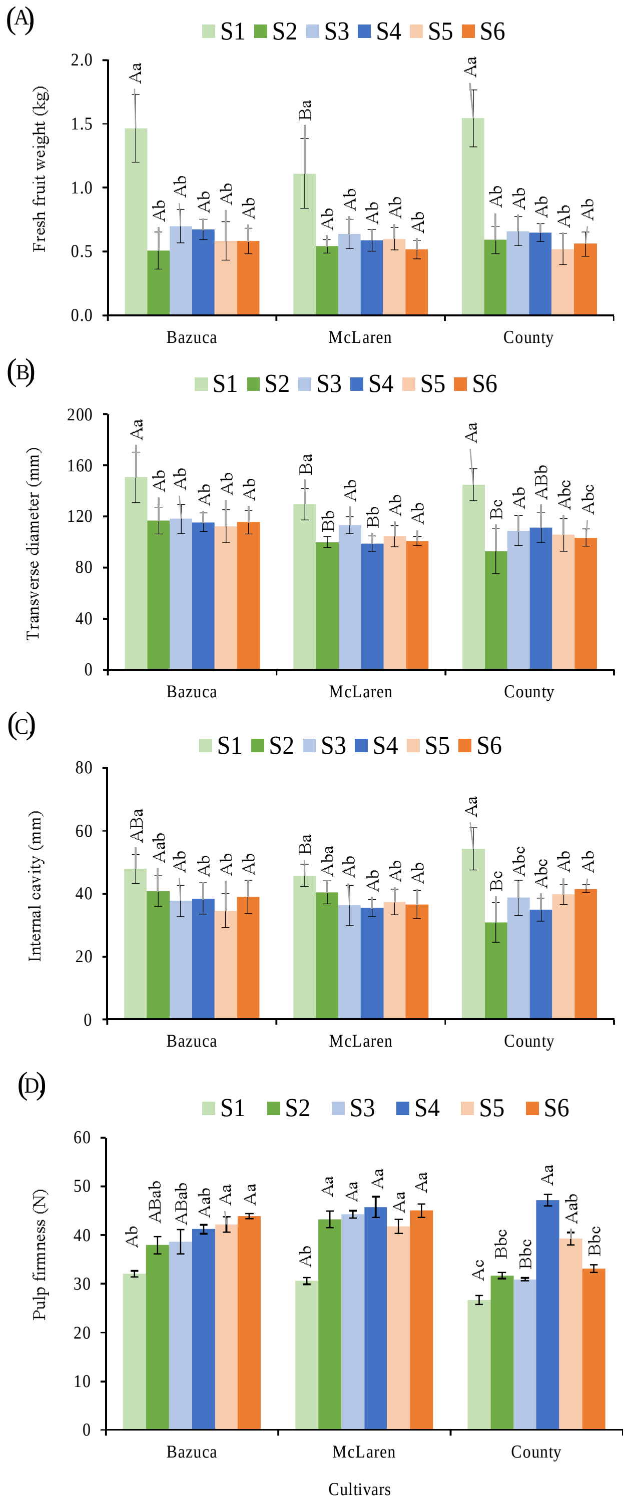
The cultivars differed significantly for TD with solutions S1, S2 and S4. With solutions S1 and S4, the highest values occurred in the Bazuca and County cultivars, while with the S2 solution the Bazuka cultivar was superior to the others. The standard nutrient solution (S1) afforded higher TD values in all three cultivars, of 150.7 mm (Bazuca), 129.71 mm (McLaren) and 145.09 mm (County). With the addition of NaCl to the nutrient solution (S2), values of 116.74 mm (Bazuka), 99.99 mm (McLaren) and 92.93 mm (County) were obtained, resulting in a loss of 22.53%, 22.91% and 35.95%, respectively. There was a significant difference for the saline solutions (S2, S3, S4, S5 and S6) in the County cultivar, where the nutrient solutions enriched with potassium (S3 and S4) expressed the highest values, reducing the effect of salt stress on the TD of the fruit (Figures 2B).

Table 3 - Summary of analysis of variance for fruit fresh weight (FFW), fruit transverse diameter (TD), internal cavity (CAV), pulp thickness (PT), pulp firmness (FIRM), soluble solids (SS), titratable acidity (TA) and soluble solids/titratable acidity ratio (SS/TA) in the fruit of three melon cultivars fertigated with different saline nutrient solutions

SV	DF	MS							
		FFW	TD	CAV	PT	FIRM	SS	TA	SS/TA
C	2	112445.94**	1920.53**	19.19^{ns}	101.52**	451.88**	5.01^{ns}	0.017**	6366.13**
NS	5	9292782.73**	3649.34**	432.17**	242.14**	457.80**	3.44^{ns}	0.0005^{ns}	335.51^{ns}
CxNS	10	501105.50*	149.55*	78.92**	16.42^{ns}	79.84**	7.12**	0.0009**	1223.29**
Residual	90	20249.58	147.40	22.29	13.51	31.41	1.97	0.000314	242.53
CV (%)		19.66	9.81	11.96	11.46	14.5	14.57	14.46	20.32

*and **significant at a level of $p < 0.05$ and $p < 0.01$, respectively; ns – not significant at a level of 5%; C – = cultivars; NS – nutrient solutions; CV – coefficient of variation

Figure 2 - Fruit fresh weight (A), transverse diameter (B), internal cavity (C) and pulp firmness (D) in fruit of melon cultivars fertigated with different saline nutrient solutions



S1 – standard nutrient solution (SNS); S2 – SNS + NaCl (5.0 $dS\ m^{-1}$); S3 – S2 enriched with K (50%); S4 – S2 enriched with K (100%); S5 – S2 enriched with Ca (50%); S6 – S2 enriched with Ca (100%). Uppercase letters refer to the difference between varieties and lowercase letters between nutrient solutions by Tukey's test ($p < 0.05$)

Santos *et al*. (2018), working with eggplant under salt stress and different K/Ca ratios, also found a reduction in fruit diameter when these were subjected to salinity, as well as the positive action of potassium in reducing the effect of salt stress.

The increase in fruit diameter, even when subjected to saline solutions supplemented with potassium, may be related to the important role played by this nutrient in reducing salt stress through osmotic adjustment and better ionic balance, reducing sodium absorption and increasing the K/Na^+ ratio (CHAKRABORTY *et al*., 2016).

There was a significant difference between cultivars for the internal cavity of the fruit (CAV) when fertigated with the standard nutrient solution (S1) and for the saline solution with NaCl (S2). For solution S1, the highest values were obtained in the County (54.25 mm) and Bazuka (47.87 mm) cultivars, although the latter does not differ statistically from the McLaren (45.83). For solution S2, the highest values for CAV were found in the Bazuca (40.85 mm) and McLaren (40.41 mm) cultivars (Figure 2C).

When analysing the effect of the nutrient solution on the CAV variable, it was found that the addition of NaCl (S2) affected CAV only in the County cultivar, giving the lowest value (30.9 mm) and resulting in a loss of 43.04%. However, the addition of extra potassium (S3 and S4) and calcium (S5 and S6) to the saline solution caused a reduction in CAV in the Bazuca and McLaren cultivars compared to the standard nutrient solution (S1); on the other hand, for the County cultivar, the addition of extra Ca (S5 and S6) increased the CAV (Figure 2C).

Pulp firmness (FIRM) differed between cultivars in the S2, S3 and S6 solutions. The highest values occurred with the Bazuka (S2 = 32.08 N, S3 = 38.64 N, S6 = 43.91 N) and McLaren (S2 = 43.24 N, S3 = 44.32 N, S6 = 45.06 N) cultivars, while the County cultivar had the lowest FIRM, of 26.68, 31.71 and 33.10 N, for S2, S3, and S6, respectively (Figure 2D).

Similar behaviour was seen in the Bazuca and McLaren cultivars for the effect of the nutrient solutions on FIRM, where the use of saline water afforded an increase, especially the saline solutions enriched with K and Ca. For the County cultivar, the highest values (47.19 N) were seen in the saline nutrient solutions enriched with 100% K (S4) and 50% Ca (S5), showing a reduction at the highest concentration of Ca (S6) (Figure 2D).

The increase in the firmness of the fruit pulp as a response to salt stress may be related to the formation of smaller and thicker cells induced by the salinity (FLORES *et al*., 2003). Potassium promotes firmer fruit, probably due to its relationship with the water status of the plants and maintenance of cell turgor (MARSCHNER, 2012).

On the other hand, calcium plays a special role in maintaining the structure of the fruit, interacting with the pectin of the cell wall to form calcium pectate, which gives the fruit a firmer texture (CYBULSKA; ZDUNEK; KONSTANKIEWICZ, 2011).

The ideal values of FIRM vary for each cultivar, with a minimum value of 30 N recommended for the cultivars under analysis in the present study (COSTA, 2017). As such, the standard nutrient solution (S1) gave a value closer to the desired value for the Bazuca and McLaren cultivars. As for the County cultivar, values closest to those recommended were found in fruit subjected to the S2 saline solutions, and to the solution enriched with 50% potassium (S3).

When analysing pulp thickness (PT), it can be seen that the highest values were obtained in the Bazuca and McLaren cultivars, despite the latter not differing significantly from the County cultivar (Table 4).

Fruit with thicker pulp is a desirable characteristic, since it increases the edible part of the fruit, improving its quality. In addition, greater pulp thickness together with a smaller cavity has proved to be a desirable characteristic, since it increases pulp yield, in addition to affording greater resistance to handling and transport, and increasing the post-harvest shelf life (DALASTRA; ECHER; HACHMANN, 2015).

It can also be seen from Table 4 that the standard nutrient solution (S1) gave fruit with thicker pulp, with a reduction when subjected to the nutrient solutions, and the greatest losses with solutions S2 and S6, of 26.42% and 24.02%, respectively. However, for the saline solutions, the addition of extra potassium (S3 and S4) provided an increase in PT, inhibiting the harmful effects of salinity on this variable (Table 4).

Table 4 - Mean values for pulp thickness in melon cultivars fertigated with different saline nutrient solutions

Cultivar	Pulp thickness (mm)
Bazuca	33.75 a
McLaren	32.07 ab
County	30.40 b
Nutrient solution	
S1	38.42 a
S2	28.27 d
S3	33.46 b
S4	32.49 bc
S5	30.61 cd
S6	29.19 cd

S1 – standard nutrient solution (SNS); S2 – SNS + NaCl (5.0 dS m^{-1}); S3 – S2 enriched with K (50%); S4 – S2 enriched with K (100%); S5 – S2 enriched with Ca (50%); S6 – S2 enriched with Ca (100%). Uppercase Values followed by different letters in a column differ by Tukey's test ($p < 0,05$)

These results are in line with those presented by Dias *et al*. (2011a), who also found decreasing linear behaviour for pulp thickness in the melon with increasing salinity of the nutrient solution. Silva *et al*. (2014) also found an increase in pulp thickness in melon fruit using increasing doses of potassium.

This reduction in characteristics related to fruit size under the effect of salt stress occurs because the long-term exposure of a plant to salt stress can result in a water deficit, the effect of a reduction in the osmotic potential of the soil solution, resulting in physiological changes, with energy expended to maintain metabolic activity, thereby affecting growth and production (SILVA *et al*., 2020b).

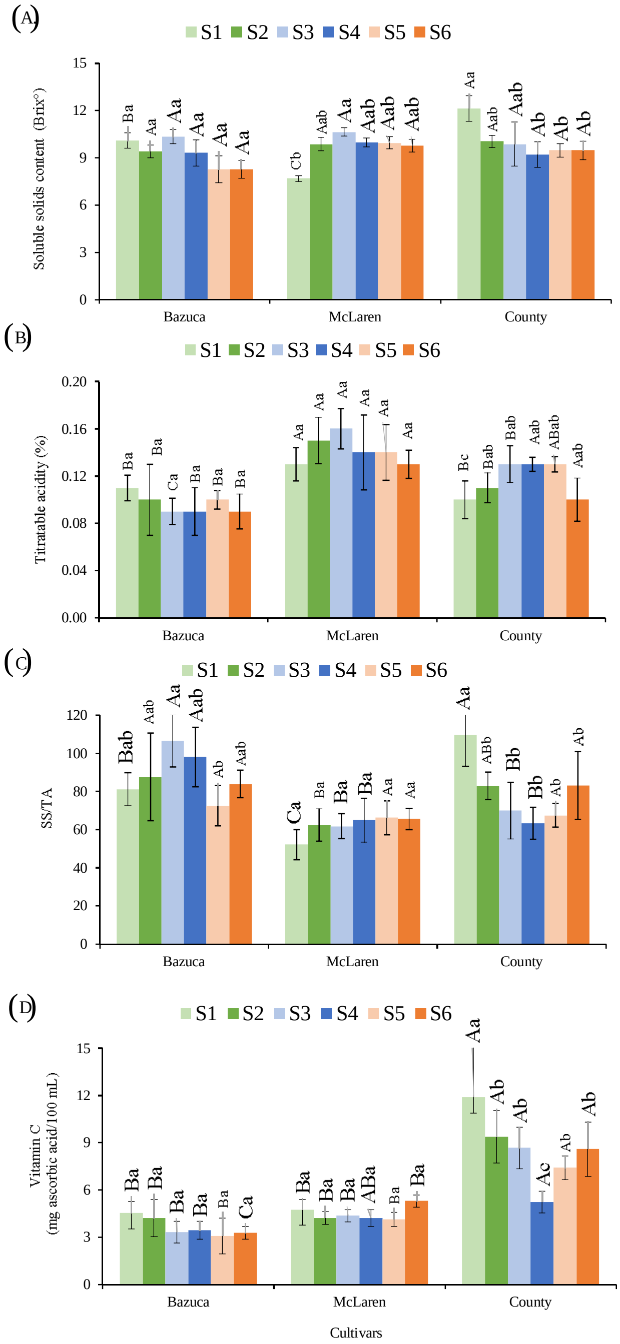
When the soluble solids content (SS) was analysed, significant differences were seen between the cultivars submitted to the standard nutrient solution (S1), with the County cultivar having the highest SS (12 ºBrix), followed by Bazuka (10 ºBrix), and McLaren with the lowest (8 ºBrix). There was, however, no significant difference between the cultivars for the different saline nutrient solutions (Figure 3A).

The minimum SS content for the melon is 9 ºBrix; however, for the external market, the minimum required content varies depending on the cultivar. For the Bazuka cultivar (cantaloupe), for example, the minimum content is 10 ºBrix, while for the McLaren (Gallia) the ideal range is between 12 to 14 ºBrix, and for the County (Orange) between 10 to 13 ºBrix (COSTA, 2017). It can be seen, therefore, that the fruit of the Bazuca and County cultivars have a soluble solids content within the range required by the export market. On the other hand, for the fruit of the McLaren cultivar, the value for SS was below the required standard.

When analysing the effect of the nutrient solutions on SS, it was found that the Bazuca cultivar showed no significant difference between the solutions, with a mean SS of 9.3 ºBrix. For the McLaren cultivar, adding NaCl to the nutrient solution afforded an increase in SS, especially with the additional 50% potassium (S3), giving a soluble solids content of 10.5 ºBrix, an increase of 40% compared to the SS values obtained with solution S1 (7.5 ºBrix). The County cultivar showed a higher SS when fertigated with the standard S1 solution (12 ºBrix), with a reduction when saline water was used to prepare the solution; however, there was no significant difference between the saline nutrient solutions (Figure 3A).

An increase in the soluble solids content, as well as a reduction in the fresh weight of melon fruit in response to salinity, was also reported by Pereira *et al*. (2017), who pointed out that the responses are correlated, since a reduction in fruit weight results in a higher concentration of photoassimilates (solutes).

Figure 3 - Soluble solid content (A), titratable acidity (B), SS/TA ratio (C) and vitamin C content (D) in the fruit of melon cultivars fertigated with different saline nutrient solutions



S1 – standard nutrient solution (SNS); S2 – SNS + NaCl (5.0 dS m^{-1}); S3 – S2 enriched with K (50%); S4 – S2 enriched with K (100%); S5 – S2 enriched with Ca (50%); S6 – S2 enriched with Ca (100%). Uppercase letters refer to the difference between varieties and lowercase letters between nutrient solutions by Tukey's test ($p < 0.05$)

The McLaren cultivar showed higher values for titratable acidity (TA) than those obtained with the Bazuka cultivar for all of the nutrient solutions. Furthermore, it was superior to the County cultivar for solutions S1, S2 and S3. There was no significant difference in the effect of the nutrient solutions on TA for the Bazuca or McLaren cultivars, with mean values of 0.096% and 0.14%, respectively. Whereas for the County cultivar, there was a difference between solutions, with the lowest value seen for the standard solution (S1) and the highest values for the saline solutions enriched with an additional 50% and 100% potassium (S3 and S4), and an additional 50% calcium (S5) (Figure 3B).

Despite this increase, each of the cultivars showed TA values within the recommended range, which should be less than 0.5% (DALASTRA; ECHER; HACHMANN, 2015). Silva *et al*. (2014) also reported an increase in titratable acidity in Cantaloupe and Yellow melons in response to increasing doses of potassium.

For the ratio between soluble solids and titratable acidity (SS/TA) with the standard nutrient solution (S1), the highest values occurred in the County cultivar (109.75), followed by the Bazuka cultivar (81.25), while the McLaren had the lowest ratio (52.14) (Figure 3C).

The effect of the nutrient solutions on the SS/TA ratio varied according to the cultivar under analysis, with a significant response seen only in the Bazuca and County cultivars. For the McLaren cultivar, there was no significant difference between solutions, with a mean SS/TA ratio of 66.2. For the County cultivar the highest SS/TA ratio occurred when fertigated with the standard nutrient solution, and for the Bazuca, the highest values occurred with the saline nutrient solutions and those with an additional 50% (S3) and 100% K (S4), of 106.55 and 98.09, respectively (Figure 3C).

A higher ratio between soluble solids and titratable acidity is a desirable feature in the consumer market for fresh fruit, as this high ratio indicates an excellent combination between sugars and acids that correlates with a mild flavour (CHITARRA; CHITARRA, 2005). Paiva *et al*. (2018) found a reduction in TA and an increase in SS in the tomato when fertigated with more-highly concentrated potassium solutions, even when subjected to salinity levels of up to 3.5 dS m^{-1}.

The highest vitamin C content was found in fruit of the County cultivar regardless of the nutrient solution, with the highest value, 11.89 mg ascorbic acid 100 mL^{-1}, occurring with the standard solution (S1). The other cultivars differed from each other only with the saline nutrient solution, and with the additional 100% Ca (S6), for which the McLaren cultivar had lowest vitamin C content (Figure 3D).

The nutrient solutions had no significant effect on the vitamin C content of the Bazuca or McLaren cultivars, with mean levels of 3.64 and 4.50 mg ascorbic acid 100 mL^{-1}, respectively. For the County cultivar, the use of saline water reduced the vitamin C content, the effect being enhanced with the additional 100% K (S4) (Figure 3D).

According to Lima *et al*. (2020), the reduction in the ascorbic acid content and, consequently, in the vitamin C content, may be related to changes in the translocation of photoassimilates due to the stress caused by the excess of salts in the irrigation water. Dias *et al*. (2011b) point out that this response is a consequence of the reduced synthesis of hexose sugars, originally D-glucose or D-galactose.

CONCLUSIONS

1. Salt stress reduced the physical characteristics of the fruit of the three noble melon cultivars;
2. The nutrient solution enriched with 50% K (S3) did not reduce the effect of salt stress on fresh weight or fruit size in the melon, however, did afford an increase in fruit quality.

REFERENCES

ALVES, A. S. *et al*. Production and quality of mini watermelon under salt stress and K^+/Ca^{2+} ratios. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 27, n. 6, p. 441-446, 2023.

ALVES, J. P. H. *et al*. Caracterização hidrogeoquímica da água de reservatórios em processo de salinização no Nordeste do Brasil. **Revista Brasileira de Recursos Hídricos**, v. 26, p. 1-16, 2021.

ANUÁRIO BRASILEIRO DE HORTI E FRUTI. 2022. Santa Cruz do Sul: Editora Gazeta. Disponível em: https://www.editoragazeta.com.br/anuario-brasileiro-dehorti-fruti-2022/. Acesso em: 10 mar. 2023.

CASTELLANE, P. D.; ARAÚJO, J. A. C. **Cultivo sem solo**: hidroponia. Jaboticabal: FUNEP, 1995. 43 p.

CHAKRABORTY, K. *et al*. External potassium (K^+) application improves salinity tolerance by promoting Na^+ exclusion, K^+ accumulation and osmotic adjustment in contrasting peanut cultivars. **Plant Physiology and Biochemistry**, v. 103, p. 143-153, 2016.

CHITARRA, M. I. F.; CHITARRA, A. B. **Pós-colheita de frutas e hortaliças**: fisiologia e manuseio. 2. ed. Lavras: UFLA, 2005. 785 p.

COSTA, N. D. **Coleção plantar**: a cultura do melão. 3. ed. Brasília, DF: Embrapa, 2017. 202 p.

CYBULSKA, J.; ZDUNEK, A.; KONSTANKIEWICZ, K. Calcium effect on mechanical properties of model cell walls and apple tissue. **Journal of Food Engineering**, v. 102, n. 3, p. 217-223, 2011.

DALASTRA, G. M.; ECHER, M. M.; HACHMANN, T. L. Desempenho de cultivares de melão, em função do número de frutos por planta. **Journal of Agronomic Sciences**, v. 4, n. 1, p. 26-41, 2015.

DIAS, N. S. *et al*. Concentração salina e fases de exposição à salinidade do meloeiro cultivado em substrato de fibra de coco. **Revista Brasileira de Fruticultura**, v. 33, n. 3, p. 915-921, 2011a.

DIAS, N. S. *et al.* Nutrient solution salinity effect of greenhouse melon (*Cucumis melon* L. cv. Néctar). **Acta Agronômica**, v. 67, n. 4, p. 517-524, 2018.

DIAS, T. J. *et al*. Qualidade química de frutos do maracujazeiro-amarelo em solo com biofertilizante irrigado com águas salinas. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 15, n. 3, p. 229-236, 2011b.

FERREIRA, D. F. Sisvar: computer statistical analysis system. **Ciência e Agrotecnologia**, v. 38, n. 6, p. 109-112, 2014.

FLORES, P. *et al.* Tomato yield and quality as affected by nitrogen source and salinity. **Agronomie, EDP Sciences**, v. 23, n. 3, p. 249-256, 2003.

GURGEL, M. T. *et al.* Qualidade pós-colheita de variedades de melões produzidos sob estresse salino e doses de potássio. **Revista Brasileira de Ciências Agrárias**, v. 5, n. 3, p. 398-405, 2010.

IBGE. **Produção de melão**. 2021. Disponível em: https://www.ibge.gov.br/explica/producao-agropecuaria/melao/br. Acesso em: 11 mar. 2023.

LIMA, G. S. *et al.* Physicochemical quality of fruits of west indian cherry under saline water irrigation and phosphate fertilization. **Revista Caatinga**, v. 33, n. 1, p. 217-225, 2020.

MARSCHNER, H. **Mineral nutrition of higher plants**. 3. ed London: Elsevier, 2012. 643 p.

MUKAMI, A. *et al*. Varietal differences in physiological and biochemical responses to salinity stress in six finger millet plants. **Physiology and Molecular Biology of Plants**, v. 26, n. 8, p. 1-14, 2020.

OLIVEIRA, F. A. *et al*. Salinity tolerance of tomato fertigated with different K^+/Ca^{2+} proportions in protected environment. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 25, n. 9, p. 620-625, 2021b.

OLIVEIRA, G. B. S. *et al*. Potassium nutrition as a strategy to mitigate salt stress in melon grown under protected cultivation. **Semina Ciência Agrária**, v. 42, n. 6, p. 3219-3234, 2021a.

PAIVA, F. I. G. *et al.* Qualidade de tomate em função da salinidade da água de irrigação e relações K/Ca via fertirrigação. **Irriga**, v. 23, n. 1, p. 180-193, 2018.

PEREIRA, F. A. L. *et al.* Tolerance of melon cultivars to irrigation water salinity. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 21, n. 12, p. 846-851, 2017.

RAHMAN, A. *et al*. Calcium supplementation improves Na^{+}/K^{+} ratio, antioxidant defense and glyoxalase systems in salt-stressed rice seedlings. **Frontiers in plant science**, v. 7, p. 609, 2016.

SANGTARASHANI, E. S.; TABTAABAEI, S. J.; BOLANDNAZAR, S. Yield, photosynthetic efficiency and quality parameters of cherry tomato as affected by Ca^{2+} and K^{+} under NaCl salinity. **International Journal of Agriculture and Crop Sciences**, v. 5, n. 12, p. 1280-1288, 2013.

SANTOS, J. M. *et al.* Saline stress and potassium/calcium ratio in fertigated eggplant. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 22, n. 11, p. 770-775, 2018.

SILVA, M. C. *et al*. Características produtivas e qualitativas de melão rendilhado adubado com nitrogênio e potássio. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 18, n. 6, p. 581-587, 2014.

SILVA, R. C. P. *et al*. Bell pepper production under salt stress and fertigation with different K^{+}/Ca^{2+} ratios in a protected environment. **Acta Scientiarum. Agronomy**, v. 42, p. 1-11, 2020a.

SILVA, S. S. *et al*. Production and quality of watermelon fruits under salinity management strategies and nitrogen fertilization. **Semina: Ciências Agrárias**, v. 41, n. 6, p. 2923-2936, 2020b.

TAIZ, L. *et al*. **Physiology and plant development**. 6. ed. Porto Alegre: Artmed, 2017. 858 p.