

Original Research Article

Effect of Saline Concentrations in Melon Under Different Substrates in Hydroponic System

ABSTRACT

The culture of melon is one of the most important vegetable activities in the world, it is a species cultivated as vegetable and marketed as fruit, presenting with this greater market value. The Brazilian Northeast is the main region producing melon, with the semi-arid regions as highlight. These regions present edaphoclimatic characteristics that provoke the process of salinization, hindering the exploitation of plant species. The culture of melon is considered as moderately tolerant to salinity, but due to the worsening effects of salinity, it is necessary to develop strategies and new cultivars of melon tolerant to salinity. Thus, the objective of this work was to evaluate the effect of saline concentrations in melon on different substrates in hydroponic system. The experiment was carried out at the Rural Federal University of Pernambuco, in a greenhouse, in which the completely randomized design was used in the subdivided plots scheme, with the plots being the 4 saline concentrations and the subplots the 3 substrates in 4 replicates. Each plot consisted of 4 pots of 400 ml, with perforations at the base, in which they had two plants in each. The electrical conductivity (CE) levels were 2.0; 5.0; 8.0 and 11.0 dS.m⁻¹. The salt used was sodium chloride (NaCl). The substrates used were washed sand, coconut powder and the commercial substrate (Basaplant). The CE of 2 dS.m⁻¹ presented a higher growth rate, with a mean growth of 2.88 cm per day, the CE's of 5, 8 and 11 dS.m⁻¹, respectively presented a growth rate of 2.33; 1.77 and 1.23 cm per day. The increase in the concentration of salts in the solution negatively influenced the morphological and color characteristics of the melon. The substrates washed sand, coconut powder and Basaplant presented no significant difference in the effects on the melon culture. The substrate type did not influence the effect of the salt on the melon.

Keywords: *Salinity, Cucumis melo L., Electrical conductivity.*

1. INTRODUCTION

The melon is the fruit of one of the cultivated species of greater importance for Brazil, being a vegetable, but its fruits marketed as fruit. In 2017, 224,688 tons of the fruit (40% of the total produced) were exported, totaling US\$ 148,741,470. The states of Rio Grande do Norte and Ceará represent 98% of national exports of crops [1,2,3,4].

The main poles producing melon are in semi-arid regions, which have a favorable climate for the development of culture, but this same climate leads to the formation of some adverse factors, such as soil salinity, which is a natural process, but intensified by anthropic action. In the Brazilian Northeast there are approximately 23,000 hectares of irrigated perimeters, of which 25% are already salinized [5,6].

Plants subjected to saline stress undergo changes throughout their structure, cellular metabolism, physiological activities, altering their growth rate and consequently production. Melon is considered a moderately tolerant to salinity, but tolerance depends on several factors, such as genotype, salt type, salt concentration, period of exposure to salt, substrate in which the plant is fixed, among other factors [7,8].

High concentrations of salts in the soil or water used cause changes in soil, substrate and solution, and consequently in the plant, these alterations go from decreasing of the pH, alterations of the physical and chemical properties, among others, being important to know the soil or substrate and the water used, because the greater the electrical conductivity of the solution, the higher the toxicity indexes in the plants due to the accumulation of salts in the leaves [9,10].

In hydroponic melon crops it is common for water to have a high level of salinity depending on the origin, so it is important to define the maximum electrical conductivity that plants support without losing their characteristics. Another important point is the choice of the substratum for plant fixation, which may be sand, sawdust, coconut fiber, scrub among other materials, each of which may increase the negative effect of salinity on plants [11].

The objective of this work was to evaluate the effect of salt concentrations in melon under different substrates in a hydroponic system.

2. MATERIAL AND METHODS

The experiment was conducted in the Department of Agronomy, planting area of the Rural Federal University of Pernambuco, Campus Dois Irmãos, Recife-PE (8°01'09" S and 34°56'43" W), between July and August 2016, being carried out in a greenhouse of the arch type, with 20 m of length, 8 m of width, right foot of 3.0 m, with side shields with 50% shading and ceiling covered with 150 micron thick low density polyethylene film.

The experimental design was completely randomized in the scheme of subdivided plots, the plots being the four salt concentrations and the subplots the three substrates, in four replications. Each plot consisted of four 400 ml pots, with perforations at the base, in which they had two plants in each.

The salinity levels were 2.0; 5.0; 8.0 and 11.0 dS.m⁻¹, which were applied on hydroponic masonry benches 5 m long and 2 m wide, with slope of 12%. The salt used was Iodine Sodium Chloride (NaCl), which consists of 360 mg/100g Na, 8mg/100g Cl and 25ug/100g I. The substrates used were washed sand, coconut powder and the commercial substrate (Basaplant®).

The nutrient solution used for 2,000 L consisted of 1,767 g of Calcium Nitrate, 1,100 g of Potassium Nitrate, 440 g of MKP, 900 g of Magnesium Sulphate, 51 g of Quelatec®, 51 g of Ultra Iron and 3.35 g of boric acid, diluted in 130 ml of H₂O. The conductivity of this solution was about 2.0 dS.m⁻¹, to compose the other electrical conductivities was added salt until reaching the proposed conductivity, the conductivities presented variation of ± 0.2 dS.m⁻¹. The pH of this solution ranged from 6.0 to 6.5, being controlled with the use of caustic soda (NaOH). The automated hydroponic system emitted water on the bench for 15 min, with an interval of 45 min.

The variety of melon (*Cucumis melo* L.) used was of the yellow type, the hybrid SF 10/00, used as commercial standard and because it is one of the most used in the Northeast of Brazil.

The variables evaluated were:

Seedling Emergency Percentage (% EP): Count of germinated seedlings, carried out at 4, 6 and 8 days after planting (DAS).

Burning of cotyledons (QC): Quantified by means of visual notes varying from 1 to 5 (1 - No burning, 2 - 0.1 to 25% of burning, 3, 26 to 50% of burning, 4 to 75% of burning, 5 to 76 to 100% of burning). The cotyledons evaluated at 10 DAS and leaves at 13, 16, 19 and 22 DAS.

Burning of leaves (QF): Quantified by means of visual notes varying from 1 to 5 (1 - No burning, 2 - 0.1 to 25% of burning, 3, 26 to 50% of burning, 4 to 75% of burning, 5 to 76 to 100% of burning). The cotyledons evaluated at 10 DAS and leaves at 13, 16, 19 and 22 DAS.

Change in the morphology of cotyledons and leaves: Quantified by means of visual notes varying from 1 to 3 (1 - no change, 2 - 0.1 to 60% of leaf closure, 61 to 100% of leaf closure) (graph 1). The cotyledons evaluated at 10 DAS and leaves at 13, 16, 19 and 22 DAS.

Plant height (AP): Measured using a millimeter ruler from the base of the plant to the height of the apical meristem, evaluated at 10, 13, 16, 19 and 22 DAS.

Leaf area (AF): Estimated by means of the equation $y = 0.826x^{1.89}$ ($R^2 = 0.97$), where y corresponds to leaf area ex average leaf width [12], being evaluated at 13, 16, 19 and 22 DAS.

Number of leaves (NF): Count the number of leaves at 13, 16, 19:22 DAS.

Fresh mass (MF): The fresh mass was evaluated at 22 DAS, in which the weighing of 4 plants was carried out in a precision scale.

Dry mass (MS): The dry mass was evaluated after drying the fresh mass of four plants in a greenhouse of negative flow at 72°C for 48 hours, being weighed in digital scale.

The leaf color was also evaluated at 22 days, using the Minolta CR-400 colorimeter, previously calibrated on a white surface according to the standards set by the manufacturer. The reading was performed in the median region of the leaf, about 1 cm of the central vein, were evaluated two leaves per plant, collected in the median region.

Three color parameters were evaluated: L*, a* and b*. The value of a* characterizes coloration in the region of red (+a*) to green (-a*), the value b* indicates coloring in the range of yellow (+b*) to blue (-b*). The value L gives us the luminosity, varying from white (L=100) to black (L=0).

Chroma is the relation between the values of a* and b*, where the real color of the analyzed object is obtained. Hue-angle is the angle formed between a* and b*, indicating the color saturation of the object. For the calculation of Chroma the mathematical formula (1) was used and, to calculate Hue-Angle, the formula (2) is used.

$$C = \sqrt{a^2 + b^2} \quad (1)$$

$$H^\circ = \arctan b/a \quad (2)$$

The statistical analyzes used were analysis of variance, polynomial regression for salt concentrations, Tukey test at 5% probability for the substrates. A correlation was performed by Pearson, verified by t test at 1 and 5% probability.

At 22 DAS, transplantation was carried out, for 5 L polyethylene vessel, with coconut powder substrate, in which it was conducted free, with spacing of 0.6 m between each vessel. In this stage the recovery of the plants after saline stress was evaluated, in which the nutrient solution was the same as in the previous step, but with electrical conductivity of 2 dS.m⁻¹.

In this step, a variance analysis was performed and polynomial regression for the electrical conductivities of the previous stage. The height of the main stem was evaluated at 10 and 20 days after transplanting, measuring from the cervix to the apical meristem.

3. RESULTS AND DISCUSSION

In Table 1, it can be observed that the electrical conductivity (CE) of the solution influenced the germination only in the count at 4 days after sowing (DAS), the higher the CE, the lower the germination, being represented by the equation $y = 39.98 + 11.22x - 1.16x^2$ ($R^2 = 95.71\%$), that is, the salinity makes the germination of the seeds difficult, influencing the speed of germination. At germination at 6 and 8 DAS, there was no significant difference between the CE's, with respective average of 82.29 and 86.46% respectively.

Table 1. Averages of germination, burning and morphological alteration as a function of CE.

CE(dS.m ⁻¹)	Germ 4 DAS	Germ 6 DAS	Germ 8 DAS	Q. Cot	Q. 13/16/ 19/22 DAS	M. Cot	M. 13/16/19 DAS	M. 22 DAS
2	57.81	80.21	83.64	1.01	1.00	1.00	1.00	1.00
5	67.19	83.33	85.52	1.04	1.00	1.00	1.00	1.00

8	55.72	80.21	87.39	1.21	1.00	1.00	1.00	1.33
11	23.43	85.41	89.27	1.48	1.00	1.00	1.00	2.00
Averages	-	82.29	86.46	-	0.00	0.00	0.00	-
Regression	$Y = 39.98 + 11.22x - 1.16x^2$	-	-	$Y = 1.06 - 0.03x + 0.007x^2$	-	-	-	$Y = 1.19 - 0.12x + 0.019x^2$
R ²	95.71	-	-	97.83				100
C.V. (%) 1	26.24	12.05	6.58	5.56	0.00	0.00	0.00	4.93
C.V. (%) 2	26.95	20.01	8.86	6.72	0.00	0.00	0.00	5.78

CE - Electrical Conductivity. Germ 4 DAS - Germination at 4 days after sowing; Germ 6 DAS - Germination at 6 days after sowing; Germ 8 DAS - Germination at 8 days after sowing; Q. Cot - Burning of cotyledons; Q. 13/16 DAS - Burning of the leaves at 13, 16 and 19 days after sowing. Q. 22 DAS - Burning of the leaves at 22 days after sowing; M. Cot - Change in cotyledon morphology. M 13; 16; 19 and 22 - Change in leaf morphology at 13; 16; 19 and 22 days.

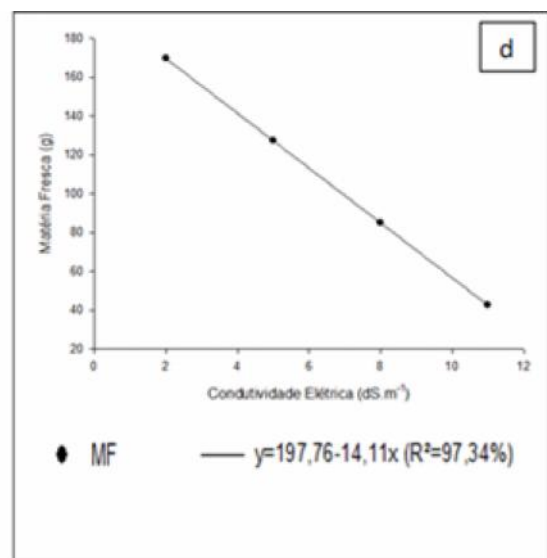
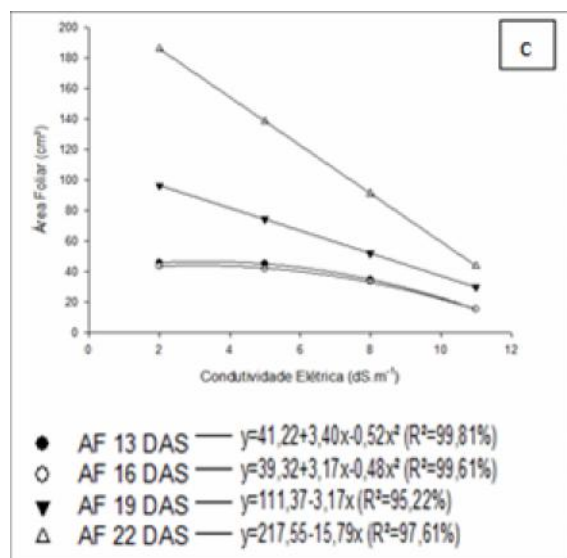
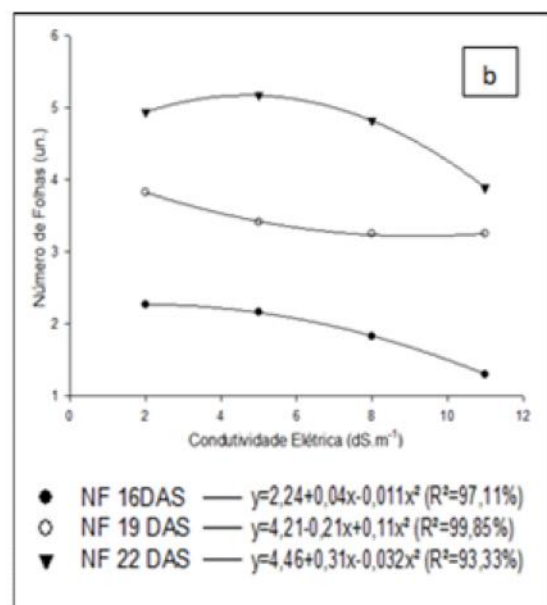
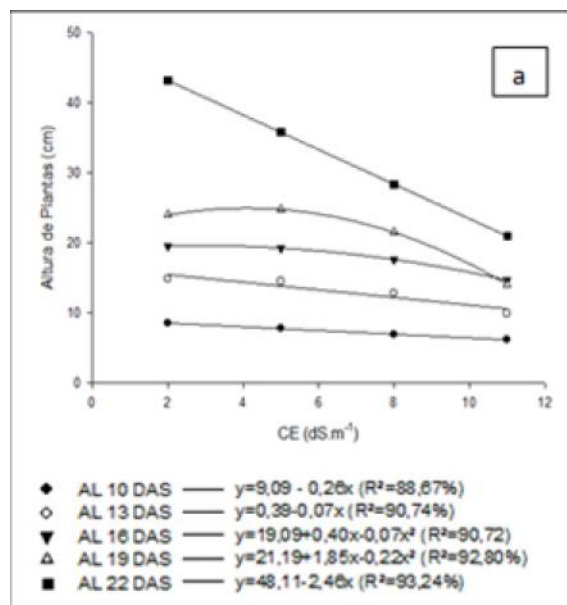
The germination of the melon is impaired by the CE of the solution, in which CE's greater than 8 dS.m⁻¹, decrease seed germination, as the osmotic potential of the substrate is reduced, inducing less capacity of water absorption by the seeds, in addition to the toxic effect of salt, which hinder normal functioning of the vital structures of the seed [13,14].

As for the burns due to the excess of salt in the vegetative organs, only the cotyledons suffered damage as a result of the CE increase, being able the same is estimated by the equation $y = 1.06 - 0.03x + 0.007x^2$ ($R^2 = 97.83$). Cotyledons submitted to CE of 2.0, 5.0 and 8.0 dS.m⁻¹ presented minimal but increasing damages, while the CE 11.0 dS.m⁻¹ presented about 10% of burnings, in counterpart, the leaves did not undergo burning in any of the evaluation periods.

Morphological changes occurred at 22 DAS, It may be explained by the equation $y = 1.19 - 0.12x + 0.019x^2$ ($R^2 = 100\%$), where the CE's of 2 and 5 dS.m⁻¹, showed no changes, in the CE of 8 dS.m⁻¹ there were small changes and in the CE of 11 dS.m⁻¹ the leaves presented great changes in the morphology, with tendency to foliar closure.

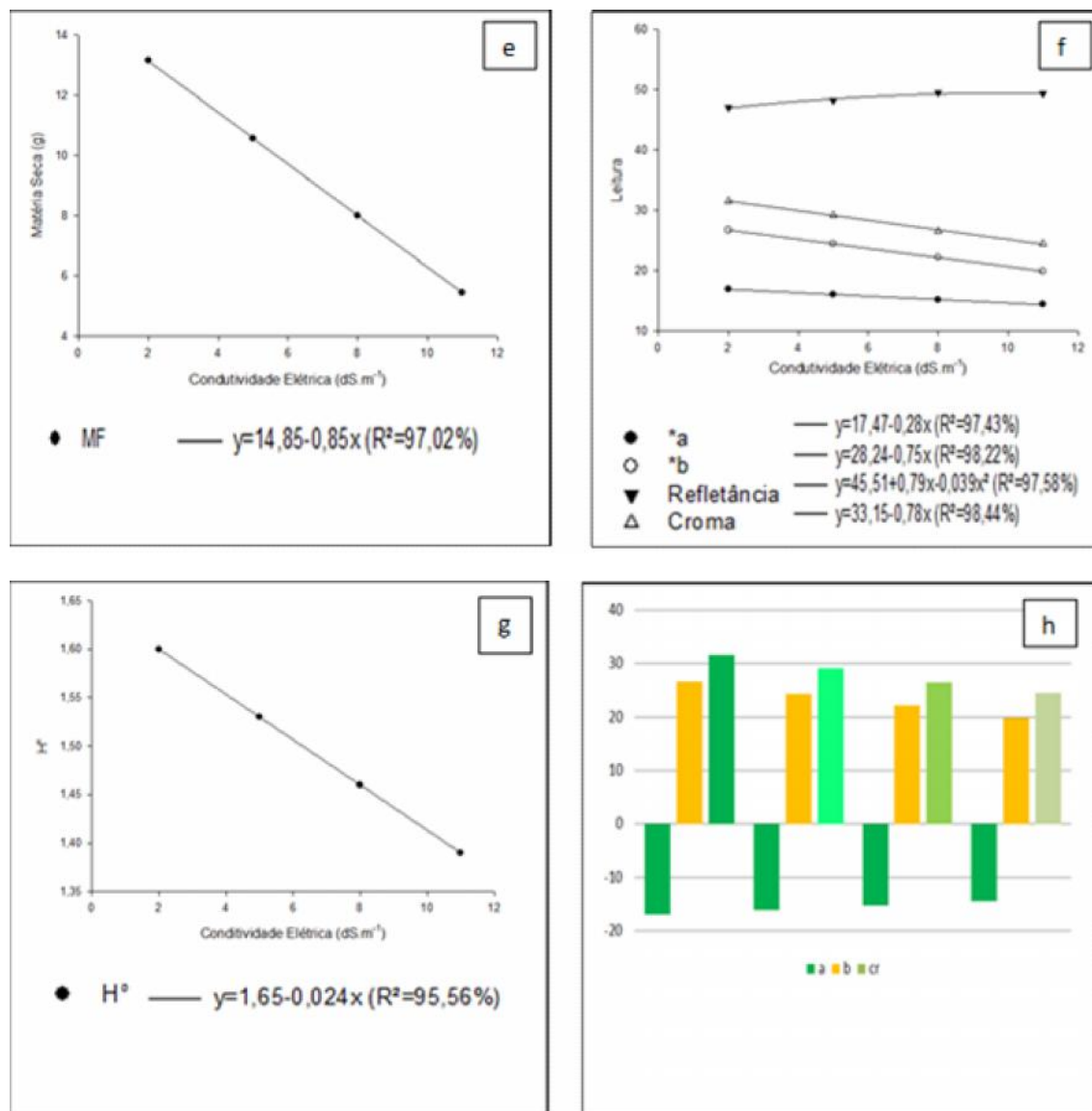
Graph 1 (A) shows the behavior of plant height (AL), which was influenced by the CE increase, in which in the CE of 2 dS.m⁻¹ presented higher growth rate, with average growth of 2.88 cm per day, the CE's of 5, 8 and 11 dS.m⁻¹, presented a growth rate of 2.33; 1.77 and 1.23 cm per day. In all the epochs of evaluation the growth of the plants remained constant, presenting small variation at 10 DAS in growth, with a loss of 0.26 cm per unit increase in CE and a large increase over the cycle, being that at 22 DAS the loss was 2.46 cm per unit increase of the CE.

Graph 1. Melon reactions to different electrical conductivities.



178
179

180
181



a- Height of plants as a function of conductivity; b - Number of leaves per plant in function of the electrical conductivity; c - Leaf area in function of the electrical conductivity; d - Fresh mass depending on the electrical conductivity; e - Dry mass as a function of the electrical conductivity; f - Coloring Angle (H^+) as a function of the electrical conductivity; h - combination of readings a, b and chroma in the different electrical conductivities.

In graph 1 (B), the CE's influence the number of leaves (NF) from DAS 16, at 13 DAS the number of leaves was 1 for all CE's. CE's 2 and 5 dS.m^{-1} showed small variations in NF in the CE of 11 dS.m^{-1} , the decrease in the number of leaves compared with CE 2 dS.m^{-1} was 1.05 un at 22 DAS.

In graph 1 (C), leaf area (AF) of melon can be observed in the CE function, as the CE increases, the AF decreases for all epochs of evaluation. The AF at 22 DAS presented a reduction of 15.79 cm^2 per unit increment of the CE.

In graphs 1 (D and E), it is observed that the fresh mass (MF) and dry mass (MS) presented similar behavior, presenting a reduction as the CE increases, for the MF, the unit loss of fresh mass was 14.11 g per unit of CE, having in the CE 2 dS.m^{-1} 169.54 g and in CE 11 dS.m^{-1} 42.54 g. For MS, the loss was 0.85 g per unit of increased CE, presenting 13.14 g in CE 2.0 dS.m^{-1} and 5.44 in CE 11.0 dS.m^{-1} . The amount of water in the plants was also influenced by the CE, being 92.24; 91.69; 90.57

and 87.21% water respectively for the CE's 2.0; 5.0; 8.0 and 11.0 dS.m⁻¹, that is, the amount of water contained in the plants reduces with the increase in CE.

High concentrations of salts in soil and water cause morphological changes, structural and metabolic effects on melon seedlings, inhibit its growth and development, reducing the percentage of dry mass in plants, in fruit size and yield [15,16].

The decrease in growth and dry mass is related to the reduction of the photosynthetic capacity of the plants, by means of ionic interactions promoted by the excess of salts and sodium, thus causing the reduction in the accumulation of photoassimilates due to the lower production, for this reason also provides greater energy expenditure, which occurs mainly due to the reduction of the osmotic potential, promoting the reduction of water availability for plant growth, in addition to the burning of the leaves extremities [17,18].

Due to the toxic actions of the salt in the melon, there is a greater energy expenditure for plant maintenance, decrease in leaf number, and leaf area, which promotes a significant decrease in the photosynthetic area, causing greater physiological disorders in the chain, limiting the normal development of the crop.

In the graphs 1 (F and G), one can observe the results of the readings of the colorimeter, in which the reading *a, b, Chroma and H° presented reduction, because as the CE increases, it decreases the values of its readings, that is, the plant loses the intensity of green (graph 1 (h)), becoming opaque green. The reflectance was higher in the higher CE's, because due to change in the coloring of the leaf, the luminosity was more reflected, consequently less absorbed.

According to [17], the excess of salt in the plant tissues significantly changes the photosynthetic rate, which indirectly can be observed by the coloring of the leaves, because the proportion of chlorophyll and carotenoid pigments is altered. Then it was observed that with the increase of the concentration of salts in the plant the change of intensity of the green, prevents the penetration of light beams into the cells, which consequently decreases the production of photoassimilates.

According to the Tukey test at 5% probability, it can be concluded that for germination at 4, 6 and 8 DAS the commercial substratum Basaplant (78.21%) showed a higher percentage of germination, differing from Sand (46.09%) at 4 DAS, and at 6 and 8 DAS Basaplant (96.09 and 96.88%) showed no significant difference with Sand (82.81 and 86.72%) (Table 2).

Table 2. Averages of germination, burning and alteration in the anatomical as a function of the substrates.

Substrate	Germ 4 DAS	Germ 6 DAS	Germ 8 DAS	Q. Cot	Q. 13/16/ 19/22	M. Cot	M. 13/16	M. 19/22
Sand	46.09 b	82.81 b	86.72 ab	1.31b	1.00	1.00	1.00	1.38a
Coconut powder	28.91 a	67.96 a	75.78 a	1.00a	1.00	1.00	1.00	1.31a
Basaplant	78.21 c	96.09 b	96.88 b	1.25ab	1.00	1.00	1.00	1.31a
Averages	-	-	-	-	1.00	1.00	1.00	1.33

Averages followed by the same letter in the column do not differ each other by the Tukey test at 5% probability. EC - Electrical Conductivity. Germ 4 DAS - Germination at 4 days after sowing; Germ 6 DAS - Germination at 6 days after sowing; Germ 8 DAS - Germination at 8 days after sowing; Q. Cot - Burning of cotyledons; Q. 13/16 DAS - Burning of the leaves at 13, 16 and 19 days after sowing. Q. 22 DAS - Burning of the leaves at 22 days after sowing.

The onset of burning occurred only in the cotyledons, in the sand substrates and Basaplant larger damages occurred, presenting respective notes of 1.31 and 1.25, already the coconut powder did not show burning. In the leaves there was no burning in any of the evaluations.

The change in morphology did not occur in the cotyledons, nor in the leaves at 13, 16 and 19 DAS. At 22 DAS plants in the three substrates presented small morphological changes, but did not show any difference between them, with a mean score of 1.33.

Table 3 shows the comparative averages between the substrates used in the production of melon seedlings for some agronomic variables, which can be concluded that for plant height (AL) there was

no significant difference in the AL assessed at 10, 13, 16 and 19 DAS, with averages of height of the melon of 7.37; 13.04; 17.80 and 21.09 cm. AL at 22 DAS was higher in the commercial substratum Basaplant (35.32 cm) without statistically differing coconut powder (30.93 cm).

Table 3. Averages height and number of leaves at the evaluation times according to the substrates.

Substrate	AL 10DAS	AL 13DAS	AL 16DAS	AL 19DAS	AL 22DAS	NF 13DAS	NF 16DAS
Sand	7.15a	12.81a	17.57a	20.34a	29.98a	1.00a	1.68a
Coconut powder	7.31a	12.77a	17.52a	21.41a	30.93ab	1.00a	2.00a
Basaplant	7.64a	13.54a	18.30a	21.52a	35.32b	1.00a	2.00a
Averages	7.37	13.04	17.80	21.09	-	1.00	1.89
C.V. (%) 1	10.63	6.27	4.59	7.80	12.58	20.47	22.47
C.V. (%) 2	9.49	10.03	7.36	8.49	16.82	17.96	18.66

Means followed by the same letter do not differ statistically by the Tukey test at 5% probability. AL 10 DAS - Plant Height at 10 days after sowing (cm); AL 13 DAS - Plant Height at 13 days after sowing (cm); AL 16 DAS - Plant Height at 16 days after sowing (cm); AL 19 DAS - Plant Height at 19 days after sowing (cm); AL 22 DAS - Plant Height at 22 days after sowing (cm); NF 13 DAS - Number of leaves at 13 days after harvest (un); NF 16 DAS - Number of leaves at 16 days post harvest (un). C.V. (%) 1 - Coefficient of Variation of the plots. C.V. (%) 2 - Coefficient of Variation of subplots.

The NF of the melon was not influenced by the substrates, which presented means of 1.0; 1.89; 3.31 and 4.72 un., respectively at 13, 16, 19 and 22 DAS.

For the leaf area of the melon at 13, 16 and 22 DAS there was no significant difference between the evaluated substrates, with respective means of 33.86; 35.28 and 14.88 cm². The leaf area at 19 DAS was higher in the plants fixed in the substrate Basaplant (67.85 cm²) and sand (61.85 cm²) (Table 4).

Table 4. Average number of leaves and leaf area at the evaluation times according to the substrates.

Substrate	NF 19DAS	NF 22DAS	AR 13DAS	AR 16DAS	AR 19DAS	AR 22DAS
Sand	3.12a	4.65a	32.64a	33.73a	61.85ab	111.07a
Coconut powder	3.12a	4.75a	32.55a	33.75a	59.78a	109.43a
Basaplant	3.68a	4.75a	36.40a	38.37a	67.85b	124.14a
Averages	3.31	4.72	33.86	35.28	-	114.88
C.V. (%) 1	9.23	25.05	22.47	20.27	9.23	25.05
C.V. (%) 2	13.85	16.81	18.66	17.96	13.85	16.81

NF 19 DAS - Number of leaves at 19 days after harvest (un); NF 22 DAS - Number of leaves at 11 days post harvest (un); AR 13 DAS - Leaf area at 13 DAS (cm²); AR 16 DAS - Leaf area at 16 DAS (cm²); AR 19 DAS - Leaf area at 19 DAS (cm²); AR 22 DAS - Leaf area at 22 DAS (cm²). C.V. (%) 1 - Coefficient of Variation of the plots. C.V. (%) 2 - Coefficient of Variation of subplots.

The fresh mass (MF) was influenced by the different substrates, presenting the coconut powder and Basaplant the best results, with regard to the dry mass (MS), it can be observed that the different substrates did not show any statistical difference between them (Table 5).

Table 5. Average of substrates for fresh mass and dry mass.

Substrate	MF	MS
Sand	95.00a	8.56 ^a
Coconut powder	111.87b	9.94 ^a
Basaplant	111.25ab	9.38 ^a
Averages		9.29

Means followed by the same letter do not differ statistically by the Tukey test at 5% probability. MF - Fresh Mass (g); MS - Dry Mass (g).

According to the Tukey test at 5% probability for the unfolding of the substrates within each CE it can be concluded that the luminosity of the melon leaves submitted to CE of 2, 5 and 8 dS.m⁻¹ did not present difference in reflectance, with averages of 47.01; 48.28 and 49.55, respectively for CE's 2, 5

and 8. In CE 11 dS.m⁻¹ coconut powder and sand (51.32 and 49.45) presented higher reflectance, differing from Basaplant (47.45) (Table 6).

Table 6. Substrate unfolding within each electrical conductivity for the reflectance.

Substrate	Refletance			
	Electrical Conductivity			
	2.0	5.0	8.0	11.0
Sand	46.43 a	49.48 a	50.45 a	49.45 ab
Coconut powder	46.85 a	47.48 a	48.75 a	51.32 b
Basaplant	47.75a	47.88 a	49.45 a	47.45 a
Averages	47.01	48.28	49.55	-

Averages followed by the same letter do not differ statistically in the column.

Table 7 shows the coloring parameters of the melon leaves, that did not present significant difference by the test of Tukey to 5% of probability, for none of the substrates submitted for fixing the melons, with averages of 15.64; 23.31; 48.83; 28.05 and 1.50 respectively for the variables *a, *b, L, Chroma and H°.

Table 7. Averages of readings and colorimetric indexes.

Substrate	Reading *a	Reading *b	L	Croma	H°
Sand	15.43a	23.27a	48.95a	27.91a	1.51a
Coconut powder	15.61a	22.85a	48.60a	27.65a	1.48a
Basaplant	15.88a	23.81a	48.95a	28.59a	1.51a
Averages	15.64	23.31	48.83	28.05	1.50

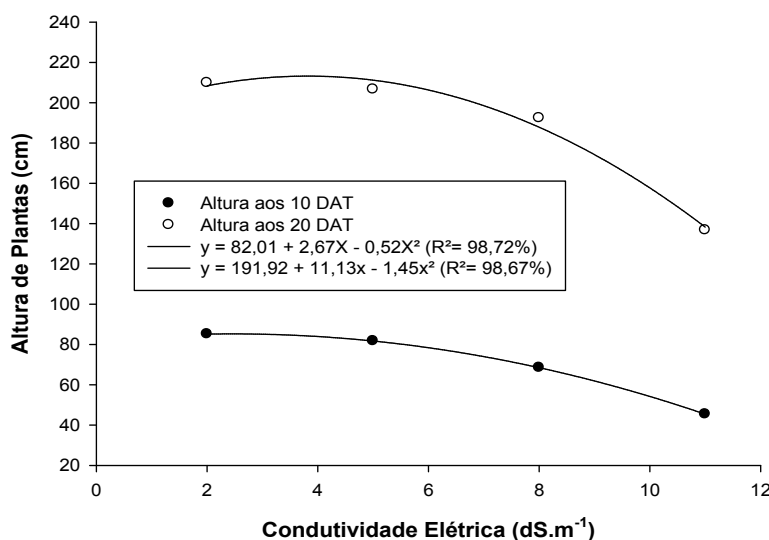
Averages followed by the same letter do not differ statistically in the column. L - Reflectance; H - Hue-angle.

In hydroponic crops, the substrates had little influence on the effects of salinity on plants, because due to the nutritive solution is the main source of electrical conductivity in function of the salts provided, due mainly to the osmotic potential of the solution. Already the substrates that could increase the negative effect of the excess of salt due to the matrix potential of the solid part, was minimized in this system, but along of long-lasting crops, these can accumulate salts.

The reduction of the osmotic potential due to excess salt in the solution is one of the main factors that negatively influence the plant, because it accelerates the absorption and consequently the accumulation of salts in the plant cells. The presence of salts in the soil solution increases the retention forces by their osmotic effect and, therefore, the magnitude of the problem of water scarcity in the plant. The increase in osmotic pressure (PO) caused by excess soluble salts, may reach a level where the plants will not have sufficient suction forces to overcome this PO and, as a consequence, the plant will not absorb water, even from apparently moist soil (physiological dry) [19].

In graph 2, it can be observed that it was not possible to recover the plant that was submitted to high salt concentration. For even if the substrate is altered with the decrease of salt, in the cells of the vegetable there is still the accumulation of salt, in this way, it is not possible to have a full recovery of the development of the melon, influencing the mineral composition of the plant [7,19,20].

Graph 2. Height of plants after transplanting as a function of the electrical conductivity.



These results evidenced the possibility of the use of saline soil, of saline water in irrigation and use in hydroponic solutions, being necessary to develop cultivars that present a greater tolerance to the salinity, to further explore these resources through this culture, which naturally exhibits moderate tolerance to salinity, having sufficient variability to be exploited by breeding programs [9,21,22].

According to Pearson's correlation (Table 8), there was a high correlation between germination and plant height (0.71), germination and leaf area (-0.94), germination and chroma (0.95), leaf morphology and fresh mass (-0.99), chroma and height (0.88), chroma and leaf area (-0.80), number of leaves and fresh mass (0.99), number of leaves and dry mass (0.93), and fresh mass and dry mass (0.93).

Table 8. Pearson correlation for the morphological variables and color intensity of the melon.

Variables	Germ	Morf	Alt	AF	NF	CR	MF
Anat	0.21						
Alt	0.71*	-0.54					
AF	-0.94**	-0.54	-0.42				
NF	-0.21	-1.00	0.54	0.54			
Croma	0.95**	-0.08	0.88**	-0.80*	0.076		
MF	-0.24	-0.99**	0.51	0.57	0.99**	0.04	
MS	-0.56	-0.93**	0.18	0.81*	0.93**	-0.31	0.93**

** Significant by t test at 1% probability; * Significant by t test at 5% probability. Germ - Percentage of germination; Morf - Alteration in Morphology; Alt - Height of Plants; AF - Foliar area; NF - Number of leaves; CR-Chroma; MF - Fresh mass; MS - Dry mass.

From the observed correlations, the variables that show correlation with chroma, are the most important in identifying toxicity, because they allow with the use of the colorimeter equipment to indirectly determine another character, which in this case for germination and plant height was positive, indicating that the more intense the color of the leaves, the higher the percentage of germination and the greater the height of plants. For the leaf area the correlation was negative, indicating that the greater the green intensity, the smaller the leaf area.

According to [15,16], plants submitted to salinity present reduced growth, so that according to the results found in this research can estimate the height and leaf area of the melon based on the value of chroma. The green pigmentation in the leaves is the result of the proportion of chlorophyll and carotenoids, so that plants with higher chlorophyll content present higher amounts of chloroplasts, responsible for carrying out the transformation of solar energy in organic energy [17,23,24].

In this study, plants with lower chroma value show reduced growth, in contrast the leaf area tends to be larger, in view of the melon strategy in storing the excess salt in the vacuoles [7,17].

4. CONCLUSION

The increase in the concentration of salts in the solution influenced negatively the morphological and coloring characteristics of the melon leaves.

The substrates sand, coconut powder and Basaplant® did not present significant difference in the effects on the culture of the melon.

The intensity of leaf color can be used to measure and diagnose the salinity of the melon.

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