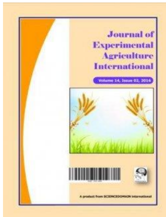

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Initial Growth of Melon Plant in Different Substrates and Salt Waters

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: Was aimed at to evaluate the initial growth of the melon plant under saline conditions in different types of substrates.
Place of Study: The work was accomplished in the Federal University of Campina Grande in Pombal, Paraíba in Brazil.
Methodology: Four proportions of substrates were used: S1 (100% Commercial Substrate Carolina Soil ® — SCC); S2 (50% of SCC and 50% of Sand); S3 (50% of SCC and 50% of Soil) and S4 (33,33% of SCC + 33,33% of Sand + 33,33% of Soil), and five levels of electric conductivity: T1 (0,3 dS m^{-1}); T2 (1,2 dS m^{-1}); T3 (2,2 dS m^{-1}); T4 (3,2 dS m^{-1}) and T5 (4,2 dS m^{-1}).

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The length of plantules was evaluated (aerial and root), stem diameter, number of leaves, mass dries (aerial, root and total), biomass production and index of tolerance.
Results: All the variables presented significant effect demonstrating that the appraised factors interfere simultaneously in the appraised characteristics.
Conclusion: In the conditions of the referred study, the salinity in the irrigation water interferes negatively in the initial growth of melon plant plantules. The formulation of composed substrate for the mixture of the commercial substrate Carolina Soil® with soil (50% of both) it was shown efficient in the initial growth of the melon plant to cultivate 'Amarelo Ouro' under conditions of saline stress.

Keywords: Cucumis melo L.; saline stress; cultivation; substrate Carolina Soil®; proportions.

1. INTRODUCTION

The melon (*Cucumis melo* L.) it is a tropical olerícola, belonging to the family of Cucurbitáceas and cultivated at several countries of the world. In Brazil, the Northeast Area stands out for being the main producing of melon. The states of Ceará and Rio Grande do Norte are the main producers, the same ones, answer for practically all the production and export of the Brazilian melon with more than 90% [1].

In spite of adaptability for to the edaphoclimatic conditions of the Northeast Area, the cultivation of the melon plant in the Northeastern semiarid, is in risk, due to problems with the salinity of the water and of the soil, that can harm the productivity and quality of the fruits [2]. The salinity affects the growth of the plant in all the development stadiums, however the initial growth is the most affected for the salinity, in most of the agricultural cultures [3]. The daily application of water with high electric conductivity in the irrigation harms several cucurbitaceae, among them, watermelon plant [4,5] and melon plant [6,7].

In function of that, the substrate used for the production of seedlings should present physical and chemical properties appropriate to the development of the plants, especially the leaching capacity of salts [8,9]. Use of commercial substrates presents high concentration of nutrients, however besides the high cost, the leaching of nutrients happens in a hast manner, soon use of formulations of that substrate with soil or manure with high tenor of organic matter, it can be alternative viable [10].

Therefore, the initial growth of the plants is the most prejudiced phase for the harmful effects caused by the salinity, being done necessary the implementation of techniques that make possible the production of the melon plant irrigated with saline water in this phase of the development. In this context, it was aimed at with that work, to evaluate the initial growth of the melon plant to cultivate 'Amarelo Ouro' under saline stress and different substrates.

2. MATERIALS AND METHODS

The work was accomplished in the Center of Sciences and Technology Agro-Food of the Federal University of Campina Grande, campus Pombal, Paraíba. According to the climatic classification of Köppen, adapted Brazil [11], the climate is of the type BSh, representing climate hot and dry semiarid, with medium precipitation from 700 to 900 mm year-1, the annual medium temperature of 26,1°C and annual medium evaporation from 1000 to 1100 mm [12].

The experiment was conducted in randomised complete block design with a factorial scheme 4 x 5, being four proportions of substrates: S1 (100% Commercial Substrate Carolina Soil ® — SCC); S2 (50% of SCC and 50% of Sand); S3 (50% of SCC and 50% of Soil) and S4 (33,33% of SCC + 33,33% of Sand + 33,33% of Soil), and five levels of electric conductivity: T1 (0,3 dS m^{-1}); T2 (1,3 dS m^{-1}); T3 (2,3 dS m^{-1}); T4 (3,3 dS m^{-1}) and T5 (4,3 dS m^{-1}), with five repetitions. The commercial Substrate Carolina Soil® possesses in composition peat, vermiculite and charred peel of rice. The used soil possesses the following chemical properties: pH = 6,90; P = 1,80; K = 146; Ca = 2,86; Na = 0,07; Mg = 0,80; Al = 0,08; H+ Al = 1,55; BS = 4,17; CEC = 5,72.

Seeds were used of cultivating of melon plant 'Amarelo Ouro' obtained at specialised commercial market. The seeds were put to soak in water distilled by 24 hours before the sowing. Being the sowing accomplished in black polypropylene containers with capacity for 180 ml, being put two seeds in each halfway form container to 1 cm of depth. After the stabilisation of the emergency to the 10 days after the sowing took place the rough-hewing.

The preparation of the irrigation waters regarding the respective salinity levels was accomplished being used water of existent provisioning in the place (0,3 dS m-1), with the following characteristics: pH = 7.0; EC = 0.3; K+ = 0.3; Ca+2 = 0.2; Mg+2 = 0.6; Na+ = 1.4; SO4-2= 0.2; CO3-2 = 0.0; HCO3- = 0.8; Cl- = 0.3; SAR = 2.21. Being increased the chloride of sodium (NaCl) according to the equation of [13], soon afterwards being checked the conductivity wanted with use of a portable conductivity meter fitting the temperature of 25°C. The irrigations were accomplished daily, staying the substrate in field capacity, based on the lysimeter method of drainage, being the added applied sheet of a leaching fraction of 20%. The applied volume was certain with the following formula: Va = (La — (Vd/n)) / (1-FL), in that, Va = applied volume; La = previous sheet; Vd = drained volume; n = number of containers; FL = fraction of leaching.

To the 27 days after the sowing of the plantules was determined:

Length of plantules (area and of root): it was measured with measuring tape aid in the lap of the plant to the apex (cm),

Stem diameter: measured to 2 cm above the soil in the lap of the stem with aid of digital caliper (mm),

Number of leaves: through counting of the leaves completely expanded,

Mass dries of plantules (aerial, root and total): to the different parts of the plantules (aerial and root) they were put for drying in greenhouse of forced circulation to 72ºC even constant weight, for drying, and later heavy in analytical scale, being the expressed results in grams for plantule.

Biomass production: With mass, it dries, and the breeze was made calculations percentile of biomass expressed in (%) in agreement with [14].

Index of tolerance to the salinity: with the mass data it dries, the index of tolerance was calculated to the salinity (%), according to the methodology of [3].

The results were submitted to the variance analysis for the diagnosis of significant effects for the test F, comparison of averages for the qualitative factor (substrates), for the test of Tukey, and regression analysis for the quantitative facts (saline levels), being used the Software Sisvar version 5.6 [15].

3. RESULTS AND DISCUSSION

The variance analysis for the variable's length of plantules (aerial and root), diameter of the stem, number of leaves, mass dries (aerial, root and total), biomass production and index of tolerance, presented interactive effect ($p < 0.01$) for all the analysed variables, demonstrating that the appraised factors (substrates and salinity), they interfere simultaneously in the initial growth of the melon plant, as presented in the Table 1.

For the length of the aerial part of melon plant plantules, was verified that the substrates S2, S3 and S4 were adjusted to quadratic equations with maximum of 11.91; 10.96 and 9.98 cm in the salinity 1.86; 3.19 and 3.27 dS m-1, respectively, with tendency to respective decreases of 24; 6.02 and 4.87% in the salinity of 4.3 dS m-1 (Fig. 1A). However, S1 decreased 12.87% in function of the saline increment in the irrigation water, between 0.3 and 4.3 dS m-1. Like this, the substrats S3 and S4 presented smaller reductions in relation to the other substrates, possibly, for the soil mixture and commercial substrate to provide better cultivation conditions.

That reduction in function of the addition of salts in the water, can be justified second [7] to the they study salinity in the irrigation water in melon plant, that the salinity causes poisonous effects due to the accumulation of ions, where that ionic toxicity, during the germination process and development of the plantule, causes several physiologic and biochemical disturbances, as the hormonal unbalance and the reduction of the use of reservations.

The salinity about the irrigation water, as well as, the formulations of substrates interfered the root length of the melon plant plantules significantly. Was observed reductions of 8.61 and 9.71%, in S1 and S4, respectively, proportional to the unitary increment of salts in the irrigation water (Fig. 1B). [5] to the analyse the development of plantules of watermelon cv. Crimson Sweet in biossaline water consisted that the increment of salts in the water, together with exhibition prolongation to the salt reduces the development of the plantules.

Table 1. Summary of the analysis of variance of the length of the aerial part (LAP) and root (LR), diameter of the stem (DS), number of leaves (NL), mass dries aerial part (MDAP), root dry mass (RDM), total (MDT), biomass production (BP) and index of tolerance to the salinity (ITS) in the initial growth of melon plant plantules (Amarelo Ouro) in function of different substrates and saline levels, UFCG, Pombal, 2018

SV	DF	Medium square								
		LAP	LR	DS	NL	MDAP	RDM	MDT	BP	ITS
S	4	10.94**	181.73**	1,02**	0.17 ^{ns}	0.01**	0.18**	0.26**	140.80**	5987.19**
C	3	97.32**	201.67**	4.72**	1.38**	0.59**	0.09**	1.06**	105.51**	3709.15**
S x C	12	7.59**	173.17**	3.54**	0.67**	0.006**	0.16**	0.16**	77.49**	463.60**
Block	3	0.13^{ns}	2.47^{ns}	0.03^{ns}	0.05^{ns}	0.0003^{ns}	0.0003^{ns}	0.002^{ns}	3.86^{ns}	78.21^{ns}
Residue	57	15.22	0.72	1.03	0.08	0.0002	0.0001	0.0013	3.70	31.27
Total	79									
CV (%)		4.86	4.00	4.02	14.40	7.91	7.05	9.60	17.46	7.74
Average		10.62	21.28	3.35	2.02	0.19	0.18	0.38	10.95	72.28

*^{ns} no significant, ** significant to 1% of probability; * significant to 5% of probability for the test F; DF (degree of freedom); SV (source of variation) CV (variation coefficient)*

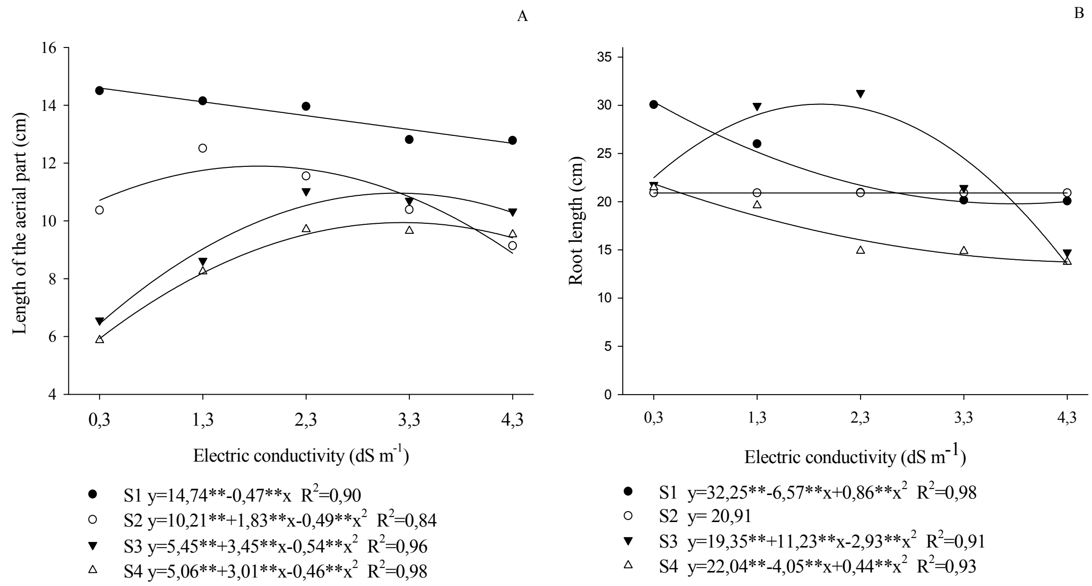

Fig. 1. Length of the aerial part (A) and root (B) of melon plant plantules (Amarelo Ouro) in function of different substrates and saline levels, UFCG, Pombal, 2018

In compensation, S2 didn't present significant adjustment, with average 20.91cm, and S3 increased 34% until the dear conductivity of 1.9 dS m-1, refusing 55% for 4.3 dS m-1. Probably, this substrate presented that effect positive, due this proportion (sole + commercial substrate) to favor smaller leaching of nutrients of the substrate and a better humidity retention, because, the salinity causes osmotic effect that it hinders absorption of water with excess of salts in the substrate.

The current damages of the salinity were also observed, in the number of leaves in the substrate S1, refusing 37.95% in the interval between 0.3 and 4.3 dS m-1, similar to the root length, S2 didn't present significant adjustment, with average 1.9 leaves (Fig. 2A). Results fellow creatures were found for [9] with reductions in the number of leaves as there was an increment of salts in the irrigation water in watermelon plant, the authors still verified reduction in the potassium content and increment in the tenor of sodium in the leaves, justifying poisonous effect of the salinity. Still in the emission to foliate, contrarily S3 added from 1.4 to 2.3 leaves in the electric conductivity of 3.2 dS m-1, decreasing with larger saline levels in the irrigation water. Positive effect was also verified in S4 with increment of 40% between the smallest and larger saline level.

In relation to the stem diameter, all the studied substrates if they adjusted to the quadratic model, with equivalent maximum points to 3.84; 3.77; 3.67; 3.33 mm in the dear conductivity of 2.41; 2.96; 1.75 and 2.63 dS m-1, corresponding S1, S2, S3 and S4 (Fig. 2B). The low value of the diameter observed in the substrate S4 can be related with the low tenor of nutrients of the substrate, taking into account that was used only 33.33% of the commercial substrate in this treatment, affecting like this the nutrition of the plantules, what might still have favored to the substrate smaller retention of water and consequently delimitation of the development of the root system and of the caulinar diameter.

The salinity threshold of the second melon plant [16] it is of 2.2 dS m-1, being considered a culture moderately sensitive, as well as the watermelon plant, explaining that quadratic behavior in the caulinar diameter, however handling conditions can provide better development in superior saline levels [17].

The mass dries of the aerial part of the melon plant plantules (Fig. 3A) it presented quadratic behavior when they were driven in the substrates S1 and S2 reaching dear maximum of 0.37 and 0.35g in the salinity 3.5 and 2.5 dS m-1, respectively, however, the unitary increase of the chloride of sodium (NaCl) in the irrigation water it caused decreases in the mass accumulation dries of 1.7% in S1, already for S2, was observed that that reduction was more accentuated. In relation to the substrate S3, decreasing lineal behavior was verified with reduction of 31.85% in the salinity 4.3 dS m-1 if compared with cultivated them with water of 0.3 dS m-1. The substrate S4 was not adjusted significantly to a mathematical model in the regression analysis. Therefore, taking into account that as larger the mass accumulation dries more vigorous they are the plantules, the substrate S1, reduced the harmful effects caused by the saline stress up to 2.3 dS m-1, in this variable.

That reduction in the mass dries of the aerial part of plantules in function of the independent of the used substrate saline levels, it was also verified for [8], that study about influence of the saline water and different substrates in the initial growth of the melon plant to the 32 DAS, it observed that substrates composed by soil and composed organic (2:1) and soil and bovine manure (2:1) they presented dry mass of 2.37 and 0.80 g in the concentration 0.3 dS m-1, reducing respectively for 1.22 g and 0.48 g in the concentration of 4.5.

In relation to mass it dries of the root (MSR), it was observed that all the appraised substrates presented quadratic behaviour reaching dear minimum value of 0.02 and 0.1 g for S2 and S4, in the conductivity of 4.3 dS m-1 and dear maximum of 0.21g in the substrate S3, in the salinities of 3.5 dS m-1. For the substrate S1 there was a drastic reduction in function of the increase of the salinity of the irrigation water reached minimum of 0.00 with water of 3.13 dS m -1.

In what refers the mass total drought (MST), was verified that the substrate S1 presented quadratic behaviour, with tendency the drastic reduction with the increase of the saline levels, reaching esteemed of 0.41 g ma conductivity of 3.27 dS m-1 minimum value. The substrates S2 and S4 presented decreasing lineal behaviour with reduction of 25 and 47%, in the electric conductivity of 4.3 dS m-1 if compared with the smallest appraised saline level, reaching dear minima of 0.16 and 0.12 g. Already in the substrate S3, the data were adjusted to a quadratic equation reaching maximum mass accumulation dries of 0.28 g, when cultivated with water of 3.2 dS m-1 (Fig. 3C).

The reduction in the mass accumulation dries is related with the reduction of the photosynthetic capacity of the plants, current of ionic interactions promoted by the excess of salts of sodium, which reduces the production of photo assimilates and it increases the expense of energy for the plant, due, the reduction of the osmotic potential, which delimits the readiness of water for the growth and vegetable development for time [18]. Similar results were found for [3] to they evaluate cultivate of melon plant submitted to the salinity in the irrigation water.

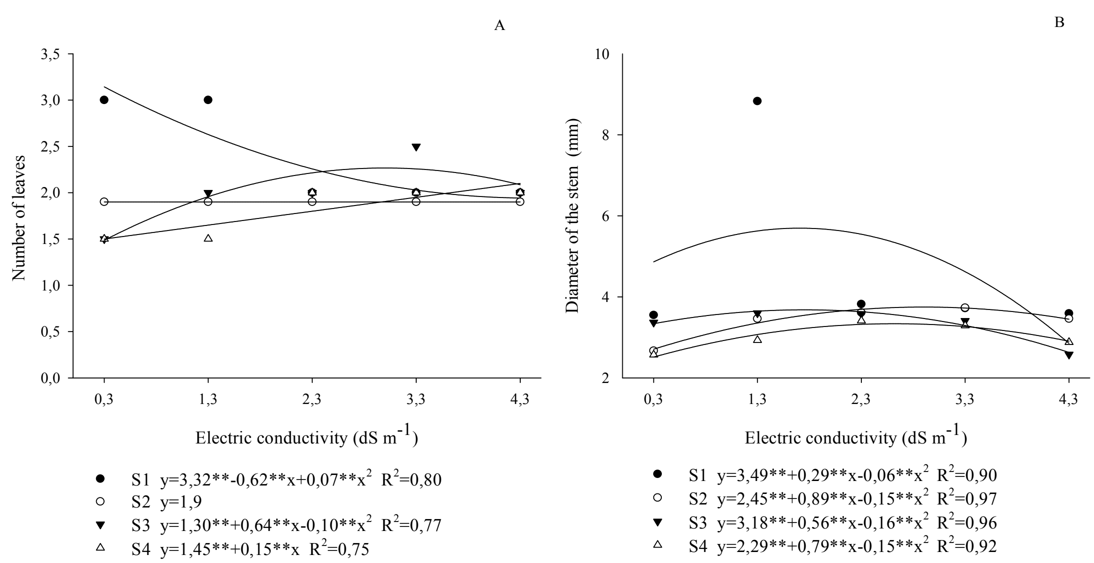

Fig. 2. Number of leaves (A) and diameter of the stem (B) of melon plant plantules (Amarelo Ouro) in function of different substrates and saline levels, UFCG, Pombal, 2018

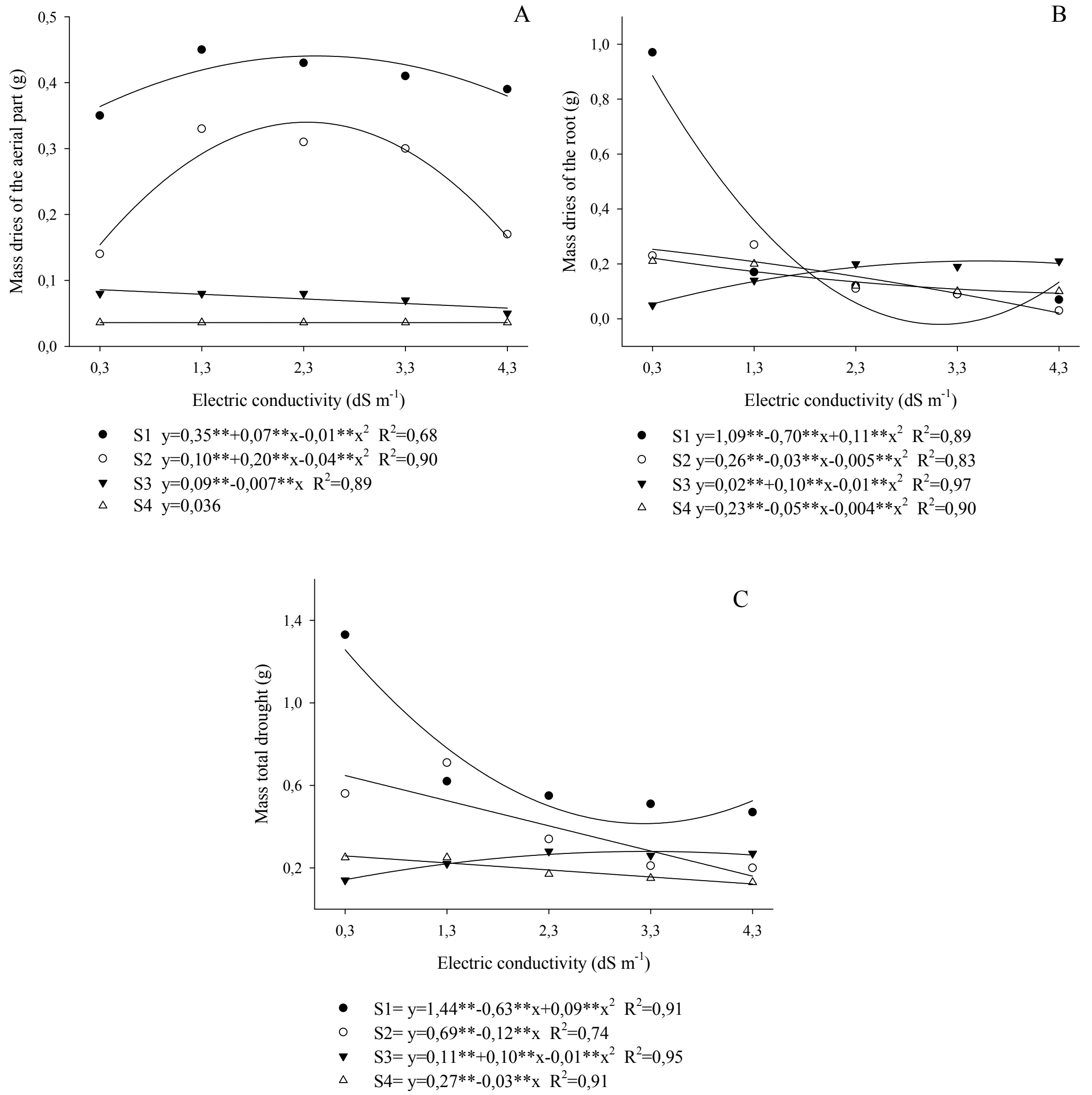

Fig. 3. Mass dries of the aerial part (A); root (B) and total (C) of melon plant plantules (Amarelo Ouro) in function of different substrates and saline levels, UFCG, Pombal, 2018

The percentile of biomass had significant interference among salinity in the water x substrates, positive effect was verified in the substrate S3, in relation to the other substrates, with increment of 3.11% proportional the unitary addition of salts in the irrigation water. The other substrates refused with increase in the electric conductivity of the irrigation water, with a minimum of 6.9, 10.4 and 6.6% (S1, S2 and S4) in the conductivity of 2.6, 3,18 and 3.2 dS m-1 (Fig. 4A). Therefore, the substrate S3 possesses promising properties for growth of melon plant plantules, even under saline conditions.

The poisonous accumulation of ions Na+ and Cl - in the leaves, due excess of salts in the soil, they are correlated to the stomatal closure and non-stomatal factors, as for instance, reduction in the chlorophyll content, both limiting the amount of photo assimilates production, and consequently biomass production [18]. The largest reduction in the substrate that just possesses the commercial substrate is probable due the nutrients be quickly assimilate, being subject to the removal for the leaching process of the salts, in a more way accentuated than the formulation of the mixture of the same with soil [10].

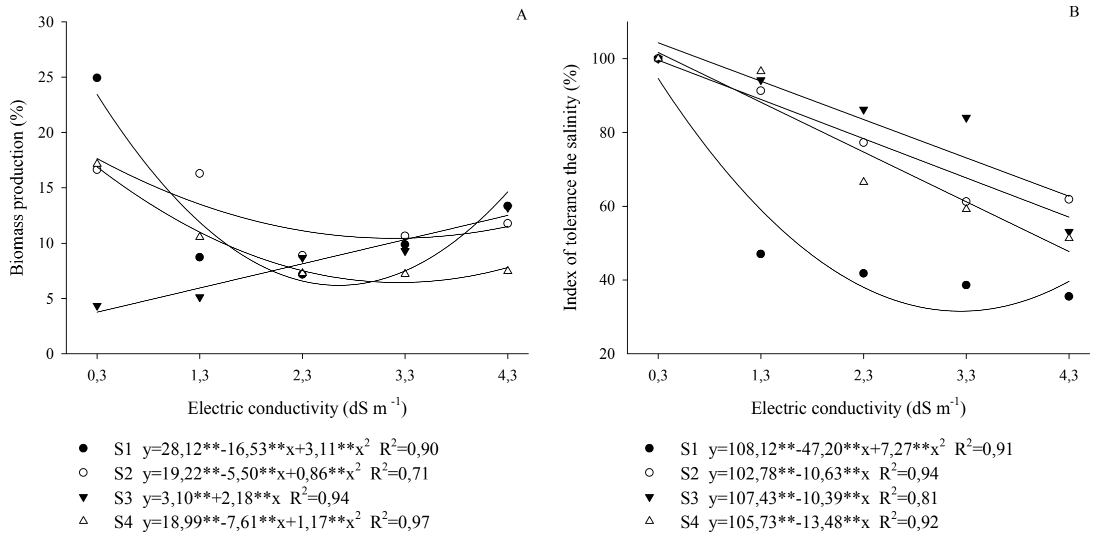

Fig. 4. Biomass production (A) and index of tolerance the salinity (B) of melon plant plantules (Amarelo Ouro) in function of different substrates and saline levels, UFCG, Pombal, 2018

As larger the index of tolerance (IT), less degraded in the accumulation of photo assimilates meet to the melon plant plantules in conditions of the saline stress, therefore the substrate S3 presented larger IT with accumulation of 62.75% in the largest electric conductivity of the water. In terms of tolerance, soon afterwards, S2 was verified with 57.07% and rising S4 with 47.76% of accumulation in biomass in the level saline 4.3 dS m-1, as moderately sensitive. And to the coming plantules of S1 they were affected strongly with smaller IT of 31.55% in the saline level of 3.24 dS m-1, being like this, more sensitive to the salinity.

Dias NS et al. [19] to the evaluate the saline concentration and exhibition phases to the salinity of the melon plant cultivated in substrate of coconut fiber, they observed that the phase of initial growth in the melon plant is the most sensitive to the salinity of the water and that the substrate use that conditions prolongation of the humidity favors cultivation atmosphere lessening the harmful effect of the salinity, in relation to the cultivation only in soil.

4. CONCLUSION

In the conditions of the referred study, the salinity in the irrigation water interferes negatively in the initial growth of melon plant plantules.

The formulation of the composed substrate for the mixture of the commercial substrate Carolina Soil® with soil (50% of both) it was shown effective in the initial growth of the melon plant to cultivate 'Amarelo Ouro' under conditions of saline stress.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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