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Production of Seedlings of Yellow Passion Fruit Plant in Different Substrates and Saline Levels

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Abstract

In the process of production of seedlings the formulation of substrates that supply the nutritional needs and make available appropriate humidity tenor is relevant for the success and the reduction of costs of the producing with other inputs. In this perspective, it is known that alternative substrates are rich in organic matter, which possesses extenuating action for the harmful effect of the salinity. Therefore, it was aimed at to evaluate the effect of saline waters and formulations of substrates in the production of seedlings of yellow passion fruit plant. Experiment was driven in atmosphere protected in the dependences of the Federal University of Campina Grande, Pombal, Paraíba. The randomized block design was used in factorial outline 5 × 5, being five levels of salinity of the irrigation water (0.3; 1.3; 2.3; 3.3 and 4.3 dS m^{-1}) and five substrates: S1 = soil; S2 = soil, goat manure and bovine manure (1:1:1); S3 = soil and goat manure (3:1); S4 = soil and bovine manure (3:1); S5 = soil, goat manure and bovine manure (3:0.5:0.5). To the 52 days after the sowing the growth analyses and quality of the seedlings were checked. The growth of the passion fruit plant seedlings was inhibited by the salinity in the irrigation water. However, the use of organic inputs in the formulation of the substratum lessens the harmful effect of the saline stress, being the best substratum, soil and bovid manure in the proportion 3:1.

Keywords: *Passiflora edulis Sims*, abiotic stress, organic input, vegetable production

1. Introduction

The yellow passion fruit plant (*Passiflora edulis* Sims f. flavicarpa Deg.), it belongs to the family Passifloraceae and to the gender Passiflora, is a fruitful species thoroughly cultivated in tropical and subtropical climate and that it presents great economical and social relevance to Brazil (Bernacci et al., 2013; Silva, Machado, Santos, & Azevedo, 2016). In Brazil, in the harvest 2016 141.01 tons were produced by hectare of passion fruit plant, being the Northeast Area the largest producer in area, however responsible just for 13.320 t/ha, being the Southeast Area with larger income in area 18.233 t/ha, possibly for the investment in technification, in the Northeast the state of Paraíba presents productivity of 9.286 t/ha (IBGE, 2016).

In spite of the Northeast area of Brazil to present a significant area of production of yellow passion fruit, it faces problems with the excess of salts in the soil and in the irrigation water, what limits and it commits the development and establishment of the seedlings and consequently the productivity (Moura et al., 2017). The salinity is one of the abiotic factors that more it causes limitation in the production of the cultures, because, it favors the nutritional unbalance, inhibition of the absorption of cations other, decrease of the osmotic potential and toxicity of specific ions (mainly Na^+ and Cl^-), to the point of to commit vital physiologic activities the plant (Taiz, Zeiger, Moller, & Murphy, 2017). However, through strategies in the handling of the cultures is possible to reduce the harmful effects of the salinity on the production of seedlings as for instance the use of appropriate substrates.

The selection of the substrate to be used, is one of the fundamental stages in the system of production of seedlings, should exercise direct influence on the final acting of the plants in the production field (Sá et al., 2015). Therefore, the substrate should guarantee the mechanical sustentation of the root system and to allow the gaseous changes between the roots and the external air, as well as, to facilitate the supply of water and nutritious for the plants, also presenting physical characteristics, chemistries and biological that favor the obtaining of seedlings of better quality (Castoldi, Freiberger, L. A. Pivetta, L. G. Pivetta, & Echeir, 2014; Costa, Pereira, & Costa, 2014).

Several studies show that the effects of the salinity can be lessened with the use of substrates of animal origin, as for instance, in the culture of the pineapple (Sá et al., 2015) and papaya tree (Lima Neto et al., 2016). Nascimento et al. (2016) in the culture of the yellow passion fruit plant evaluating the benefits of the use biofertilizers in submitted plants the growing salinity, they verified beneficial and extenuating effects with use of this organic input.

However, works that seek the production of formulations of alternative substrates for the production of seedlings, seeking mitigation of the effect caused by the saline stress in the culture of the passion fruit plant are scarce (Oliveira et al., 2015), which it would be an alternative for the producer as cost reduction and use of salty water. In this context, it was aimed at with this work to evaluate the production of seedlings of yellow passion fruit plant submitted to different substrates and different saline waters.

2. Materials and Methods

2.1 Location and Experimental Conduction

The experiment was conducted in vegetation home in the Center of Sciences and Technology Agrifood of the Federal University of Campina Grande, located in the municipal district of Pombal, Paraíba. The randomized block design was used in factorial outline 5×5, corresponding to five levels of salinity of the irrigation water (0.3; 1.3; 2.3; 3.3 and 4.3 dS m^{-1}) and five substrates: S1 = soil; S2 = soil, goat manure and bovine manure (1:1:1); S3 = soil and goat manure (3:1); S4 = soil and bovine manure (3:1); S5 = soil, goat manure and bovine manure (3:0.5:0.5), with four repetitions. The chemical characterization of the soil and of the substrates it was accomplished in the Laboratory of Soils and Mineral Nutrition of Plants (UFCG/CCTA), using the methodologies used by Embrapa (1997), and the data are presented in the Table 1.

Table 1. Chemical characteristics of the soil and of the substrates used in the production of the seedlings of yellow passion fruit plant irrigated with saline water, UFCG, Pombal, PB, 2018

	pH	CE	P	N	K^+	Na^+	Ca^{2+}	Mg^{2+}	Al^{3+}	H^++Al^{3+}	SB	CTC	MO
	H_2O 1:2.5	dS m^{-1}	mgdm-3	%	----------------------------------				cmol$_c$/dm^3		----------------------------------		g kg^{-1}
Soil	6.50	0.32	16.0	1.00	1.39	0.61	2.70	2.50	0.00	0.32	7.20	8.21	16.0
CM	6.47	1.09	98.0	2.40	3.80	1.54	4.52	2.63	0.00	0.00	12.5	10.9	40.0
GM	7.26	0.74	2.86	3.80	2.68	4.50	2.60	2.93	0.00	0.00	14.5	11.72	42.0

Note. P, K, Na: Extractor Mehlich 1; SB: Sum of Exchangeable Bases; H + Al: Extractor Acetate of Calcium 0.5 M, pH 7.0; CTC: Capacity of Cation Exchange; Al, Ca, Mg: Extractor KCl 1 M; M.O.: Organic Matter-Walkley-Black. Cattle manure (CM), Goat manure (GM).

The seeds were extracted of fruits of sour passion fruit, to cultivate BRS Gigante Amarelo, properly healthy and in complete maturation stadium, acquired in free market of the municipal district of São João Rio do Peixe - Paraíba. The method used for removal of the aril of the seeds was the mechanic with use of a blender, whose helixes were stamped with adhesive ribbon to avoid damages to the seeds and washed in running water with aid of a mesh sieve dies. Later, the seeds were put to dry on leaves of paper towel in room temperature of approximately 25 °C for a period of five days.

The employed containers for the production of the seedlings were sacks of black polyethylene, perforated, and with capacity of 1 dm^3. Before seeding the seeds were immersed in solution of sodium hypochlorite to 2% for five minutes, for elimination of pollutants. Soon afterwards, took place the direct sowing being accomplished through the addition of two seeds by sack to 2 cm of depth. The plantule emergency began to the 10 days after the sowing (DAS), where took place the rough-hewing of plantules to the 15 DAS, being left a plantule by sack.

The preparation of the irrigation waters regarding the respective salinity levels was made using water of existent provisioning in the place (0,3 dS m^{-1}), being increased the chloride of sodium (NaCl) according to the equation of Rhoades, Kandiah e Mashali (2000), soon afterwards being checked the conductivity wanted with use of a portable conductivity meter of the mark instrubras, model KR-30, for the obtaining of the other pre-established saline levels (1.3; 2.3; 3.3 and 4.3 dS m^{-1}).

The irrigations with the saline waters were initiate after the emergency of the plantules (10 DAS) and they extended up to the 52 DAS, moment in that the emission of tendrils was observed, considering the seedlings as soon as was capable for transplant in field, staying in field capacity, with a daily application, not making use of leaching blade, due to the short period of experimental time.

2.2 Analyzed Variables

To the 52 DAS was determined:

Height of the plant: being measured the plant starting from the soil until the apex with measuring tape aid and the results were expressed in centimeters.

Number of leaves: it was accomplished by the counting of expanded leaves and completely formed.

Total fresh mass of the plant: certain for the weighting of the plants immediately after they be removed of the substrates, in semianalitic precision scale. The results were expressed in grams by plant.

Total dry mass of the plant: the plants of the previous evaluation were put in paper bags kraft and put in greenhouse of forced circulation of air regulated the a temperature of 65 °C for a period of 48 hours and later heavy in scale, being the medium results expressed in grams by plant.

Biomass production: accomplished with base in the methodology of Emon et al. (2015) and expressed by the formula: PB = MST/MFT ×100, in that: MST = Total dry mass of the plant and MFT = total fresh mass of the plant.

Index of tolerance the salinity: determined by the methodology described for Araújo et al. (2016), in that: ITS (%) = (Production of MST in the saline treatment)/(Production of MST in the treatment controls) × 100.

Index of Dickson quality: To evaluate the quality of the seedlings the methodology it was used described for Dickson et al. (1960), through the following formula: IQD = MST/[(H/DC) + (MSPA/MSR)], in that: MST = total dry mass (g); H = height (cm); DC = diameter of the lap (mm); MSPA = dry mass of the aerial part (g); MSR = dry mass of the root (g).

2.3 Analyze Statistics

The obtained data were submitted to the variance analysis by the test F to 5% of probability. When significant, the averages regarding the substrates were compared by the test Tukey ($p < 0.05$), and the averages regarding salinity of the water were appraised for analysis of polynomial regression to 5% of probability. The statistical analysis was accomplished being used the program SISVAR v.5.6 (Ferreira, 2014).

3. Results and Discussion

The variance analysis for the variables: height, number of leaves, fresh and dry mass total, biomass production, index of tolerance and of Dickson quality, it presented interactive effect for all the analyzed variables ($p < 0.05\%$), demonstrating that both factors, formulations of substrates and saline levels, interfere in an united way in the growth and quality of seedlings of yellow passion fruit plant.

Table 1. Variance analysis for the variables: height of the plant (HEIG), diameter of the stem (DIAM), number of leaves (NL), total fresh mass (TFM), total dry mass (TDM), biomass production (PB), index of tolerance (IT) and index of Dickson quality (IQD), in function of the different substrates and different electric conductivities in seedlings of yellow passion fruit plant, UFCG, Pombal, PB, 2018

FV	GL	Medium Square						
		HEIG (cm)	NL	TFM (g)	TDM (g)	PB (%)	IT (%)	IQD
Substrate (S)	4	1183.71**	79.18**	6472.06**	271.60**	88.42**	184.77**	0.82**
Electric Conductivity (CE)	4	2109.62**	12.08**	1078.86**	56.66**	20.51**	773.18**	0.08**
S*CE	16	38.88**	1.20*	157.15**	5.85**	2.86**	42.63**	0.01**
Block	3	112.36**	0.38ns	0.08ns	0.07**	0.75ns	60.99*	0.002*
Residue	72	2.15	0.54	0.38	0.01	0.74	18.76	0.0007
Total	79							
CV (%)		3.22	9.80	5.59	2.06	4.27	4.70	7.75
General average		45.63	7.54	32.89	6.54	20.18	92.07	0.34

Note. ** significant to 1% ($p < 0.01$); ^{ns}: No significant; FV: Variation source; CV: Variation coefficient.

In the height of the passion fruit seedlings (Figure 1), it was verified proportional declines to the increase in the electric conductivity of the irrigation water, with respective decreases in the substrates S1 (soil), S2 (soil, goat manure and bovine manure (1:1:1), S3 (soil and goat manure (3:1)), S4 (soil and bovine manure (3:1)) and S5 (soil, goat manure and bovine manure (3:0.5:0.5) of 46.41; 53.58; 40.87; 31.14; 48.87% between the highest (4.3 dSm^{-1}) and lower (0.3 dSm^{-1}) saline levels, thus demonstrating lower reductions with soil use and goat manure in the proportion 3:1 (S3).

The use of organic inputs with the intention of reducing the depressive effects of the salinity of the water is seen as alternative, because the organic matter stimulates liberation of humic substances causing increase in the production of organic solutes, as sugars, free amino acids, proline and betaine glycine, that it affects the nutrition of the plant positively (Nunes et al., 2018). Still, according to Sá et al. (2014) the use of the goat manure in the proportion from 39 to 50% in the substrate promotes increment in the formation of seedlings of yellow passion fruit plant.

That inferior growth observed in the passion fruit plants irrigated with saline water 2.3, 3.3 and 4.3 dS m^{-1} is related with the addition of salts, what provokes reduction of the absorption of water and nutritious for the plant, that if submitted to the saline stress begin the systematic process of osmotic adjustment to maintain the turgidity of the cells, what consequently causes this growth and slow development of the plants under the abiotic stress (Deinlein, et al., 2014; Guerzoni et al., 2014). Corroborating, Torres et al. (2014) they ended that the taxes of absolute and relative growth in height, leaf diameter, number of leaves, area to foliate, length of the root and fresh phytomass of the precocious dwarfish cashew tree were influenced negatively by the salinity of the irrigation water.

The saline levels and the different substrates influenced in the same way, the number of leaves, where she can observe that the substrate just soil presented the smallest values and it didn't vary significantly, with average 4.2. However, the other substrates provided reductions with increment of the equivalent saline levels to 30.67; 10.41; 1.70 and 25.76% for S2, S3, S4 and S5, respectively, if compared the largest and smaller saline level (Figure 1B).

Sá et al. (2015) evaluating seedlings of pinheira in two substrates: S1 (50% soil + 25% of bovine manure + 25% of sand) and S2 (40% soil + 40% of bovine manure + 20% of sand), in different electric conductivities of the irrigation water, they observed that the high concentrations of salts in the irrigation water inhibit the emergency, the growth and the earnings of biomass of the seedlings of pinheira, and that the best substratum was S2, larger due manure concentration.

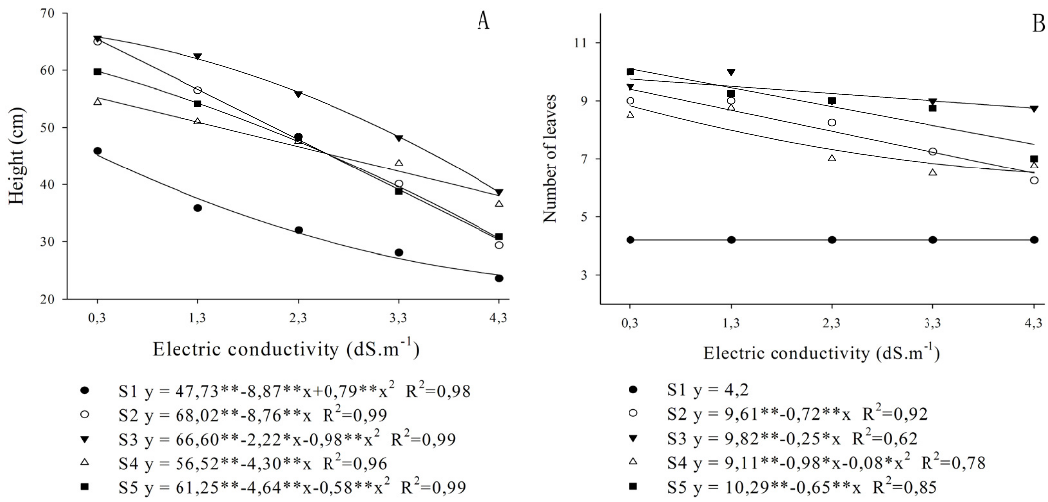

Figure 1. Height of the plant (A) and number of leaves (B) in function of the different substrates and different electric conductivities in seedlings of yellow passion fruit plant, UFCG, Pombal, PB, 2018

Note. S1 = soil; S2 = soil, goat manure and bovine manure (1:1:1); S3 = soil and goat manure (3:1); S4 = soil and bovine manure (3:1); S5 = soil, goat manure and bovine manure (3:0.5:0.5).

The phytomass accumulation was also affected by the substrates and saline levels. In the breeze total mass it was verified that S5 behaved quadratically with larger accumulation (56.70 g) in the level of 1.40 dS m^{-1}, decreasing starting from this level (Figure 2A). At the time that presented behavior to the other formulations of substrates inversely proportional with addition of salts in the irrigation water, corresponding to 17.04; 11.65; 7.65 and 7.47% of unitary reduction, in the substrates S1, S2, S3 and S4, respectively, and as well as in the growth the mass accumulation also had smaller reductions in the seedlings of the substrate S3.

That reduction is related with the inhibition of the growth and consequently of biomass accumulation that is caused by the poisonous effects of the absorbed salts by the plants, consequent of the low capacity of osmotic adjustment of the species and for the reduction of the total potential of water provoked by the increase of the saline concentration (Lúcio et al., 2013).

In relation to the total dry mass a quadratic behavior was observed in all of the appraised substrates, reaching dear maximum values of 13 and 6.01 when cultivated in 0.3 dS m^{-1} in the substrates S3, S4, respectively, refusing with addition of salts in the water of irrigation 7.65 and 7.47%, respectively. While, the minimum values (0.47 and 5.70) they were observed in the substrates S1 and S2 in the conductivity 3.42 and and 3.49 dS m^{-1}, respectively. In compensation, S5 presented increment of 0.3% until the dear electric conductivity of 0.56 dS m^{-1}, decreasing 60% until the saline level of 4.3 dS m^{-1}.

Oliveira et al. (2015) evaluating the interaction of the irrigation water and different substrates in the production of seedlings of yellow passion fruit plant, cultivated in similar climatic conditions the one of this work, it observed reduction in the mass accumulation dries in function of the unitary increase of the salinity of the irrigation water, independent of the used substrate, with reduction of 65.8% for plants cultivated 3.5 dS m^{-1} if compared with cultivated them with salinity of 0.3 dS m^{-1}.

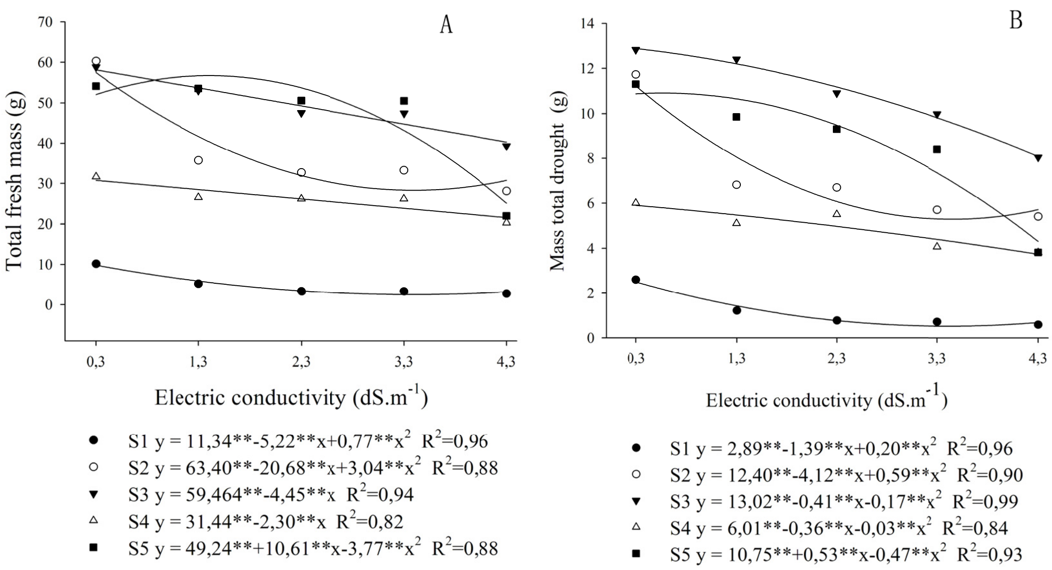

Figure 2. Fresh mass (A) and dry mass (B) in function of the different substrates and different electric conductivities in seedlings of yellow passion fruit plant, UFCG, Pombal, PB, 2018

Note. S1 = soil; S2 = soil, goat manure and bovine manure (1:1:1); S3 = soil and goat manure (3:1); S4 = soil and bovine manure (3:1); S5 = soil, goat manure and bovine manure (3:0.5:0.5).

In relation to the percentile of biomass (PB), there were reductions with the increment of the salinity, however in the substrate S3 PB of the passion fruit plant seedlings presented increment up to 1.73 dS m^{-1}, corresponding to 22.98% of PB, refusing starting from this saline concentration. While us other substrates to the seedlings presented reductions of 16.01 (S1); 8.21 (S2) and 17.52% (S5) between the largest and smaller saline level (Figure 3A).

According to Andrade et al. (2017) the use of organic input in the production of passion fruit plant seedlings affects significantly in a positive way the biomass percentage, the area to foliate it executes and the area reason to foliate. That superiority of the substrate with goat manure in the proportion soil + EC (3:1) it can is related due the same to present tenor of organic matter (42 g Kg^{-1}) superior to the bovine manure (40 g Kg^{-1}).

The percentile of biomass and the index of tolerance the salinity demonstrated that the use of organic inputs in the formulation of alternative substrates for the production of seedlings provides increase in the tolerance of the seedlings in relation to the salinity. It was observed that the largest values were found in the substrate formulation (S3), maintaining the relative income of biomass around 91.7% in the level of 4.3 dS m^{-1} with smaller unitary reductions of 2.07% in function of the saline levels. Us other substrates, the relative income of biomass was 80.05; 86.05; 84.76 and 82.44%, corresponding to reductions of 5; 3.66; 4.2 and 4.26% with addition of salts in the irrigation water.

The passion fruit plant is one of the cultures considered moderately sensitive to the salinity, in other words, it possesses salinity threshold around 2.3 dS m^{-1} (Holanda, Amorim, Ferreira Neto, Holanda, & Sá, 2016). However it is known that the noxious effect of the salinity is superior in the initial growth of the culture, if compared to the other phenological phases, but the use of the manure in the formulation of the substrate provided mitigation of this effect, being from addition relevance to the producer for the reduction of costs and reuse of salty water.

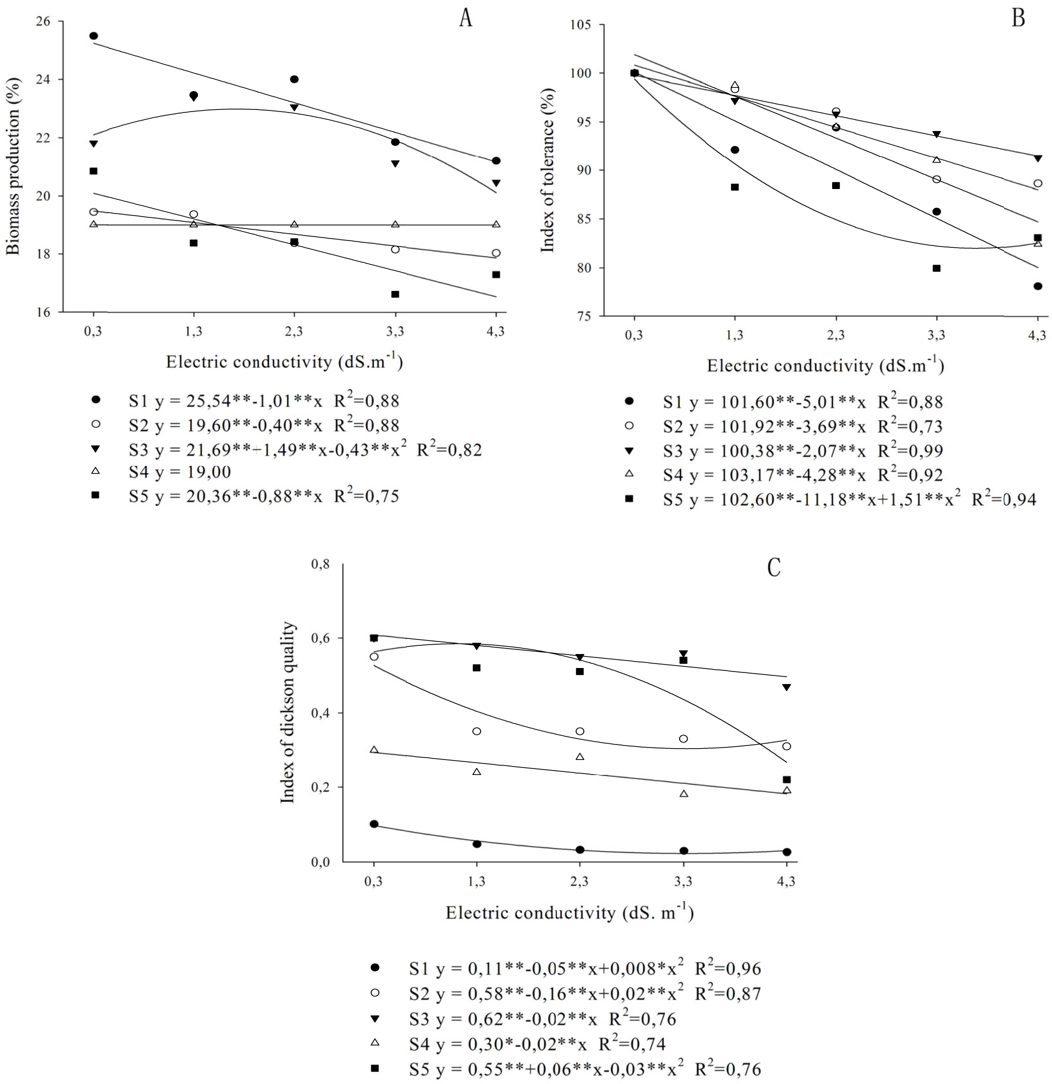

Figure 3. Biomass production (A); index of tolerance (B) and index of Dickson quality (C) in function of the different substrates and different electric conductivities in seedlings of yellow passion fruit plant, UFCG, Pombal, PB, 2018

Note. S1 = soil; S2 = soil, goat manure and bovine manure (1:1:1); S3 = soil and goat manure (3:1); S4 = soil and bovine manure (3:1); S5 = soil, goat manure and bovine manure (3:0.5:0.5).

When analyzing the quality of the seedlings (IQD) of yellow passion fruit plant, it was possible to verify that the best substrate was S3 (soil + goat manure 1:1), since the highest values (0.61) and the lowest reductions (13.09% between the largest and smaller saline level) they were observed in this substrate, possibly for the electric conductivity of the goat manure (0.74 dS m^{-1}) to be inferior to the bovine manure (6.47 dS m^{-1}), with smaller accumulations associated the daily addition of saline solution in the substrate.

In relation to the other substrates, the smallest values of IQD were found in the substrate just soil, of 0.09 in the saline concentration of 0.3 dS m^{-1} for 0.04 in 4.3 dS m^{-1}, demonstrating like this, the relevance of the use of organic inputs in the process of substrate formulation as extenuating to the effect of the saline stress. The substrate S2 and S4 demonstrated reductions of 50 and 27%, respectively in the interval between 0.3 and 4.3 dS m^{-1}. While, quadratic behavior was verified in the substrate S5, with maximum point in the electric conductivity of 1 dS m^{-1}, corresponding to 0.58 IQD. Such fact is explained by the formulation of the substrate to be composed by the two inputs, bovine and goat, in the proportion 0.5:0.5.

As larger IQD, larger the quality of the seedlings, Medeiros et al. (2016), evaluating the interaction between the saline water and biofertilizers of bovine manure in the formation and in the quality of seedlings of yellow passion fruit plant in Areia city, Paraíba, it observed reduction of the quality of the seedlings in function of the unitary increase of the salinity, however the addition of organic inputs reduced the harmful effects of the salinity, presenting values of 0.43 IQD when irrigated with water with conductivity of 0.42 dS m^{-1}, affirming although the seedlings presented quality for they be taken to the field when cultivated with levels of up to 1 dS m^{-1}, with 0.21 IQD.

4. Conclusions

The use of organic inputs in the formulation of the substrate is an alternative to lessen the harmful effects of the saline stress, being the best substrate, soil and goat manure in the proportion 3:1.

The growth of the passion fruit plant seedlings was inhibited by the salinity in the irrigation water.

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