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Agricultural ambience and salt stress in production of yellow passion fruit seedlings

Carla Ingryd Nojosa Lessa[2*], Geocleber Gomes de Sousa[1], Henderson Castelo Sousa[2], Fred Denilson Barbosa da Silva[1], Silas Primola Gomes[1], Thales Vinicius de Araújo Viana[2]

[1]University for the International Integration of Afro-Brazilian Lusophony, Redenção, Brasil
[2]Federal University of Ceará, Fortaleza, Brazil
*Corresponding author, e-mail: ingryd.nojosal@gmail.com

Abstract

The objective was to evaluate the initial growth and gas exchange of yellow passion fruit seedlings irrigated with saline water under different environments. The experiment was conducted of the University of International Integration of Afro-Brazilian Lusophony, Redenção-CE. The experimental design used was entirely randomized, in factor arrangement 4 x 2, referring to four environments with different shade screens (black screen; white screen; red screen; all with 50% shading; and full sun) and the values of electrical conductivity of irrigation water (0.3 and 3.0 dS m^{-1}), with five repetitions. The following variables were evaluated: number of leaves, plant height, leaf area, photosynthesis, transpiration, stomach conductance, instantaneous water use efficiency, electrical conductivity of the saturation extract and soil pH. The environment with black screen provides greater performance in leaf area, plant height and root length and was more efficient for the production of dry mass of the aerial part and the root of passion fruit seedlings in both irrigation waters. The red screen environment stimulates greater photosynthesis, transpiration, stomach conductance and chlorophyll in passion fruit seedlings irrigated with low salinity water, while the black screen mitigated saline stress for these variables. The full sun environment provided greater instantaneous water use efficiency in passion fruit seedlings for treatment with low salinity water and the black screen environment with high salinity water.

Keywords: *Passiflora edulis*, protected environment, salinity

Introduction

The passion fruit (*Passiflora edulis*) is widely produced in the Northeast Region corresponding to 70% of the national production. It occupies a prominent position among the fruit trees of greater economic expression in Brazil, especially in recent decades (Bezerra et al., 2016; Silva et al., 2019).

The low availability of good quality water resources in the semi-arid region drives the use of saline water, thus increasing the level of toxic ions to the plants, reflecting in alterations in the osmotic potential, in the ionic toxicity and in the unbalance in the absorption of nutrients, reflecting from the production of seedlings to productivity (Diniz et al., 2018; Silva Junior et al., 2020).

However, one of the important stages to maximize the productivity of quality fruit species is the formation of seedlings. According to Natale et al. (2018) this technique constitutes one of the most important stages in the establishment and uniformity of orchards. Other important factors in this process are the type of substrate, protected environment, container volume, irrigation and fertilization, which according to Costa et al. (2015) provide conditions for obtaining high quality plants.

It is important to highlight that seedlings produced in a protected environment present better results in the field, with greater size and vigour, being able to ensure homogeneity and early harvest (Cavalcante et al., 2018; Silva Junior et al., 2020). The use of the protected environment aims to enable cultivation in times of high energy availability (Rebouças et al., 2015), also ensuring high productivity in times of lower product supply.

In this sense, the work aims to evaluate the initial growth and gas exchange of yellow passion fruit seedlings irrigated with saline water and cultivated in

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different environments.

Material And Methods

The experiment was conducted from July to September 2019 in the experimental area of the Auroras Seedling Production Unit (UPMA), Auroras campus, University of the International Integration of the Afro-Brazilian Lusophony (UNILAB), Redenção, Ceará. According to Köppen's classification the region's climate is Aw' type, tropical climate with dry season.

The experimental design used was entirely randomized, in factor arrangement 4 x 2, referring to four environments with different shade screens (black screen - BS; white screen - WS; red screen - RS; all with 50% shading; and full sun - FS) and the values of electrical conductivity of irrigation water (0.3 and 3.0 dS m^{-1}), with five repetitions.

The container used was black polyethylene bag (12 x 18 cm), filled with the substrate composed of aloof, sand and manure, in the proportion 2:1:1, respectively. Sowing was done at a depth of 2 cm, with three seeds per container. At 10 days after sowing (DAS) thinning was performed, leaving only one per container. To perform the analysis of the substrate, it was sent to the laboratory of the Federal University of Ceará (UFC), where it was determined the chemical attributes, indicated in Table 1.

The meteorological data obtained during the experiment are shown in Table 2. During the research there was a precipitation of 41.4 mm, recorded by the station belonging to UPMA.

Table 1. Chemical attributes of the substrate used before the application of saline water.

O.M	N	P	Mg	K	Ca	Na	pH	ESP (%)	ECse (dS m^{-1})
g kg^{-1}		mg kg^{-1}	$cmol_c\ dm^{-3}$						
10.55	0.65	78	0.6	0.56	4.5	0.17	7.2	2	0.76

O.M - Organic matter; ESP - Percentage of exchangeable sodium; ECse - electrical conductivity of the soil saturation extract.

Table 2. Average values of temperature and humidity of the different environments during the experiment.

Types of screen	Temperature (°C)		Relative Humidity (%)	
	Max	Min	Max	Min
Full Sun - FS	33	32	48	46
Black Screen - BS	33	32	48	45
Red Screen - RS	34	33	47	44
White Screen - WS	33	32	44	41

The low salinity water used for irrigation came from the Ceará Water and Sewage Company (CAGECE), which supplies UPMA. The high salinity water was prepared using NaCl, $CaCl_2.H_2O$, $MgCl_2.6H_2O$ salts, the quantity of which was determined in order to obtain the electrical conductivity of water (ECw) desired, in the proportion 7:2:1, obeying its ratio between ECw and its concentration (mmolc L^{-1} = EC x 10) according to Rhoades et al. (2000). The irrigation management was carried out obeying the drainage lysimeter principle proposed by Bernardo et al. (2019), keeping the soil in the field capacity, with daily frequency.

The evaluations were carried out when the seedlings reached their transplanting point, at 60 DAS, according to Gontijo (2017). The growth variables analyzed were: plant height (PH) and root length (RL), with the aid of a graduated ruler; leaf area (LA), through the multiplication of width and height, with the aid of a graduated ruler and then multiplied by the correction factor (0.74) proposed by Cavalcante et al. (2009).

The analysis of gas exchange (photosynthesis (A), stomach conductance (gs), transpiration (E) and instantaneous water use efficiency (WUEi)) were measured in the same period (60 DAS), using an IRGA infrared gas analyzer in open system, equipped with an artificial radiation source with an intensity adjusted to 2000 µmol m^{-1} s^{-1}, the measurements were made between 8 to 10 h, in completely expanded sheets. Then, measurements of the relative chlorophyll index (RCI) were performed on the same sheets, using a non-destructive method with a portable meter (SPAD - 502 Plus, Minolta, Japan).

For biomass evaluation, samples were identified according to the treatments and packed in paper bags. Subsequently, they were placed to dry in a forced air circulation oven at 60°C for 72 h. Then the shoot dry matter (SDM) and root dry matter (RDM) were evaluated with the help of an analytical balance.

As for the substrate, simple samples from each container were collected and sent to the laboratory for analysis of the following variables: electrical conductivity of the soil saturation extract (ECse) and the hydrogen ion potential (pH), following the methodology contained in Richards (1954).

The data of the evaluated variables were submitted to analysis of variance, by Tukey's test at a level of 0.01 or 0.05 of probability, using the computer program

Assistat. 7.7 Beta (Silva & Azevedo, 2016).

Results and Discussion

The analysis of variance (Table 3) reveals a significant effect on the interaction between screen and water for dry matter in the air and root. For the variables leaf area, plant height, root length and the electrical conductivity of the soil saturation extract, there was a significant effect for the isolated factors screen and water, while the pH only for the water factor.

As shown in figure 1A, the leaf area values were statistically higher for the seedlings produced in the black screen. The black screen possibly has a capacity to provide greater thermal comfort when compared to full sun and other screens, causing the plants to have a lower energy expenditure and consequently have a higher growth (Goes et al., 2019).

Table 3. Summary of analysis of variance for leaf area (LA), plant height (PH), root length (RL), shoot dry matter (SDM), root dry matter (RDM), electrical conductivity of the saturation extract (ECse) and the hydrogen potential (pH) depending on the types of shade screens and irrigation water (high and low salinity).

Variation Sources	DF	Mean Square						
		LA	PH	RL	SDM	RDM	ECse	pH
Screens (S)	3	940.77**	130.34**	32.38**	1.66**	1.66**	0.60**	0.01^{ns}
ECw (E)	1	1130.87**	63.45**	39.89**	2.18**	3.89**	22.44**	0.50**
(S) x (E)	3	111.10^{ns}	9.73^{ns}	5.74^{ns}	0.07*	1.10**	0.16^{ns}	0.01^{ns}
Treatments	7	612.36**	69.09**	22.04**	1.05**	1.74**	3.53**	0.08**
Residue	24	64.22	4.26	4.49	0.02	0.07	0.06	0.009
CV (%)	-	19.12	18.87	12.75	15.95	35.9	18.87	1.33

DF - Degrees of freedom; CV - Coefficient of variation; *, ** and ns Significant at $p \leq 0.05$, $p \leq 0.01$ and not significant, respectively.

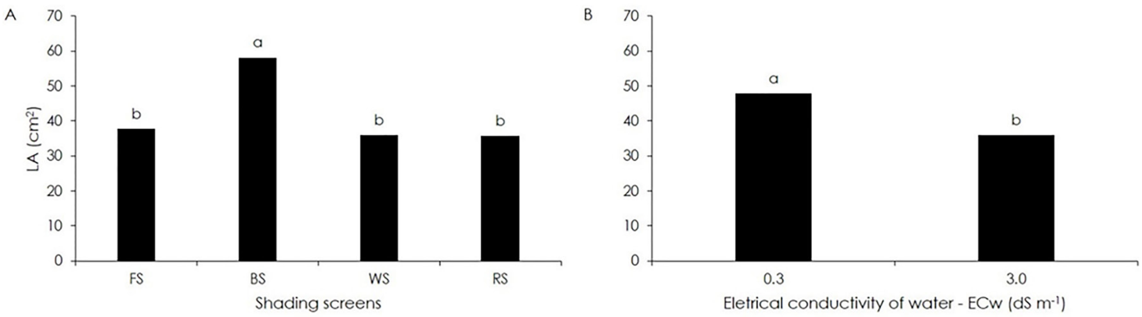

Figure 1. Leaf area - LA of passion fruit seedlings in function of shade screens (A) and in function of the conductivity of the irrigation water (B). FS - Full sun; BS - Black screen; WS - White screen; RS - Red screen; Means compared by Tukey test at $p \leq 0.05$.

Celedonio et al. (2016) working with the fig tree culture observed that the protected environment (50% shading of the screen) provided greater leaf area values of the fig tree up to 90 DAS.

According to the data presented in figure 1B, the seedlings irrigated with water of 1.0 dS m^{-1}, presented higher values, differing statistically from those irrigated with water of higher salinity. The decrease in leaf area is a reflection of the excess salts, which can cause a reduction in the emission and expansion of leaves (Munns & Tester, 2008).

Similarly, Nascimento et al. (2017) observed a reduction in leaf area in passion fruit seedlings irrigated with saline water. Melo Filho et al. (2017) working with pitombeira seedlings also found that the leaf area was significantly affected by the increased electrical conductivity of the irrigation water.

The black screen was statistically better than the others for plant height (Figure 2A). This result is possibly associated with lower availability of radiation in the black screen, causing greater heights as mechanism for acclimatization to light deficit, favoring the etiolation seedlings under these conditions (Araujo et al., 2006).

Similar results for seedling height were found by Goes et al. (2019) working with okra seedlings and by Costa et al. (2015) working with *Dipteryx alata* Vog. seedlings, in this same type of protected environment.

The average values for plant height as a function of the salinity of irrigation water are presented in figure 2B, where the water with higher salinity presents lower values of plant height differing statistically from those that were irrigated with lower salinity water.

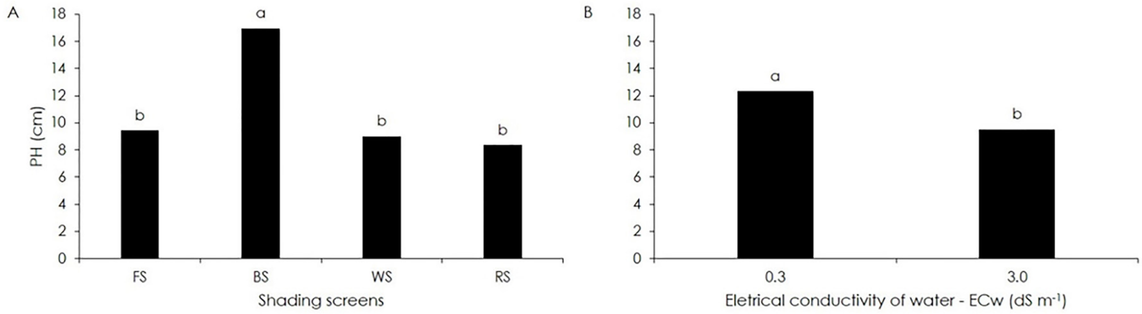

Figure 2. Plant height - PH of passion fruit seedlings as a function of shade screens (A) and as a function of the conductivity of the irrigation water (B). FS - Full sun; BS - Black screen; WS - White screen; RS - Red screen; Means compared by Tukey test at $p \leq 0.05$.

This reduction may be related to the inability of the plants to perform the osmotic adjustment, succeeding a water deficiency, which may cause morphological changes of the plants (Taiz et al., 2017).

Similar results for height reduction of yellow passion fruit seedlings irrigated with salt water were recorded by Bezerra et al. (2016). In the crop of the pitombeira irrigated with increasing salinity, Melo Filho et al. (2017) observed reduction of plant height during seedling formation.

According to figure 3A, the average values of dry matter of the aerial part were statistically superior in the seedlings for all the environments that were irrigated with low salinity water, however, the black screen obtained better result, that is, this performance can be associated to its low luminosity, provided by the presence of physical protectors (Klein et al., 2017), ensuring greater plant growth and cell elongation, providing a greater photosynthetic area, when compared to full sun plants and consequently greater accumulation of biomass (Goes et al., 2019; Taiz et al., 2017).

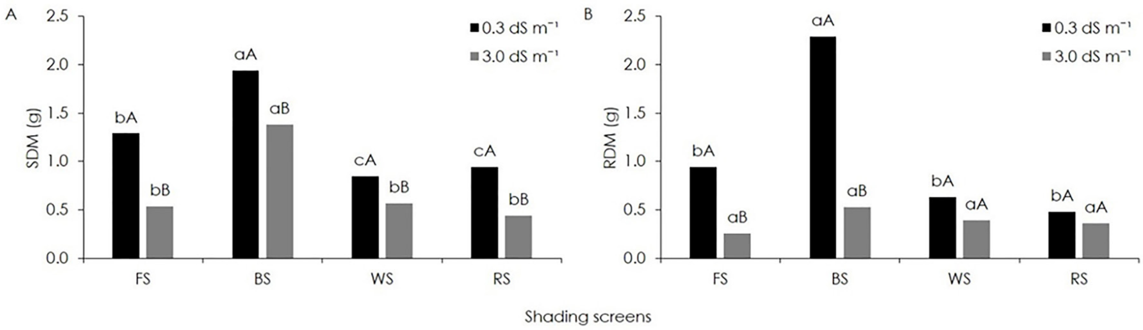

Figure 3. Shoot dry matter - SDM (A) and root dry matter - RDM (B) of passion fruit seedlings under saline stress and different shade screens. FS - Full sun; BS - Black screen; WS - White screen; RS - Red screen. Lowercase letters at the same level of salinity or uppercase letters in the same environment, do not differ statistically from each other by the Tukey test ($p \leq 0.05$).

As for saline stress, soluble salts accumulate in plants, causing a reduction in turgidity, consequently reducing the distribution of photoassimilates (Oliveira et al., 2015). Bezerra et al. (2016) working with passion fruit seedlings under saline stress in a protected environment observed a reduction in the dry matter values of the aerial part. A similar trend to this study was reported by Melo Filho et al. (2017) working with seedlings of pitombeira irrigated with saline water and grown in a protected environment.

According to figure 3B, there was a difference between the irrigation waters only for full sun and black screen, these presenting higher values than the other environments.

This result confirms the hypothesis of Costa et al. (2015) when they state that the main factor that defines the yield, both in the field and in protected environments, is the elevation of solar radiation, which associated with saline stress become stress factors for plants, because it presents osmotic activity that retains water and the action of ions in protoplasm (Taiz et al., 2017).

Nascimento et al. (2017) working with passion fruit seedlings in a protected environment or in full sun found a reduction in the dry matter of the root with the increase in the electrical conductivity of irrigation water. Diniz et al. (2018) evaluating the saline stress in mahogany seedlings in a protected environment showed a reduction in the dry mass of the root with an increase in the salinity of the irrigation water.

According to figure 4A, the environments full sun, black and white screen differed statistically from the red screen. The present result refers to the statement of Corrêa et al. (2012) when they reported that the reception of red light leads to a change in the metabolism of the plants, changing parameters of growth or a greater acclimatization of the seedlings to the black and white screen.

These results differ from those found by Goes et al. (2019) working with okra seedlings, where the red screen provided greater performance in the length of the radicle in relation to black and full sun.

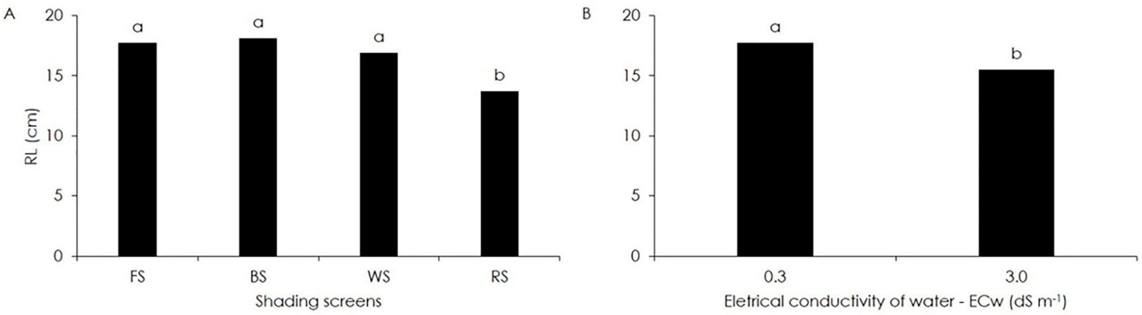

Figure 4. Root length - RL as a function of shade screens (A) and as a function of the electrical conductivity of irrigation water (B). FS - Full sun; BS - Black screen; WS – White screen; RS - Red screen; Means compared by Tukey test at p ≤ 0.05.

Low salinity water presents higher mean values for root length (Figure 4B), differing statistically from high salinity water.

The reduction in root length due to increased salinity may be related to the restriction of water availability through osmotic effects, causing toxicity and nutritional disorders reducing water absorption and consequently lower root development (Oliveira et al., 2015). Similar results for root length reduction due to increased salinity were found by Melo filho et al. (2017), working with pitombeira seedlings.

For the electrical conductivity of the saturation extract (Figure 5A) the environment at full sun and red screen had the highest values and differed statistically from the others.

The increase of the ECse in these environments is linked to the high rate of evapotranspiration provided by the same, reflecting in greater accumulation of salts in the substrate.

A contrasting result to present study was obtained by Eloi et al. (2007), evaluating the cultivation of tomatoes in an environment protected with black screen under saline stress , verified an increase in the electrical conductivity of soil saturation extract.

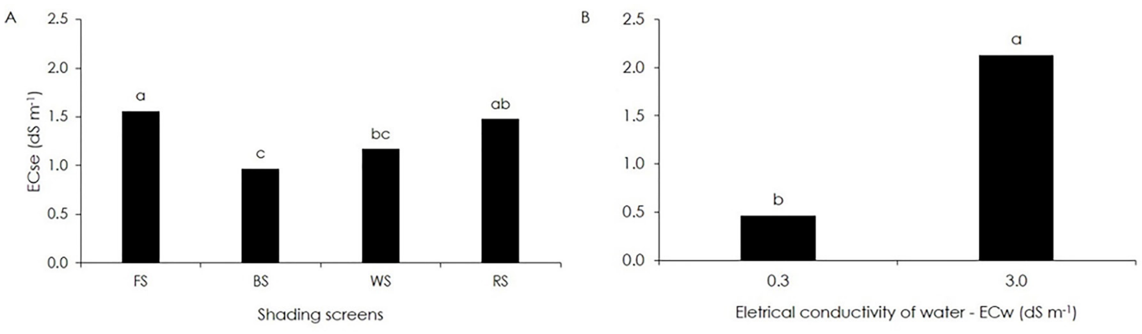

Figure 5. Electrical conductivity of the saturation extract - ECse as a function of shade screens (A) and as a function of the electrical conductivity of the irrigation water. FS - Full sun; BS - Black screen; WS - White screen; RS - Red screen; Means compared by Tukey test at p ≤ 0.05.

In figure 5B, the ECse in the treatment with high salinity water was statistically superior to the low salinity treatment. This behaviour is due to the increase of salts in irrigation water during the study. Souza et al. (2017), working with noni seedlings showed the increase of the ECse due to the increase of salinity of the irrigation water.

It is verified in figure 6, that the pH decreased with the increase of the electric conductivity of the irrigation water.

This reduction of pH can be explained by the increase of salts in the water, such as calcium chloride ($Cacl_2$), having led to the substitution of anions such as carbonates and bicarbonates, promoting the increase of H^+ concentration in the soil solution (Freitas et al., 2007).

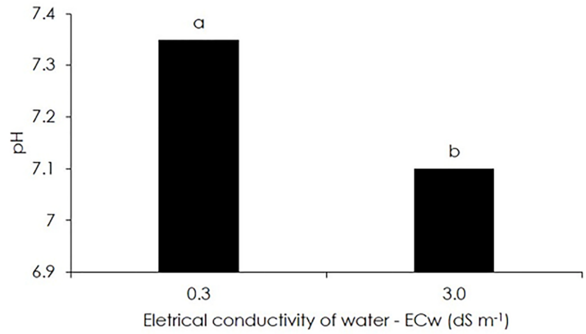

Figure 6. Hydrogenionic potential as a function of the conductivity of irrigation water. Means compared by Tuckey test at p ≤ 0.05.

Similar results were found by Rodrigues et al. (2018) working with soil chemical attributes in an area irrigated with saline water. These same authors obtained pH reduction due to increased conductivity of irrigation water.

According to the analysis of variance (Table 4), there was a significant effect for the interaction between irrigation water and screen for the variable's photosynthesis, transpiration, stomach conductance, chlorophyll and water use efficiency.

Table 4. Summary of analysis of variance for photosynthesis (A), transpiration (E), stomatal conductance (gs), instantaneous water use efficiency (WUEi) and relative chlorophyll index (RCI) as a function of the types of shade screens and irrigation water (high and low salinity).

VS	DF	Mean Square				
		A	E	gs	WUEi	RCI
Screens (S)	3	4.24*	0.53**	0.004^{ns}	0.200*	180.31**
ECw (E)	1	117.73**	6.46**	0.09**	3.93**	843.88**
(S) x (E)	3	16.32**	0.62**	0.01**	2.69**	127.97**
Treatments	7	25.63**	1.42**	0.02**	1.80**	252.67**
Residue	24	0.93	0.08	0.001	0.06	6.52
CV (%)	-	15.4	12.53	24.95	9.55	8.24

VS – Variation sources; DF - Degrees of freedom; CV - Coefficient of variation; *, ** and ns Significant at p ≤ 0.05, p ≤ 0.01 and not significant, respectively.

For the photosynthesis (Figure 7A), only on the black screen there was no difference between the irrigation water, and the low salinity water was higher on RS, WS and FS than on the high salinity water.

The highest values for red screen, possibly is related to light transfer of the spectrum in the red wave band, promoting better quality diffused light, influenced in the increase of photosynthetic capacity of plants. However, the effect of saline stress reduced photosynthesis in both environments.

This situation is in agreement with Silva et al. (2019) when they verified a reduction of photosynthesis in yellow passion fruit plants with the increase of salinity of irrigation water.

As presented in Figure 7B, concerning perspiration, the water of 0.3 dS m^{-1}, provided higher values in all environments, differing statistically from the high salinity water. This result can be explained by the reduction in stomach conductance (Figure 7C), which occurred independently of the environment, due to the saline stress and consequently decreases perspiration.

These reductions are possibly linked to a mechanism of adaptation to excess salts, since the osmotic closure when associated with minimal perspiration causes a reduction in the concentration of salts in the leaves (Guimarães et al., 2019). Similar results were obtained by Silva et al. (2019) working with yellow passion fruit seedlings submitted to saline stress.

For stomach conductance (Figure 7C), a

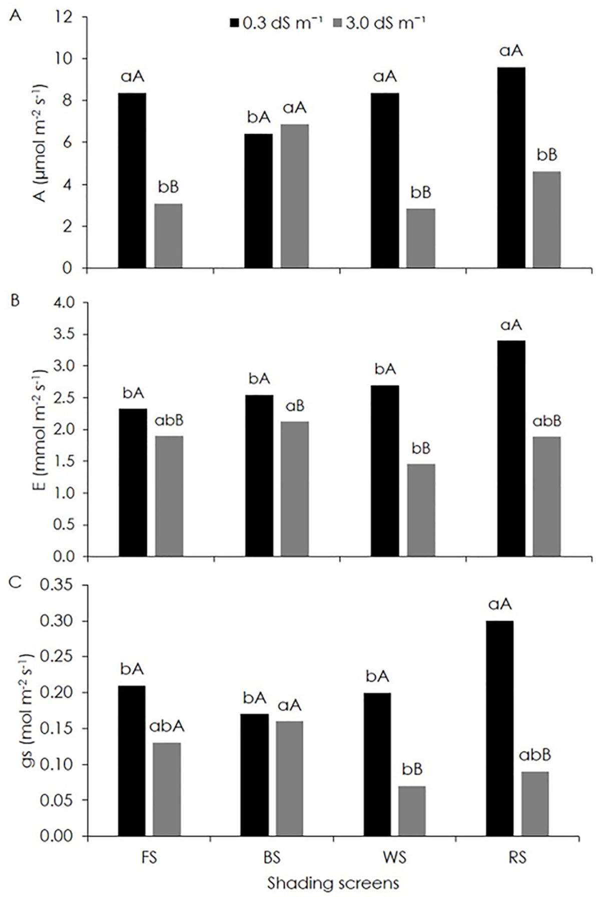

Figure 7. Photosynthesis - A (A), transpiration - E (B) and stomatal conductance - gs (C) of passion fruit seedlings under saline stress and different shade screens. FS - Full sun; BS - Black screen; WS - White screen; RS - Red screen. Lowercase letters at the same level of salinity or uppercase letters in the same environment, does not differ statistically from each other by the Tukey test (p ≤ 0.05).

difference in water (high and low salinity) was presented only for the white and red screen, and the water with lower conductivity was statistically superior. The partial closure of the stomata is possibly a consequence of the osmotic effect, due to the accumulation of salts in the soil, (Dias et al., 2017), occurring independently of the cultivation environment.

Similar results were found by Silva et al. (2019) working with passion fruit seedlings under saline stress.

For the instantaneous water use efficiency (Figure 8A), low salinity water was superior in full sun, WS and RS differing statistically from high salinity water, while black screen showed higher values in high salinity water.

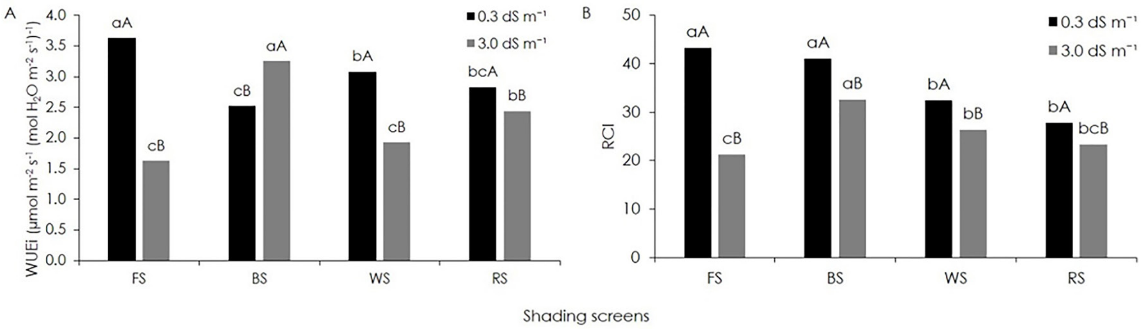

Figure 8. Instantaneous water use efficiency - WUEi (A) and relative chlorophyll index - RCI (B) in passion fruit seedlings under saline stress and different shade screens. FS - Full sun; BS - Black screen; WS - White screen; RS - Red screen. Lowercase letters at the same level of salinity or uppercase letters in the same environment, does not differ statistically from each other by the Tukey test ($p \leq 0.05$).

The decrease in the values of WUEi according to the increase of the electric conductivity of the water in the environments, may be related to their capacity to decrease the evapotranspiration, consequently decreasing the deleterious effects of the salts, since the reduction in water consumption implies a reduction in the absorption of specific ions, avoiding toxic effects on the plants (Silva et al., 2014). Similarly, Silva et al. (2019) also found lower WUEi in yellow passion fruit seedlings.

In figure 8B referring to chlorophyll, the low salinity water differed statistically from the high salinity water, for all screens.

The treatments in full sun and in the black screen when irrigated with low salinity water differed statistically from the others. The chlorophyll values in the leaves act as an indicator of the stress level and nutritional status of the plant, and under saline stress Silva et al. (2019) state that the presence of salts degrades the molecules of the photosynthetic pigment, justifying the reduction of values.

The result of this work is similar to Freire et al. (2013), when irrigating the yellow passion fruit crop in the field phase. The same authors verified a reduction in chlorophyll content when submitted to saline stress.

Conclusions

1. The black screened environment provides greater performance in leaf area, plant height and root length and was more efficient for the production of aerial dry mass and passion fruit seedling root in both irrigation waters.

2. The red screen environment stimulates greater photosynthesis, transpiration, stomach conductance and chlorophyll in passion fruit seedlings irrigated with low salinity water, while the black screen mitigated saline stress for these variables.

3. The full sun environment provided greater instantaneous water use efficiency in passion fruit seedlings for treatment with low salinity water and the black screen environment with high salinity water.

4. The saline stress negatively affected the leaf area, plant height, root length, electrical conductivity of the soil saturation extract and pH.

References

Araujo, J.R.G.; Araújo Júnior, M.M.; Menezes, R.H.N.; Martins, M.R.; Lemos, R.N.S.; Cerqueira, M.C.M. 2006. Efeito do recipiente e ambiente de cultivo sobre o desenvolvimento de mudas de mamoeiro cv. Sunrise Solo. *Revista Brasileira de Fruticultura* 28: 526-529.

Bernardo, S., Mantovani, E.C., Silva, D.D., Soares, A.A. 2019. *Manual de irrigação*. Editora UFV, Viçosa, Brasil. 545p.

Bezerra, J.D., Pereira, W.E., Silva, J.M., Raposo, R.W.C. 2016. Crescimento de dois genótipos de maracujazeiro-amarelo sob condições de salinidade. *Revista Ceres*, 63: 502-508.

Cavalcante, L.F., Sousa, G.G., Gondim, S.C., Figueiredo, F.L., Cavalcante, I.H.L., Diniz, A.A. 2009. Crescimento inicial do maracujazeiro amarelo manejado em dois substratos irrigados com água salina. *Irriga* 14: 504-517.

Cavalcante, L.F., Santos, C.J.O., Holanda, J.S., Lima Neto, A.J., Souto, A.G.L., Dantas, T.A.G. 2018. Produção de maracujazeiro amarelo no solo com calcário e potássio sob irrigação com água salina. *Irriga* 23: 727-740.

Celedonio, C.A., Medeiros, J.F., Viana, T.V.A., Saraiva, K.R., Lima, G.H.P. 2016. Área foliar da figueira em três ambientes de cultivo, sob fertirrigação de biofertilizante bovino. *Revista Brasileira de Agricultura Irrigada* 10: 586-597.

Costa, E., Dias, J.G., Lopes, K.G., Binotti, F.F.S., Cardoso, E.D. 2015. Telas de Sombreamento e Substratos na Produção de Mudas de *Dipteryx alata* Vog. *Floresta e Ambiente* 22; 416-425.

Corrêa, R.M., Pinto, J.E.B., Reis, É.S., Moreira, C.M. 2012. Crescimento de plantas, teor e qualidade de óleo essencial de folhas de orégano sob malhas coloridas. *Global Science and Technology* 05: 11–22.

Dias, A.S., Lima, G.S., Gheyi, H.R., Soares, L.A.A., Souza, L.P., Bezerra, I.L. 2017. Crescimento do algodoeiro 'brs rubi' em função da irrigação com águas salinas e adubação nitrogenada. *Revista Brasileira de Agricultura Irrigada* 11: 1945-1955.

Diniz, G.L., Sales, G.N., Sousa, V.F.O., Andrade, F.H.A., Silva, S.S., Nobre, R.G. 2018. Produção de mudas de mamoeiro sob salinidade da água irrigação e adubação fosfatada. *Revista de Ciências Agrárias* 41: 218-228.

Eloi, W.M., Duarte, S.N., Soares, T.M. 2007. Níveis de salinidade e manejo da fertirrigação sobre características do tomateiro cultivado em ambiente protegido. *Revista Brasileira de Ciências Agrárias* 2: 83-89.

Freire, J.L.O., Cavalcante, L.F., Nascimento, R., Rebequi, A.M. 2013. Teores de clorofila e composição mineral foliar do maracujazeiro irrigado com águas salinas e biofertilizante. *Revista de Ciências Agrárias* 36: 57-70.

Freitas, E.V.S., Fernandes, J.G., Campos, M.C.C., Freire, M.B.G. dos S. 2007. Alterações nos atributos físicos e químicos de dois solos submetidos à irrigação com água salina. *Revista de Biologia e Ciências da Terra* 7: 21-28.

Goes, G.F., Guilherme, J.M.S., Sales, J.R.S., Sousa, G.G. 2019. Ambiência agrícola e estresse salino em mudas de quiabo. *Revista Brasileira de Agricultura Irrigada* Edição Especial - IV SBRNS: 3646-3655.

Gontijo, G.M. *Cultivo do maracujá: informações básicas.* 2017. http://www.emater.df.gov.br/wp-content/uploads/2018/06/cartilha_maracuja.pdf <acesso em 14 Set. 2020>

Guimarães, R.F.B., Maia Júnior, S.O., Nascimento, R., Melo, D.F., Ramos, J.G., Andrade, J.R. 2019. Trocas gasosas em cultivares de alface crespa em cultivo hidropônico com água salina. *Revista Brasileira de Agricultura Irrigada* 13: 3599-3609.

Klein, J., Rodrigues, J.D., Kestring, D., Rampim, L., Aleixo, V., Battistus. A.G. 2017. Desenvolvimento inicial de plântulas de Peltophorum dubium (Spreng.) Taub. Sob protetores físicos com diferentes níveis de luminosidade. *Nativa* 5: 92-100.

Köppen, W.P. 1923. *Die klimate der erde: Grundriss der klimakunde*. Walter de Gruyter & So., Berlim, Alemanha. 369p.

Melo Filho, J.S., Véras, M.L.M., Alves, L.S., Silva, T.I., Gonçalves, A.C.M., DIAS, T.J. 2017. Salinidade hídrica, biofertilizante bovino e cobertura vegetal morta na produção de mudas de pitombeira (*talisia esculenta*). *Revista Scientia Agraria* 18: 131-145.

Munns, R., Tester, M. (2008) *Mechanisms of Salinity Tolerance*. Annual Review of Plant Biology 59: 651-681.

Nascimento, E.S., Cavalcante, L.F., Gondim, S.C., Souza, J.T.A., Bezerra, F.T.C., Bezerra, M.A.F. 2017. Formação de mudas de maracujazeiro amarelo irrigadas com águas salinas e biofertilizantes de esterco bovino. *Revista Agropecuária Técnica* 38: 1-8.

Natale, W., Lima Neto, A.J., Rozane, D.E., Parent, L.E., Corrêa, M.C.M. 2018. Mineral nutrition evolution in the formation of fruit tree rootstocks and seedlings. *Revista Brasileira de Fruticultura* 40: (e-133).

Oliveira, F.A., Lopes, M.Â.C., Sá, F.V.S., Nobre, R.G., Moreira, R.C.L., Silva, L.A., Paiva, E.P. 2015. Interação salinidade da água de irrigação e substratos na produção de mudas de maracujazeiro amarelo. Comunicata Scientiae 6: 471-478.

Rebouças, P.M., Dias, I.F., Alves, M.A., Barbosa Filho, J.A.D. 2015. Radiação solar e temperatura do ar em ambiente protegido. *Revista Agrogeoambiental* 7: 115-125.

Rhoades, J.D., Kandiah, A., Mashali, A.M. 2000. *Uso de águas salinas para produção agrícola.* UFPB, Campina Grande, Brasil. 117p.

Richards, L.A. 1954. *Diagnosis and improvement of saline and alkali soils*. US Department of Agriculture, Washington, USA. 160 p.

Rodrigues, V.S., Sousa, G.G., Saraiva, S.E.L., Cardoso, E.R.C., Pereira Filho, J.V., Viana, T.V.A. 2018. Atributos químicos do solo em área cultivada com milho sob irrigação com água salina. *Revista Brasileira de Agricultura Irrigada* 12: 3129–3138.

Silva, L.A., Brito, M.E.B., Sá, F.V.S., Moreira, R.C.L., Soares Filho, W.S., Fernandes, P.D. 2014. Mecanismos fisiológicos em híbridos de citros sob estresse salino em cultivo hidropônico. *Revista Brasileira de Engenharia Agrícola e Ambiental* 18: p.S1–S7.

Silva, F.A.S., Azevedo, C.A.V. 2016. The Assistat Software Version 7.7 and its use in the analysis of esperimental data. *African Journal Agricultural* 11: 3733-3740.

Silva, A.A.R., Lima, G.S., Azevedo, C.A.V., Gheyi, H.R., Souza, L.P., Veloso, L.L.S.A. 2019. Gas exchanges and growth of passion fruit seedlings under salt stress and hydrogen peroxide. *Pesquisa Agropecuária Tropical* 49: e55671.

Silva Júnior, F.B., Sousa, G.G., Sousa, J.T.M., Lessa, C.I.N., Silva, F.D.B. 2020. Salt stress and ambience on the production of watermelon seedlings. *Revista Caatinga*, 33: 518–528.

Souza, M.C.M.R., Menezes, A.S., Costa, R.S., Amorim, A.V., Lacerda, C.F., Ribeiro, M.S.S. 2017. Tolerância à salinidade e qualidade de mudas de noni sob diferentes ambientes e matéria orgânica. *Revista Brasileira de Agricultura Irrigada* 11: 2052-2062.

Taiz, L., Zeiger, E., Moller, I.M. 2017. *Fisiologia e desenvolvimento vegetal*. Artmed, Porto Alegre, Brasil. 858 p.

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