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Lettuce Growth in Different Pot Volumes and Irrigation Frequencies Under Saline Stress

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Abstract

This study aimed to evaluate lettuce production in different pot volumes and different irrigation frequency under saline stress. The experiment was carried out at the Department of Environmental and Technological Sciences of the Federal Rural University of the Semi-Arid, in Mossoró, RN, Brazil. Randomized block experimental design was used in factorial scheme of 2 × 3 × 3, with 3 replicates. Treatments were consisted of 2 water's salinity levels (0.5 and 2.0 dS m^{-1}), 3 frequencies of irrigation (6, 9, and 12 daily events), and 3 different pots (0.5, 1.0, and 3.0 L). Data from parameters evaluated at harvest were submitted to variance analysis and means were compared. We verified that when the lower saline water (0.5 dS m^{-1}) was used lettuce production increased when cultivated in pots of 3.0 L and submitted to 6 daily events of irrigation. When 3.0 dS m^{-1} water was used the best results were obtained in 0.5 L and nine daily events of irrigation. The combination of 0.5 L pot and six or nine daily events of irrigation better inhibited the damaging effects of salinity.

Keywords: *Lactuca sativa* L., recipient size, salinity

1. Introduction

Lettuce (*Lactuca sativa* L.) is the most consumed leafy vegetable, especially *in natura,* as salad, as it is has great importance in caloric restricted diets, once one portion of 100 grams does not hold much more than 25 Kcal (Sala & Costa, 2012). On the other side, it has great amount of mineral, fiber, and vitamins A, B1, B2, B5, and C. Moreover, it may present tranquilizing, diuretic, and laxative effects (Ribeiro, 2016).

It is also highlighted as the leafy vegetable most cultivated in hydroponic systems, due to a better visual aspect, greater durability, and easiness on cleaning (Ohse et al., 2009). From the many pros of growing in NFT (Nutrient Film Technique) hydroponic systems, we may point out a greater tolerance to salinity, due to lower matric potential incidence, surpassing total water potential, which reduces problems in plant water absorption (Dias et al., 2011; Santos et al., 2016).

However, NFT system presents some limitations, such as high electric energy consumption for nutritive solution movement throughout the system, which is estimated to be 19.7% of the total variable cost (Aita & Londero, 2000).

Several studies have already shown that lettuce is sensitive to salinity, either in traditional cultivation (Oliveira et al., 2011) or in soilless systems using inert substrate (Dias et al., 2011) or NFT hydroponic system (Al-Maskri et al. 2010; Paulus et al., 2012; Bartha et al., 2015; Soares et al., 2015), with a significant reduction in number of leaves, plant fresh weight, shoot fresh weight, shoot dry weight, shoot dry matter percentage, root fresh weight, root dry weight, root dry weight percentage, leaf area and leaf area, as well as affecting leaf nutrition and quality (Paulus et al., 2012; Neocleous et al., 2014; Bartha et al., 2015; Soares et al., 2015; Cova et al., 2017; Lemos Neto et al., 2018).

The cultivation on substrate in recipients arise as an alternative to NFT systems for the simplification in nutritive solution management and allowing energy saving, with a reduction up to 92.4% on the operating time of motor-pump (Andriolo et al., 2004).

Growth of leafy vegetables may be held in small-volume recipient, requiring special attention on irrigation and fertilization management. Due to the reduced substrate volume and, consequently, root volume, associated to low quantity of water stored, irrigation must be done carefully, with high frequency and low volume of water in each event (Marouelli et al., 2005). However, it is necessary studies on this technology, such as the recipient volume.

Plants growing in the soil are submitted to strong variations in water and nutrient availability which can also affect root growth and nutrient uptake more severely than in soilless conditions. Most of the results reported in root growth and their effects on shoot growth and plant development are related to the production of transplants in small containers or tray cells in nurseries (Trani et al., 2004; Leal al., 2011). In horticultural crops during the post-transplant period, such results are scarce in the literature.

These results are as reported by Bonachela et al. (2010), who report that the use of small volume pots ally with high frequency of irrigation can reduce the rate of diffusion and the availability of oxygen to the roots of the plants. In addition, water and nutrient absorption are an energy-dependent process and are reduced when roots are exposed in saturated environments (Morard & Silvestre, 1996).

The increase of irrigation frequency, especially in containers with smaller volume of substrate, promotes greater washing of the substrate, removing salts from the root medium. Over what was exposed, this study was developed to evaluate the effect of different recipient volumes and frequency of irrigation with nutritive solution on the production of lettuce on coconut fiber substrate.

2. Method

The experiment was carried out in protected environment of Department of Environmental and Technological Sciences of the Federal Rural University of the Semi-Arid, in Mossoró, RN, Brazil (5º11′31″ S; 37º20′40″ W, and 18 m of altitude). Region climate, according to Koeppen's classification, is BSwh' (dry and hot), with very irregular rainfall, annual average of 673.9 mm; temperature of 27 ºC and average relative air humidity of 68.9% (Carmo Filho & Oliveira, 1995).

The greenhouse used in this experiment has a metallic coated structure, 7.0 m x 18.0 m, with 126 m² of area, floor/ceiling height of 4 m, and arched roof with transparent plastic film for protection of ultraviolet rays and direct incidence of insolation on plants.

The experiment was installed in a randomized blocks experimental design in factorial scheme of 2 × 3 × 3, with 3 replicates, with the experimental unit represented by 4 pots with one plant each. Treatments consisted of combination of two levels of nutritive solution salinity (1.3 and 3.5 dS m^{-1}), three frequencies of irrigation (F1 = 6 daily events; F2 = 9 daily events; F3 = 12 daily events), and three different pots (0.5 (height = 7.8 cm, upper diameter = 10.2 cm, base diameter = 7.8 cm), 1.0 L (height = 11.6 cm, upper diameter = 14.7 cm, base diameter = 9.8 cm), and 3.0 L (height = 15 cm, upper diameter = 17 cm, base diameter = 14 cm)).

On every treatment the same daily time of irrigation was used, adjusting in three stages throughout the experiment time, starting at 7h and distributed in equidistant intervals: from transplanting (DAT) until 10 DAT (5 minutes: F1—six events of 50 seconds; F2—nine events of 33 s; F3—12 events of 25 s); from 11 DAT until 20 DAT (10 minutes: F1—six events of 100 s; F2—nine events of 67 s; F3—12 events of 50 s); from 22 DAT until 30 DAT (15 minutes: F1—six events of 150 s; F2—nine events of 100 s; F3—12 events of 75 s).

Two different waters were used for nutritive solution preparation, one natural with lower salinity (05 dS m^{-1}) and another one salinized with sodium chloride (2.0 dS m^{-1}). Nutritive solution was prepared according to Dias et al. (2011) recommendation, with the following (in g 310 L^{-1}): 150 g of calcium nitrate; 111 g of potassium nitrate; 42 g of MAP; 81 g of magnesium sulfate; 9 g of Rexolin® (11,6% of K_2O; 1.28% of S; 0.86% of Mg; 2.% of B; 0.36% of Cu; 2.66% of Fe; 0.036% of Mo; 3.48% of Mn and 3.38% of Zn).

Lettuce seedlings cv. Vera was used for transplanting, 23 days after sowing, cultivated in expanded polystyrene trays with 200 cells, in vermiculite substrate fertigated with non-saline nutritive solution via *floating* system.

Pots were filled with coconut fiber based substrate (Goden Mix Granulado) and disposed in a wood countertop, 0.60 m off the ground, in 0.25 × 0.25 m spacing (considering the central point of each pot).

For each type of saline water the was an independent irrigation system, consisting of a motor-pump, 310 L-capacity tank, microtube emitters (spaghetti), attached to polyethylene lateral pipes (16 mm-diameter), which were previously evaluated under normal operation conditions, with average flow of 2.5 L h^{-1}).

Each irrigation frequency was controlled by a timer (Digital timer, TE-2 model, Decorlux®) with capacity for 9 programs, where for F3 (12 daily events) two timers and two motor-pumps were used.

Plants were harvested at 30 days after transplanting and evaluated for following parameters: amount of leaves, considering 5 cm or larger leaves, separating dry or damaged leaves; stem diameter, using a digital caliper and measured at 0.5 cm off the substrate surface; leaf area, by leaf discs method; fresh matter, measured just after harvest in a precision scale (0.01 g); dry matter, measured after drying plants in forced air drying oven at 65 ºC until reach constant weight; specific leaf area (Equation 1); leaf succulence (Equation 2); and water content (Equation 3).

$$SLA = \frac{LA}{LDM} \tag{1}$$

where, SLA: specific leaf area, $cm^2\ g^{-1}$ of LDM; LA: leaf area, cm^2; LDM: leaf dry matter, g.

$$LS = \frac{MFF - MSF}{LA} \tag{2}$$

where, LS: leaf succulence, g $H_2O\ cm^2$ of LA; LFM: leaf fresh matter, g $plant^{-1}$; LDM: leaf dry matter, g $plant^{-1}$.

$$WC = \frac{LFM - LDM}{LFM} \tag{3}$$

where, WC: water content, %; LFM: leaf fresh matter, g $plant^{-1}$; LDM: leaf dry matter, g $plant^{-1}$.

Data was submitted to variance analysis and means were compared by Tukey test (0.05). Statistical analysis were made using the SISVAR statistical software (Ferreira, 2011).

3. Results and Discussion

From the variance analysis summary we verify that there was triple interaction between salinity (S), pot volume (V), and irrigation frequency (F) factors only for leaf area, total dry matter, and specific leaf area ($p < 0.05$). For V × F factors interaction significant response at 5% of probability was verified for dry matter, and at 1% for leaf succulence. Stem diameter, total fresh matter, leaf area, and total dry matter were all affected by the double interaction S × F ($p < 0.05$), as well as amount of leaves, leaf succulence, and water content ($p < 0.01$). Analyzing factors separately, we verify that salinity factor affected all analyzed variables, with significant effect at 5% for specific leaf area and 1% of probability for the rest. Volume of substrate factor, when isolated analyzed, affected most of the variables ($p < 0.01$), except for leaf succulence, specific leaf area, and water content ($p > 0.05$). As for the isolated effect of frequency factor, there was significant response only for water content ($p < 0.05$) (Table 1). These results show that the combination containers volumes and irrigation frequencies provided different conditions for the development of the plants, changing the response of the same to the salinity.

Table 1. Variance analysis summary for amount of leaf (AL), stem diameter (SD), total fresh matter (TFM), leaf area (LA), total dry matter (TDM), leaf succulence (LS), specific leaf area (SLA) and water content (WC) in lettuce cultivated in coconut fiber with saline water, different pot volumes and irrigation frequency

Source of variance	DF	Mean Squares							
		AL	SD	TFM	LA	TDM	LS	SLA	WC
Salinity (S)		711.41**	326.41**	124836.05**	27025269.16**	199.48**	0.00294**	19571.98*	106.68**
Pot volume (V)	2	147.91**	29.14**	22350.21**	14748105.78**	84.48**	0.00003^{ns}	4072.84^{ns}	0.64^{ns}
Frequency (F)	2	3.85^{ns}	0.87^{ns}	419.14^{ns}	100965.98^{ns}	0.009^{ns}	0.00026^{ns}	516.22^{ns}	15.78*
S × V	2	3.57^{ns}	2.14^{ns}	718.89^{ns}	338651.58^{ns}	1.50^{ns}	0.00007^{ns}	4839.43^{ns}	0.58^{ns}
S × F	2	15.63**	10.24*	832.93*	680750.19*	2.69*	0.00094**	6809.89^{ns}	30.56**
V × F	4	4.69^{ns}	3.64^{ns}	630.73^{ns}	403821.10^{ns}	2.80*	0.00052**	4350.14^{ns}	2.48^{ns}
S × V × F	4	2.09^{ns}	1.03^{ns}	238.19^{ns}	534553.45*	4.34*	0.00024^{ns}	9550.30*	2.43^{ns}
Residue	36	2.54	2.19	240.28	162013.78	0.79	0.00011	2934.27	3.78
CV (%)		12.74	15.45	17.46	17.91	16.18	18.56	12.97	12.08

Note. **, *, ns: significant effect at 1%, 5%, and no significant effect, by test F, respectively.

In the Table 2 it is presented the isolated effect of pot volumes on amount of leaves (AL), stem diameter (SD), total fresh matter (TFM), total fresh matter (TFM), and water content (WC) variables, in which it is verified that the use of pots with bigger volume for substrate (3.0 L) induced greater values, except for water content, where there was no significant difference between pots.

Table 2. Amount of leaves (AL), stem diameter (SD), commercial fresh matter (FM), and water content (WC) of lettuce in function of the pot volume used

Volume	Amount of leaves per plant	Stem diameter (mm)	Total fresh matter (g plant^{-1})	Water contente (%)
0.5 L	10.39 b	8.21 b	59.81 c	93.36 a
1.0 L	11.39 b	9.83 a	78.52 b	93.43 a
3.0 L	15.78 a	10.72 a	128.01 a	93.72 a

Note. Means followed by the same letter within columns did not differ from each other by Tukey test ($p < 0.05$).

The greater development of the variable net plants indicates that the containers with greater volume provided greater conditions of absorption of water and nutrients due to the greater storage capacity of water. These results confirm previous results (Oliveira et al., 2011; Moraes et al., 2014), which also reported reduction in leaf emission undergone through saline stress. Cardoso et al. (2015), working with lettuce in fine sand substrate in different volume pots (0.4, 1.0, and 2.5 L), also reported greater results in plants from the biggest pots.

These results are partially similar to what Heller et al. (2015) reported, on evaluating the effect of irrigations frequency and vessels geometry on lettuce, which had plants cultivated in smaller vessels with high irrigation frequency to present more leaves as non-commercial quality.

Unfolding the S × F factors for amount of leaves, stem diameter, total fresh matter, and water content variables are presented in Table 3, which shows that more saline water negatively affected AL, SD, and TFM variables, regardless of irrigation frequency used. On the other side, in greater salinity, the use of F2 frequency reflected in greater AL and TFM (Table 3).

The greatest losses in amount of leaves as response of saline stress were observed in F1 (50%) and F3 (51%), while in F2 there was a reduction of 33.1% even though it showed significant response (Table 3).

The lower frequency of irrigation (F1) increased the effect of salinity because in each event a larger volume of nutrient solution was applied, with a longer interval between irrigations, which caused less water available to the plants. On the other hand, the adoption of higher frequency (F3) increased the effect of salinity because in each event a small volume of nutrient solution was applied, not promoting the leaching of substrate salts, especially in containers with a higher volume of substrate.

The decrease in amount of leaves in response to saline stress may be related to a lower vegetative growth due to restriction in absorption process; and, as consequence, occur a reduction in soil-plant-atmosphere water flow, promoting morphological and anatomic alterations (Coelho et al., 2013).

Lettuce stem diameter reduction in response to salinity was also reported by Silva et al. (2017) and Fonseca et al. (2015). Stem diameter is of major importance in lettuce, especially for fast food industry, because, as leaves are manually separated for later slicing, the thicker the stem the faster it is separated, increasing industrial output.

Table 3. S × F interaction unfolding for amount of leaves, stem diameter, fresh matter, and water content in lettuce cultivated in substrate

Irrigation frequency	Salinity	
	1.3 dS m^{-1}	3.5 dS m^{-1}
Amount of leaves		
F1 = 6 daily events	16.89 Aa	8.44 Bb
F2 = 9 daily events	15.44 Aa	10.33 Ba
F3 = 12 daily events	16.11 Aa	7.89 Bb
Stem diameter (mm)		
F1 = 6 daily events	12.95 Aa	6.63 Ba
F2 = 9 daily events	11.01 Ab	7.69 Ba
F3 = 12 daily events	12.19 Aab	7.07 Ba
Fresh matter (g plant^{-1})		
F1 = 6 daily events	136.19 Aa	40.56 Bab
F2 = 9 daily events	135.16 Aa	52.33 Ba
F3 = 12 daily events	139.23 Aa	29.21 Bb
Water content (%)		
F1 = 6 daily events	94.71 Aa	93.16 Aa
F2 = 9 daily events	94.69 Aa	93.61 Aa
F3 = 12 daily events	95.34 Aa	89.53 Bb

Note. Means followed by the same letters, upper case within lines and lowercase within columns, did not differ from each other by Tukey test ($p < 0.05$).

Reduction in lettuce total fresh matter under saline conditions is in accordance to what was reported by other authors that used saline water in irrigation (Dias et al., 2011; Oliveira et al., 2011; Guimarães et al., 2016).

Fresh matter may be considered the most important variable in lettuce, because it gives information about crop yield. In the present study, we verified that saline strass decrease this variable in all irrigation frequencies used, with loss of 70.3, 61.3, and 79.0% for F1, F2, and F3, respectively. With that, we see a more severe effect of salinity when the highest irrigation frequency (F3) was used, with twelve daily events (Table 3).

Studies on frequency of irrigation for lettuce grown in substrate are scarce, with few studies about hydroponic system, which the greatest production obtained with the highest frequencies, with 5 minutes-interval between irrigations (Zanella et al., 2008). However, Luz et al. (2008) observed that lettuce production in NFT hydroponic system may be realized using 45 minutes-interval between irrigations, with no significant yield loss and reducing costs with energy (42.1%).

Vegetal tissue water content (WC) was not affected by salinity in plants irrigated with F1 and F2 frequencies, but reduced in function of salinity when F3 was applied. We also verified that there was no significant effect of irrigation frequencies when we used low saline water, but the highest frequency (F3) reduced WC in the highest salinity (Table 4), indicating that F3, due to less water leaching, promoted a buildup of salts. These results confirm what was presented by Ünlükara et al. (2008), who verified an increase in dry matter content in lettuce under saline stress.

Many studies show that plants cultivated in saline conditions present a reduction in water consumption (Paulus et al., 2012; Lira et al., 2015; Soares et al., 2015), however, some authors did not observe effect of salinity on vegetal tissue water content (Borghesi et al., 2013). According to Bartha et al. (2015) lettuce cultivars with lower water content presented greater tolerance to salinity stress.

In regard to leaf area (LA), we verified that the use of larger pots provided greater values of LA in F1 and F2 frequencies in both salinity levels. Analyzing F3 with the highest saline level we noted that the pots of 1.0 and 3.0 L presented the greatest values of LA (Table 4).

Table 4. Means of leaf area, total dry mass, and specific leaf area in lettuce cultivated in substrate in function of salinity, pot volume, and frequency of irrigation

CEs	Pot volume	Frequency		
		F1 = 6 daily events	F2 = 9 daily events	F3 = 12 daily events
Leaf area (cm² plant⁻¹)				
1.3 dS m⁻¹	0.5 L	2331.97 Ac**A**	1860.13 Ac**A**	2526.54 Aa**A**
	1.0 L	3195.91 Ab**A**	2693.06 Ab**A**	2627.81 Aa**A**
	3.0 L	4101.74 Aa**A**	3950.55 Aa**A**	3301.53 Aa**A**
3.5 dS m⁻¹	0.5 L	475.20 Ab**B**	849.54 Ab**B**	707.97 Ab**B**
	1.0 L	735.32 Bb**B**	1053.74 Bb**B**	1974.81 Aa**A**
	3.0 L	2910.37 Aa**B**	2556.14 Aa**B**	2582.19 Aa**B**
Total dry mass (g plant⁻¹)				
1.3 dS m⁻¹	0.5 L	5.39 Ac**A**	5.06 Ac**A**	6.40 Ab**A**
	1.0 L	7.74 Ab**A**	7.57 Ab**A**	6.23 Ab**A**
	3.0 L	9.93 ABa**A**	10.90 Aa**A**	8.38 Ba**A**
3.5 dS m⁻¹	0.5 L	1.53 Ab**B**	1.81 Ab**B**	1.70 Ab**B**
	1.0 L	1.41 Bb**B**	2.23 Bb**B**	4.79 Aa**A**
	3.0 L	6.90 Aa**B**	6.30 Aa**B**	5.63 Aa**B**
Specific leaf area (cm² g⁻¹ LDM)				
1.3 dS m⁻¹	0.5 L	433.11 Aa**A**	370.49 Aa**B**	399.74 Aa**A**
	1.0 L	412.56 Aa**B**	359.34 Aa**B**	421.65 Aa**A**
	3.0 L	412.87 Aa**A**	384.87 Aa**A**	393.87 Aa**A**
3.5 dS m⁻¹	0.5 L	362.40 Bb**B**	468.87 Aa**A**	432.11 ABa**A**
	1.0 L	518.43 Aa**A**	482.66 Aa**A**	411.69 Aa**A**
	3.0 L	423.43 Aab**A**	403.33 Aa**A**	464.33 Aa**A**

Note. * Means followed by the same uppercase letter within lines (referring to frequency within salinity and pot volume combination) did not differ from each other by Tukey test (5%); Means followed by the same lowercase letter (referring to pot volumes within salinity and frequency combination) did not differ from each other by Tukey test (5%); Means followed by bold uppercase letter within columns (referring to salinity within frequency and pot volume combination) did not differ from each other by Tukey test (5%).

Salinity negatively affected FA in plants under F1 and F2 frequencies, for all pot volumes. However, the effect of saline stress on FA was inhibited when F3 and 1.0 L pot were associated. This may have occurred because more irrigation events kept the soil moist for a longer period of time. In addition to that, we may infer that pot with capacity for 1.0 L had lower water leaching loss when compared to pots with capacity for 0.5 L, and fewer buildup of salts in substrate (3.0 L pots). This way, LA may have been less affected with this combination of pot volume and frequency of irrigation due more water available for plant absorption (Table 4).

Leaf area reduction in plants submitted to saline stress is a very common response, and it has been report by many authors (Moraes et al., 2014; Soares et al., 2015; Guimarães et al., 2016), who observed that leaf area of lettuce linearly reduces with increase in salinity.

Analyzing the LA reduction in percentage, we verified that the effect of salinity was more severe in the smaller pots, with loss of 79.6, 54.3, and 71.9% in F1, F2, and F3 frequencies, respectively (Table 4).

Leaf area is of great importance for lettuce, because it is a yield growth indicative variable, since the photosynthetic process depends on the interception of light and its conversion to chemical energy, being directly related to leaves (Taiz et al., 2017).

For some authors, the reduction of leaf area is an important adaptive mechanism of cultivated plants in environments with excess of salt and water stress (Oliveira et al., 2011; Sucre & Suáres, 2011), since under these conditions it is interesting to reduce transpiration and, consequently, decrease transport of Na^+ and Cl^- ions in the xylem and conserve of water in the plant tissues (Taiz et al., 2017).

Analyzing the TDM, we verify significant difference between irrigation frequencies when low saline nutritive solution was used in pots of 3.0 L, with the highest values in F1 and F2. However, increasing in salinity caused difference between irrigation frequencies when plants were grown in pots of 1.0 L, which F3 presented superior than the other frequencies (Table 4).

As for the effect of volume of pots on TDM, pots of 3.0 L presented TDM superior than other pots in F1 and F2 for both salinities, and F3 in the lower salinity level. However, there was no significant difference between pots of 1.0 and 3.0 L in the highest salinity level (Table 4).

We also verify in table for that the increase in electrical conductivity reduces TDM in F2 and F2, regardless of the pot used. But in F3, the level of salinity negatively affected DM values in plants cultivated in 0.5 and 3.0 L pots. According to data presented, plants cultivated in pots of 1.0 L and submitted to the highest frequency of irrigation did not show any reduction in DM due to salinity. This fact may be occurred due to great amount of water in the substrate in pots of 0.5 L, causing leaching of nutrients important to plant development, and greater evaporation in the bigger pots, because high frequency put less nutritive solution for each event, while pots of 3.0 L, with a big surface, reduced the leaching of salts in the root zone.

Dry matter reduction in tissues of plants in saline stress reflects the increase in metabolic energy cost and reduction in carbon gain, reduction of metabolic rates per unit of leaf area, reducing photosynthetic capacity (Ekinci et al., 2012).

Specific leaf area was not affected by irrigation frequencies when plants were submitted to the lowest salinity level, regardless of pot volume used. On the other side, when plants were submitted to the greatest salinity level, there was effect of irrigation frequency when 0.5 L pots were used, with the greatest SLA in F2 and F3 (Table 4). Assessing the effect of volume over SLA, we see significant response only in the highest salinity level (3.5 dS m^{-1}) and the lowest frequency (F1), with the lowest SLA in the smallest pot (0.5 L) (Table 4).

Table 5. Leaf succulence in lettuce in function of interaction between salinity and irrigation frequencies (S × F) and pot volume and irrigation frequencies (V × F)

Irrigation frequencies	Salinity		
	1.3 dS m^{-1}	3.5 dS m^{-1}	
F1 = 6 daily events	0.041 Aa	0.043 Aa	
F2 = 9 daily events	0.029 Bab	0.041 Aa	
F3 = 12 daily events	0.021 Bb	0.051 Aa	
Irrigation frequencies	Pot volume		
	0.5 L	1.0 L	3.0 L
F1 = 6 daily events	0.054 Aa	0.035 Ba	0.037 Ba
F2 = 9 daily events	0.031 Ab	0.036 Aa	0.038 Aa
F3 = 12 daily events	0.027 Ab	0.036 Aa	0.042 Aa

Note. Means followed by the same letter, uppercase in lines and lowercase in columns, did not differ from each other by Tukey test ($p < 0.05$).

We observed, for the effect of salinity over SLA, significant responses in F1 and F2. In F1, salinity reduced the SLA in plants cultivated in 0.5 L pots, but increased in 1.0 L pots. For F2, salinity increased SLA in plants grown in 0.5 and 1.0 L (Table 4).

SLA inversely proportional to the blade thickness, this way, we can affirm that with the lowest salinity level plants presented thicker leaves. Lower SLA indicates that the biomass was transferred to the leaf structure, showing a less input in biomass per unit of area and increase in leaf photosynthetic surface, what would increase the gain of carbon for the whole plant (Rasmunson & Anderson, 2002).

Leaf succulence (LS) was affected by salinity when plants were submitted to F2 and F3, with the greatest values in the greatest salinity. Analyzing the effect of irrigation frequencies in each salinity we verified significant response only in the lowest salinity (1.3 dS m^{-1}), showing reduction of LF with the increase in events of irrigation (Table 5).

The increase in LS in function of saline stress may be an indication that there was an osmotic adjustment in stressed plants (Silva et al., 2009), because LS is considered an important parameter that allows the regulation of salt concentration in leaf tissues, and depends directly on the absorption, transport and accumulation of ions in leaf tissues, increasing plant tolerance to salinity (Aldesuquy et al., 2012) and contributes to reduce the effect of salts over plant growth.

Probably, the lowest amount of events in the lowest irrigation frequency promoted a greater leaching of salts in substrate, since lower frequencies put more water per event.

4. Conclusion

Lettuce produced better in pots of 3.0 L with 6 daily events and lower saline water.

Damaging effects caused by salinity are inhibited when lettuces are cultivated in pots of 0.5 L with six or nine daily irrigation events.

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