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Application of wastewater for production of lettuce (*Lactuca sativa*) in hydroponic system

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Abstract

The study aimed to evaluate the agronomic performance of three varieties of lettuce subjected to different treatments of wastewater. The experimental design was a randomized block in a 7 x 3 split-plot with three replicates. The factors were 7 hydroponic and 3 cultivars of crisp lettuce. The solutions were formulated and optimized by considering Furlani solution as reference nutrient. The experimental portion consisted of the nutritive solutions (S). S_1 = Furlani solution; S_2 = domestic wastewater; S_3 = optimized domestic wastewater; S_4 = well water; = S_5 optimized well water; S_6 = wastewater from the UASB reactor and S_7 = wastewater optimized from the UASB reactor, the subplot was constituted of three lettuce cultivars (Verônica, Vanda and Thais). The results showed that solutions with domestic wastewater (S_2), optimized domestic wastewater (S_3), optimized well water (S_5) and the solution wastewater from the UASB reactor (S6) promoted the highest number of leaves per plant for the three cultivars. Solutions with enhanced domestic wastewater (S_3), optimum water well (S_5) and the solution formulated from the wastewater from the UASB reactor (S_6) promoted the highest stem diameter in three cultivars. The highest value of total production was obtained from Vanda cultivar, when the wastewater from the UASB reactor (S_6) was used as nutritive solution.

Keywords: Hydroponics, reuse, productivity.
abbreviations: NFT_Nutrient Film Technique; S_1_Furlani solution; S_2_domestic wastewater; S_3_optimized domestic wastewater; S_4_well water; S_5_optimized well water; S_6_wastewater solution from the Upflow Anaerobic Sludge Blanket (UASB) reactor and S_7_optimized wastewater solution from the UASB reactor; FAO_Agriculture Organization; WHO_World Health Organization; UASB_Upflow Anaerobic Sludge Blanket; EXTRABES_Experimental Station of Biological Treatment of Sanitary Sewers; LIS_Laboratory of Irrigation and Salinity; UAEA_Academic Unit of Agricultural Engineering; UFCG_Federal University of Campina Grande; Kg_kilogram; CV_coefficient of variance; DF_degree of freedom; ns_not significant; APHA_American Public Health Association; ARCRGN_Agricultural Research Company of Rio Grande do Norte S/A; NS_Number of sheets; SD_Stem diameter ; TP_ Total Production; CP_Commercial production; FSM _ Fresh Stem Mass; FLM _ Fresh Leaf Mass; C_Degree °C; ha_hectare; N_nitrogen; P_phosphor; K_potassium; mm_millimeter; g_gramme; SISVAR_statistical analysis system; Log x_transformation logarithm of x.

Introduction

Application of treated wastewater in agriculture is essential not only to serve as a source of extra water, but also to provide nutrients to the cultures. In this context, plants play a significant role, extracting macro and micronutrients provided by the wastewater necessary for their growth, avoiding accumulation, the resulting salinization of the soil and contamination of surface and ground waters (Ribeiro et al., 2009).
However, hydroponic structure itself functions as drainage and salts accumulated at the end of the cultivation can be easily discharged out of the system; thus, hydroponic systems allow the use of waste that came from desalination water, enabling a productive activity which generates income for rural communities, with greater environmental safety (Dias et al., 2010).
The use of treated wastewater can be a source of water and nutrients available for use in agriculture, even during periods of drought (Shaer Barbosa et al., 2014). On the other hand, the safety of reusing these wastewaters for irrigation purposes is crucial. To Ayers and Westcot (1999), explained that several factors should be taken into account for application of wastewater in agriculture such as physical, chemical and biological characteristics of the water. These factors are also reflected in the productivity and quality of crops, soil fertility maintenance and protection of man and the environment.

The interests on application of treated wastewater has raised recently (Bonini et al., 2014), and became an attractive option for irrigation because it reduces contamination by direct discharge of sewage into water bodies, improving the conditions potable, allowing more rational use of water resources, as alternative source of available water (Martinez et al., 2013).
Plants play a significant role by extracting macro and micronutrients provided by the wastewater necessary for their growth avoiding the buildup of those components, such as the resulting salinization of the soil and contamination of surface and ground waters (Ribeiro et al., 2009). Sewage contains more than 99.9% of water. Therefore, only 0.1% fraction of wastewater needs treatment.
Some studies have explained development of techniques such as NFT (Nutrient Film Technique), hydroponic growing system or inert substrate (Santos et al., 2012) using wastewater to produce lettuce. In hydroponic nutrient, absorption occurs through the roots of plants which receive a balanced nutrient solution containing water and nutrients essential to plant development.
The use of hydroponics has emerged as an alternative to solve problems such as unavailability of the soils suitable for agriculture; the incidence of certain soil-borne diseases hardly controlled by chemical methods, health or genetic resistance; interest in increasing the efficiency of water use and the desire to increase production and improvement of quality food (Souza Neta et al., 2013).
Production of lettuce (*Lactuca sativa* L.) in hydroponic systems is already widespread in Brazil, especially when combined with crop's short cycle (Sarmento et al., 2014). Several studies have been conducted for cultivation of vegetables using hydroponics systems (Magalhães et al., 2010; Paulus et al., 2012; Sarmento et al., 2014). However, all studies are referred to the use of solutions of mineral nutrients, particularly Furlani solution (1995) (Monteiro Filho et al., 2017).
There are few studies that relate the use of organic or organomineral solutions for the growth and production of lettuce in a hydroponic system.
Recently, studies were carried out to replace, totally or partially, the use of mineral fertilizers in the composition of the nutrient solution by alternative sources more economical and available in the rural property (Charoenpakdee, 2014). Some attempts have been made, recommending the use of biofertilizers as a substitute for the mineral nutrient solution, as long as they contain a balanced chemical composition (Dias et al., 2009). Sikawa and Yakupitiyage (2010) mentioned that there is a great potential in the use of wastewater for hydroponic production of lettuce. Monteiro filho et al. (2018) and Silva (2018) also carried out research on hydroponic lettuce production using organomineral.
Cova et al. (2017) studied the cultivation of lettuce in hydroponic system and observed that re-circulation range of lettuce crop depends on the quality of water used in the preparation of the nutrient solution. In this respect, this study aimed to evaluate the agronomic performance of three varieties of lettuce in different wastewater treatments.

Results and discussion

Table 1 shows analysis of variance, where interaction was significant at the 5% level ($p<0.05$) for nutrient solution (S) and cultivars (C) and number of sheets (NS). For parameters such as stem diameter (SD), fresh stem mass (FSM), fresh leaf mass (FLM), total production (TP) and commercial production (CP) there were significant interactions at 1% level (w <0.01).

Effects of wastewater on number of sheets (NS) and stem diameter (SD)

The number of sheets (NS) is shown in Fig. 1. The lettuce cultivars analyzed in the same solution, showed a significant difference only for using raw sewage effluent (S_2) and optimized raw sewage (S_3), in which few leaves were observed in the cultivar Vanda. A higher mean leaf number (NS) was observed in cultivar Thaís at the following solutions: domestic wastewater (S_2), optimized domestic wastewater (S_3), optimized well water (S_5) and the solution wastewater from the UASB reactor (S_6), corresponding to medium 15.00, 16.33, 16.50 and 16.16 leaves/plant, respectively. There were significantly different from the other solutions (Fig. 1). In relation to cultivar Vanda (Fig. 1), we observed that the largest average of number of leaves (NS) of lettuce were obtained in Furlani solution solution (S_1), optimized domestic wastewater (S_3), optimized water well (S_5 and wastewater solution from the UASB reactor (S_6), corresponding to a medium 14.50, 14.50, 14.83, 17.33 leaves/plant, respectively. In Veronica cultivar we found that larger size leaves were obtained in Furlani solution solutions (S_1), domestic wastewater (S_2), optimized water well (S_5) and wastewater solution from the UASB reactor (S6), respectively (Fig. 1). The number of sheets obtained in this study is lower than the average of 27 leaves / plant reported by Magalhães et al. (2010), when they evaluated the lettuce cultivars performance in hydroponic culture under two levels of electrical conductivity. Magalhães et al. (2005), studied bloodlines of lettuce cultivars under hydroponic culture using nutrient solution Furlani, averaging 38.70 leaves/plant. The smaller number of leaves observed in this study can be explained by above the recommended temperatures for the logged in lettuce cultivation environment throughout the experiment. Although the number of sheets is a feature of the cultivar, higher temperatures may encourage early flowering of the plant. Filgueira (2008) stated that the optimum temperature for lettuce crop is between 15 and 25 °C. Higher temperatures can accelerate the cultivation cycle, resulting in smaller plants. The critical conditions for development of lettuce plants are observed in values greater than 30 °C (Filgueira, 2008). Effects of solutions on cultivar Thaís showed higher mean stem diameter (SD) in the following solutions: Domestic wastewater (S_2), optimized domestic wastewater (S_3), optimized well water (S_5) and wastewater solution from the UASB reactor (S_6) corresponding to the average 13.03, 12.82, 09.13 and 13.03 mm, respectively (Fig. 2). For the Vanda cultivar, the highest values obtained for the stem diameter (SD) were the solutions: optimized domestic wastewater (S_3), optimized well water (S_5) and wastewater

Table 1. Variance Analysis of number of sheets (NS), Stem Diameter (SD), Fresh Stem Mass (FSM), Fresh Leaf Mass (FLM), Total Production (TP) Commercial Production (CP) at the end of hydroponic cultivation of the three cultivars of crisp lettuce submitted to different treatments.

		Middle square (MS)					
Source of Variation	DF						
		NS	AD	FSM (1)	FLM (2)	TP (2)	CP (2)
Solution (S)	6	33.77 **	14.46ns	0.70 **	33.05 **	33.14 **	22.80 **
Block	2	14.67ns	1.95ns	0.62 **	3.87 *	3.82 *	9.58ns
residue portion	12	5.31	3:27	00:03	1:07	1:06	3.68
Cultivating (C)	2	10.48ns	7.75 *	0.05ns	0.54ns	0.56ns	38.39ns
Cultivar x Solution	12	9.35 *	5.75 **	00.16 **	5.74 **	5.77 **	31.67 **
Residue of the subplot	26	3.70	1.94	00:02	00:51	00:51	1.86
CV 1		16.02	15.87	20.86	12.89	12.81	21.91
CV 2		13.39	12.21	17.43	8.96	8.94	15.60
Overall erage		14.37	11.41	0.85	8.04	8.05	8.75

DF - degree of freedom; [ns] not significant; ** significant at 1% probability level ($p < 0.01$); * Significant at the 5% probability level ($0.01 \leq p < 0.05$) by the F test, CV = coefficient of variance;

(1) = Log x;

(2) $\frac{x^{2,77}-1}{2,77}$

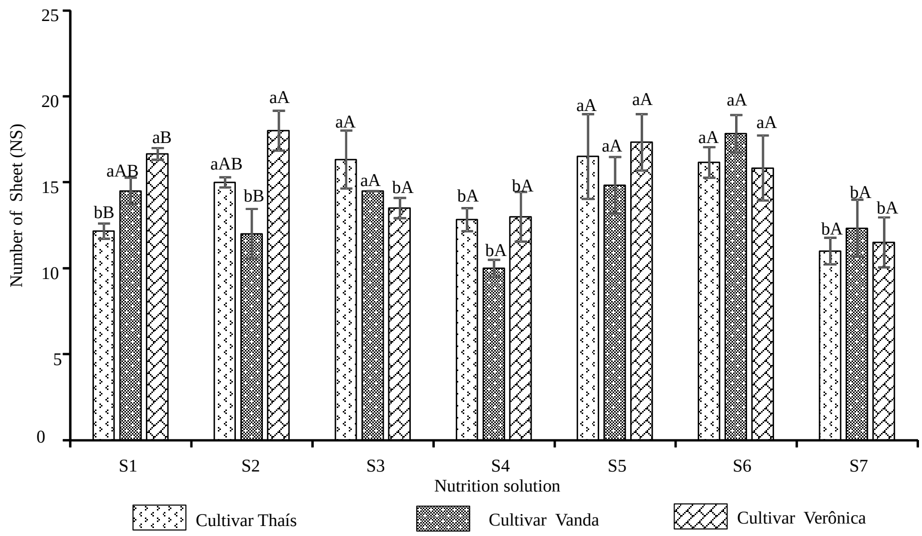

Fig 1. Number of sheets (NS) of lettuce due to the unfolding of the interaction between nutrient solutions S_1; S_2; S_3; S_4; S_5; S_6 and S_7 and cultivars of curly lettuce Thais, Vanda and Veronica. Means followed by the same letter do not differ within the same cultivar and means (test Scott Knott) followed by the same capital letter do not differ cultivars within the same solution (test Tukey). S_1 = Furlani solution; S_2 = domestic wastewater; S_3 = optimized domestic wastewater, S_4 = well water S_5 = optimized well water; S_6 = Reactor wastewater and S_7 = optimized wastewater solution of reactor.

Table 2. Physical-chemical characterization of waters used in hydroponic irrigation.

Determinations	Domestic wastewater (S_2)	Well water (S_4)	Wastewater from the (UASB) reactor (S_6)
pH	7.7	7.4	7.2
Electric conductivity (dSm^{-1})	0.957	2133	2.502
Calcium ($mmol_c$/L)	3.62	3.98	5.98
Magnesium ($mmol_c$/L)	0.75	3.47	3.42
Sodium ($mmol_c$/L)	3.94	10.57	15.55
Potassium ($mmol_c$/L)	0.38	1.26	0.01
Chlorides ($mmol_c$/L)	6.42	9.99	23.23
Carbonates ($mmol_c$/L)	0.00	0.00	0.00
Bicarbonate ($mmol_c$/L)	1.31	10.95	3.25
phosphorus (mg L^{-1})	4.51	29.30	4.14
Nitrate (NO_3^-) (mg L)	16.73	0.00	1.03
Ammonia (NH_3) (mg L^{-1})	0.61	1.27	58.6
Sodium adsorption ratio (SAR)	2.57	6.93	8.53
Class of water for irrigation	$C_2S_1T_2$	$C_3S_1T_3$	$C_3S_1T_3$

S_2= domestic wastewater; S_4= well water and S_6 = reactor waste water solution and. Class of water for irrigation: Salinity (C), sodicity (S) and toxicity (T) in ions. C_2 - Medium salinity water Água de média salinidade, C_3 - High salinity water Água de alta salinidade. S_1 - water low sodium or low sodium concentration. S_2 - medium sodic water or medium sodium concentration. T_2 - moderate toxicity problema and T_3 - severe toxicity problem.

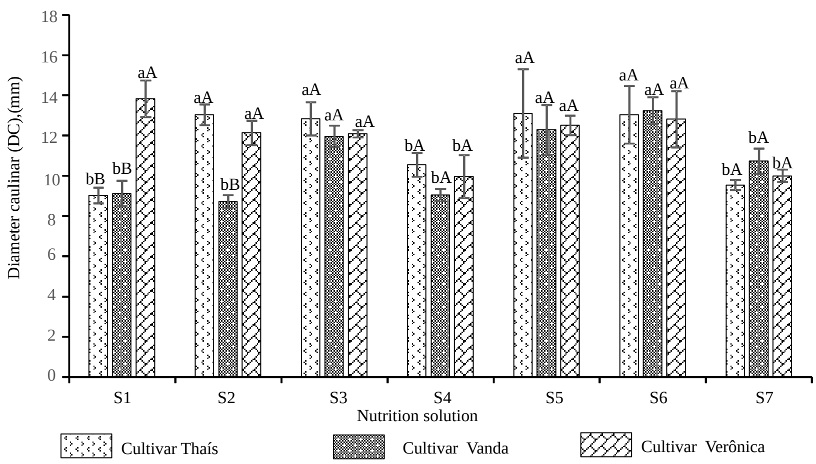

Fig 2. Stem diameter (SD) of lettuce due to the unfolding of the interaction between S_1 nutrient solutions; S_2; S_3; S_4; S_5; S_6 and S_7 and cultivars of curly lettuce Thais, Vanda and Veronica. Means followed by the same letter do not differ solutions within the same cultivar and means (test Scott Knott) followed by the same capital letter do not differ cultivars within the same solution (test Tukey). S_1 = Furlani solution; S_2 = domestic wastewater; S_3 = optimized domestic wastewater, S_4 = well water S_5 = optimized well water; S_6 = Reactor wastewater and S_7 = optimized wastewater solution of reactor

Table 3. Chemical composition of reference nutritive solution.

Solution Furlani	
Mineral salts g 1000 L^{-1} of water	
NO_3 - Nitrate	200.44
NH_4 – Ammonium	16.51432
P - Phosphor	32.7
K - Potassium	310.275
Ca - Calcium	168
Mg - Magnesium	24.65
S - Sulfur	32.5
Mn - Manganese	0.636714
Zn - Zinc	0.199144
Cu - Copper	0.0671
Bo - Boron	0.356592
Mo - Molybdenum	0.114452
Fe - Iron	2.234

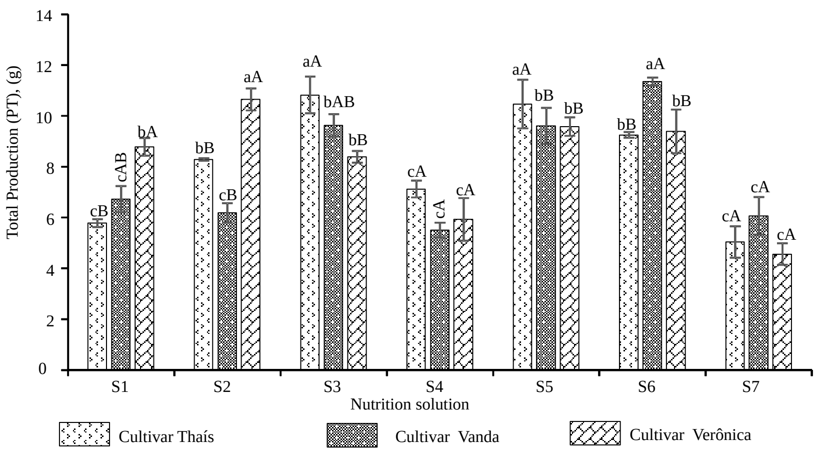

Fig 3. Total production (TP) of lettuce due to the unfolding of the interaction between nutrient solutions S_1; S_2; S_3; S_4; S_5; S_6 and S_7 and cultivars of curly Thais, Vanda and Veronica. Means followed by the same letter do not differ solutions within the same cultivar and means (test Scott Knott) followed by the same capital letter do not differ cultivars within the same solution (test Tukey). S_1 = Furlani solution; S_2 = domestic wastewater; S_3 = optimized domestic wastewater, S_4 = well water S_5 = optimized well water; S_6 = Reactor wastewater and S_7 = optimized wastewater solution of reactor

Table 4. Ingredients of the fertilizers used for the preparation of mineral nutrient solutions from the physico-chemical characterization of the waters used in hydroponic irrigation.

Ingredients	Quantity of ingredients used to prepare optimized solutions		
	S_3	S_5	S_7
Wastewater from the (UASB) reactor	199.58 L	-	-
Well water	-	199.64 L	-
Raw sewage	-	-	199.64 L
Ammonium sulfate [$(NH_4)_2SO_4$]	23.66 g	22.31g	25.09 g
Calcium nitrate [$(NO_3)_2$]	238.24 g	237.53 g	193.54g
Potassium nitrate (KNO_3)	84.06 g	80.95 g	121.74g
Potassium chloride (KCl)	46.32 g	50.04 g	0.00g
Copper Sulfate ($CuSO_4$)	0.04 g	0.04 g	0.04g
Zinc sulfate ($ZnSO_4$)	0.11 g	0.11 g	0.11g
Manganese Sulfate ($MnSo_4$)	0.49 g	0.49 g	0.49g
Magnesium sulphate ($MgSO_4$)	2.19 g	4.27 g	0.00g
Ammonium molybdate [$(NH_4)_6Mo_7O_{24}$]	0.06 g	0.06 g	0.06g
Boric acid (H_3BO_3)	0.42 g	0.42 g	0.42g
Monoammonium phosphate (MAP)	3.14 g	10.43 g	5.14g
Iron sulphate ($FeSO_4$)	12.05 g	12.05 g	12.05g

Note: S_3= optimized domestic wastewater; S_5 = optimized well water and S_7 = optimized reactor waste water solution.

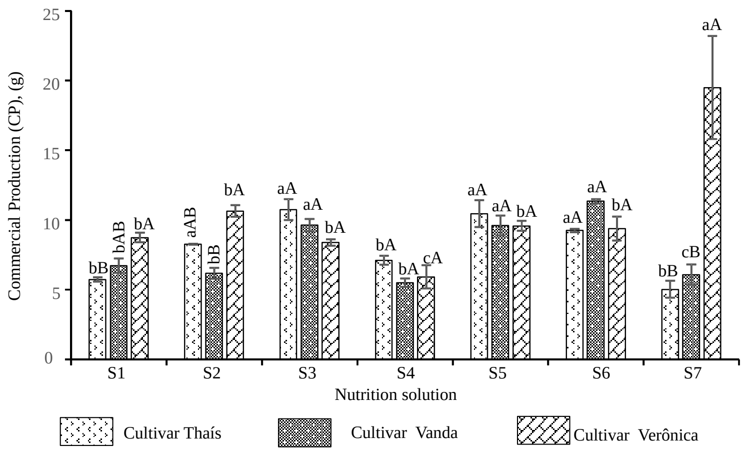

Fig 4. Commercial production (CP) of lettuce due to the unfolding of the interaction between nutrient solutions S_1; S_2; S_3; S_4; S_5; S_6 and S_7 and cultivars Thais, Vanda and Veronica. Means followed by the same letter do not differ solutions within the same cultivar and means (test Scott Knott) followed by the same capital letter do not differ cultivars within the same solution (test Tukey). S_1 = Furlani solution; S_2 = domestic wastewater; S_3 = optimized domestic wastewater, S_4 = well water S_5 = optimized well water; S_6 = Reactor wastewater and S_7 = optimized wastewater solution of reactor.

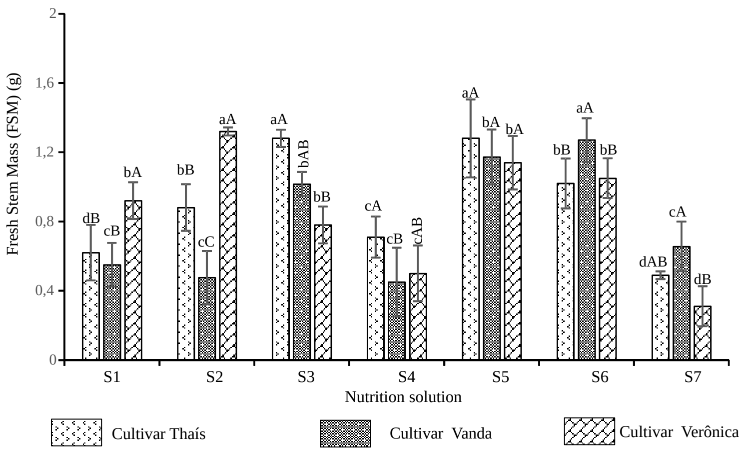

Fig 5. Fresh Stem Mass (FSM) of lettuce cultivars due to the unfolding of the interaction between mineral nutrient solutions S_1; S_2; S_3; S_4; S_5; S_6 and S_7 in cultivars of curly lettuce. Means followed by the same letter do not differ solutions within the same cultivar and means (test Scott Knott) followed by the same capital letter do not differ cultivars within the same solution (test Tukey).. S_1 = Furlani solution; S_2 = domestic wastewater; S_3 = optimized domestic wastewater, S_4 = well water S_5 = optimized well water; S_6 = Reactor wastewater and S_7 = optimized wastewater solution of reactor.

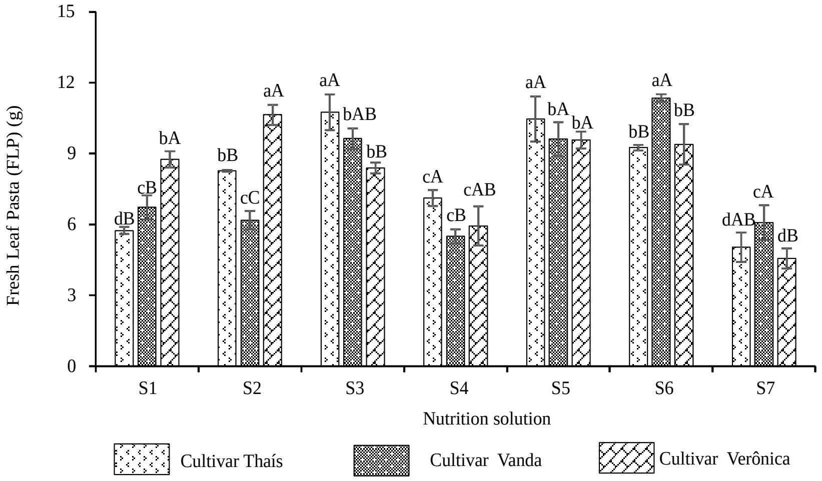

Fig 6. Fresh Leaf Mass (FLM) due to the unfolding of the interaction between nutrient solutions S_1; S_2; S_3; S_4; S_5; S_6 and S_7 and cultivars of in curly lettuce Thais, Vanda and Veronica. Means followed by the same letter do not differ solutions within the same cultivar and means (test Scott Knott) followed by the same capital letter do not differ cultivars within the same solution (test Tukey). S_1 = Furlani solution; S_2 = domestic wastewater; S_3 = optimized domestic wastewater, S_4 = well water S_5 = optimized well water; S_6 = Reactor wastewater and S_7 = optimized wastewater solution of reactor.

reactor (S6), with average match 11.96, 29.12 and 13.23 mm, respectively (Fig.2). Fig. 2, shows that the Veronica cultivar have highest mean values in solutions Furlani (S_1), domestic wastewater (S_2), optimized domestic wastewater (S_3), optimized well water (S_5) and wastewater solution from the UASB reactor (S_6), with averages corresponding to 13.83, 13.03, 12.09, 12.50 and 12.81mm, respectively.

Monteiro Filho et al. (2017) worked on the hydroponic production of lettuce using nutritive mineral and organo-mineral solutions (with the use of biofertilizer composition) and found a significant difference between stem diameter with the use of organo-mineral and solutions. As for the cultivars, the largest stem diameter was obtained by the cultivar Veronica, which was statistically different from the cultivars Vanda and Thais.

The stem diameter values observed in this study were higher than the average of 9.4 mm reported by Gonçalves et al. (2010) in a study of fertilizer levels in the culture of lettuce with localized irrigation system. Regarding the use of organic products for lettuce nutrition, Santi et al. (2013) evaluated the agronomic performance of lettuce fertilized with filter cake (residue of sugar and alcohol industrial) and 150-300-90 kg ha^{-1} of N-P-K in a protected environment and found values of 18, 17 and 16 mm for and stem diameter of cultivars Rafaela, Julia and Tainá, respectively. These results are equivalent to those found in the present study on the cultivars Thaís, Vanda and Veronica.

Beyond the agricultural point of view, the stem diameter is an important parameter for the process industry. According to Bueno (1998), the stem length and stem diameter are two characteristics of relative importance for lettuce cultivation, since larger diameter stems are undesirable. Mota et al. (2002) emphasized that fast food companies prefer plants with the stem removed easily, since it is manually removed for subsequent slicing of the head.

Comparing cultivars within the same solution, it can be seen in Fig. 2 that the stem diameter shows a significant difference only with the use of well water (S4), whereas the cultivar Vanda had lower average value of 8.72 mm and solution optimized wastewater from the UASB reactor (S7) 10.00mm.

Total production (TP) and commercial production (CP)

Fig. 3 shows the largest values of the total production (TP) for cultivar Thaís under optimized domestic wastewater solutions (S_3) and optimized well water (S_5) with averages of 151.5 to 141g / plant, respectively. As for the Vanda cultivar the highest value was found using wastewater solution of UASB (S_6) with average value 168.5g/plant and the best result for cultivar Veronica with the domestic wastewater solution (S_2) of 14.83g / plant.

The results obtained in this study were higher than those obtained by Monteiro Filho et al (2014), where they worked with the replacement of up to 16% of the mineral nutrient solution by biofertilizers and observed 2.4g/plant of lettuce using mineral solution.

Fig. 4 shows that the cultivar Thaís has higher commercial production (CP) using optimized domestic wastewater (S_3), optimized well water (S_5) and the wastewater solution from the UASB (S_6) with averages of 149, 141 and 97.66g/plant, respectively. The cultivar Vanda showed the highest average under the use of domestic wastewater (S_3), optimized well water (S_5), and wastewater from the UASB reactor (S_6) with averages of 109.5 110 66 and 168.50g/plant. For Veronica cultivar the largest commercial production (CP) was occurred when wastewater (S_2) was used with average 142.33g/plant.

Comparing the nutrient solutions on all cultivars we found that the well water (S_4) showed the lowest commercial production (CP).

Fresh stem mass (FSM) and fresh leaf mass (FLM)

Fig. 5, shows a higher fresh stem mass (FSM) for the cultivar Thais when we used the solutions: optimized domestic wastewater (S_3) and optimized well water (S_5) with 19.46 and 24.80g, respectively. For cultivar Vanda the largest value of the average was observed using optimized domestic wastewater (S_3) and optimized well water (S_5), with averages of 20.21 and 17.20g. Fig. 5 also indicates that cultivar Veronica has higher fresh stem mass (FSM) when irrigated with domestic wastewater (S_2), with average of 21.14g.

We observed in Fig. 6 that the higher fresh leaf mass (FLM) for cultivar Thaís was obtained under optimized domestic wastewater (S_3) and optimized well water (S_5) with averages of 129.54 and 116.20. Focusing on Vanda the best performance for the Fresh Leaf Mass (FLM) was occurred with the use of wastewater solution from the UASB reactor (S_6) with average value of 148.28g. Furthermore, from Fig. 6 we can see that the highest production of fresh leaf mass (FLM) belongs to cultivar Veronica when the domestic wastewater (S_2) solution was used producing average of 121.19g. These results are approximate to those obtained by Verdade et al. (2003), which they obtained in their experiment with lettuce in summer season, the average result for fresh leaf mass were 113 g/plant in a conventional greenhouse and 112 g/plant in a heated greenhouse.

Materials and methods

Experimental area location

The study was conducted in a protected environment on the premises of the State University of Paraíba-UEPB campus II of Lagoa-Seca-PB having the following coordinates: 7 ° 10 '15 "S 35 ° 51' 14" N, according to the classification climate of Köppen Geige (Brazil, 1971) and led hydroponically adopting the nutrient film technique (NFT).

Experiment installation and conducting

The experimental design was a randomized block in a 7 x 3 split-plot with three replicates, whose factors were 7 hydroponic solutions with a conductivity of 1.7 $dS.m^{-1}$ and three lettuce cultivars. The solutions were formulated and optimized using Furlani (1995) as a reference nutrient. The main plots were comprised of nutrient solution (S). S_1 = Furlani solution; S_2 = domestic wastewater; S_3 =optimized domestic wastewater; S_4 = well water; = S_5 optimized well water; S_6 = wastewater from the UASB reactor and S_7 = optimized wastewater from the UASB reactor and the subplots was constituted of three lettuce cultivars (Verônica, Vanda and Thais).

The water in the experiment was obtained from rain stored in tanks (for S_1 solution), raw sewage from the city of Lagoa Seca PB, tubular well of brackish water drilled for groundwater capture rural municipality Lagoa Seca-PB, and wastewater from the UASB reactor from the Experimental Biological Sewage Treatment Station (Extrabes) Campina Grande-PB. The waste water samples were sent for chemical analysis to Irrigation and Salinity Laboratory (LIS/DEAg/UFCG) and Soil analysis Laboratory, Water and Plant Agricultural Research Company in Rio Grande do Norte S/A - EMPARN. Tables 2 and 3 and 4 describe the chemical and physical characteristics of the effluents and waters used in the experiment.

Evaluated characteristics

The characteristics were evaluated for the following parameters 30 days after transplanting:

Number of sheets (NS) by counting the number of sheets of commercial production starting with the basal leaves until the last open leaf and stem diameter; (SD) was obtained by direct measurement with the aid of digital caliper. Total Production (TP): consisted of fresh mass production of shoots (stems and leaves) determined with the aid of a semi-analytical balance; Commercial production (CP): consisted of the production of fresh mass of shoots (stems and leaves) disregarding the yellowing leaves, dried and/or attacked by pests and diseases. It is determined with the aid of a semi-analytical balance; Fresh Stem Mass (FSM) and Fresh Leaf Mass (FLM): After determining the commercial production we determined the fresh mass production of stems and leaves, with the aid of a semi-analytical balance.

Statistical analysis

Data were subjected to analysis of variance by F test at 1 and 5% probability. When statistical significance were observed, the average values of subplots (cultivars) compared by Tukey's test at 5% probability and between solutions by regression using the statistical software SISVAR (Ferreira, 2014).

Conclusion

Solutions of domestic wastewater (S_2), optimized domestic wastewater (S_3), optimized well water (S_5) and the wastewater solution from the UASB reactor (S_6) promoted Number of sheets (NS) in all three cultivars. The highest values of Total Production (TP) for Thaís were found when we used the optimized domestic wastewater (S_3) and optimized well water (S_5). As for the Vanda cultivar the highest value was found with the use of wastewater solution from the UASB solution (S_6) and to Veronica was with the domestic wastewater (S_2). The highest values of commercial production (CP) for Thaís were found when we used the optimized domestic wastewater (S_3) and optimized well water (S_5). As for the Vanda cultivar the highest value was found with the use of wastewater solution from the UASB reactor (S_6) and for cultivar Veronica using the domestic wastewater solution (S_2).

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