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Performance of two lettuce cultivars under different amounts of irrigation in protected environment

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Abstract: The scarcity of information on the demand of water for the cultivation of vegetables, such as lettuce, in protected environment, especially with regard to the adequate management of irrigation, limits productive performance. The objective of this study was to evaluate the effect of different irrigation slides on two cultivars of lettuce in protected environment. The experiment was conducted in Chapadinha - MA, from March to May 2017. The cultivars of lettuces used were Brava and cv. Grand Rapids-TBR, in a completely randomized experimental design with 5 treatments consisting of irrigation blades: 6.0, 12.0, 16.5, 19.5 e 31.8 mm corresponding to the tensions 6, 10, 15, 30, e 50 kPa, respectively, and five replications, totaling twenty-five plots per cultivar. The following variables were analyzed: plant height, stem diameter, number of leaves, root volume, fresh shoot mass, shoot dry weight, fresh root mass, root dry mass and root length. For the cultivar Brava, the irrigation blade for tension of 50kPa, recorded the highest absolute yield of fresh and dry mass of the shoot, with averages of 65.99 g and 7.68 g, respectively. Likewise, for the cultivar cv. Grand Rapids-TBR, the 50 kPa strain also provided the highest numerical estimate for fresh and dry shoot mass, 129.09 g and 51.03 g, respectively. The blades corresponding to the tensions of 6 and 10kPa, consumed about 18 mm per plant more than the tension of 50 kPa, for both cultivars. In an equivalent way, the fresh mass of the aerial part had greater increase in the tension of 50 kPa (65.99 g).
Keywords: Vegetables, (*Lactuca sativa L.*), Tensiometry.

Introduction

Lettuce (*Lactuca sativa L.*) is the most widespread leafy vegetable nowadays grown in almost all countries (SILVA et al., 2013). Lettuce is of great importance in human food, as it is a source of vitamins and minerals, and it is considered the most consumed leafy vegetable in the country. (ZIECH et al., 2014). Its consumption is due to not only to the taste and nutritional quality but also to the ease of purchase and low cost to the consumer (OLIVEIRA et al., 2004).

It is estimated that the total area exploited with vegetables in Brazil is 800 thousand hectares, with an approximate production of 16 million tons (BISCARO et al., 2013). To the culture of lettuce, the intended area is approximately 35,000 hectares, under intensive production modalities and by family producers (SOUSA et al., 2014). Nationally, the most economically important lettuce is crespa, having a 70% preference in the market, followed by the american (15%), lisa (10%) e romana (5%) (SUINAGA et al., 2013).

Coming from a temperate climate, the adapt to high temperature and light locations are obstacles to its growth, impeding it to express its all genetical potential (SETÚBAL & SILVA, 1992). In the Northeast region of Brazil, the cultivation of this vegetable is limited to small areas, with the use of cultivars little adapted to the climatic conditions of the region, contributing to the early flowering and low productivity (QUEIROGA et al., 2001).

In this sense, cultivation in a protected environment with the use of polypropylene (sombrite) screens is necessary, since it reduces the direct incidence of sunlight on species that require smaller radiant energy flow.

In a protected environment, with a higher shading, lettuce presents greater productivity, due to the lower intensities of global and reflected irradiations and the greater diffuse radiation to produce larger leaves, as well as an increase in the amount of mass per plant. (RADIN et al., 2004).

Despite the importance of cultivation in a protected environment for Brazilian olericulture, the exiguous research results do not support the exploitation of the potential of this technology in the different climatic regions of the country, especially with regard to proper irrigation management (LIMA JUNIOR, et al., 2012).

As it is a water-demanding vegetable, proper irrigation management is needed both to supply crop water needs and to minimize

unnecessary spending and disease problems. Irrigation is a fundamental technique under protected environment, however, the use of incorrectly dimensioned blades and inefficient crop management can make the production process unfeasible (BILIBIO et al., 2010).

In the east of Maranhão, especially in the municipality of Chapadinha, in order to the lettuce cultivation growing and becoming a more expressive practice, further studies are required involving irrigation management, empowering the use of water for cultivation. Thus, the aim of this study was to evaluate the effect of different irrigation depths on two

Methods

The experiment was conducted from March to May 2017, in a greenhouse in the experimental area of the Center for Agricultural and Environmental Sciences of the Federal University of Maranhão, in the municipality of Chapadinha-MA, having the geographical coordinates: "03º44'28,7" S and "43º18'46" W and 107 m average altitude. The weather, according to Thornthwaite, is of the type $C_2s_2A'a'$, that is, subhumid, megathermal with great water deficiency in summer, with annual average temperature of 27.9 °C and rainfall that reaches annual average values of 1613.2 mm (PASSOS et al., 2016).

The soil used was a Dystrophic Yellow Latosol (SANTOS et al. 2013), mean texture, whose chemical characteristics are: pH = 5.4; M.O = 13 g dm^{-3}; P = 13 mg dm^{-3}; K = 2.9 cmolc dm^{-3}; Ca = 20 cmolc dm^{-3}; Mg = 13 cmolc dm^{-3}; Sum of Bases = 35.9 cmolc dm^{-3}; H+AL = 20 cmolc dm^{-3}; CTC = 55.9; and V = 64%. The soil was extracted and arranged in 10-liter pots, where fertilization was carried out, incorporating 0.3 g/pot of N, in the form of urea, 1.23 g/pot of P, with triple superphosphate, 0.18 g/pot of K, with potassium chloride and 140 g/pot sheep dung, obtained by the 5th approximation method (ALVAREZ et al., 1999).

Two cultivars were used, the crespa lettuce cv. Grand Rapids-TBR, which has a 50-day summer and 70-day winter cycle, light green loose-headed leaves with a large head 20-30 cm and bulky, tolerant to marginal burning. light green loose-headed leaves with a large head 20-30 cm and bulky, tolerant to marginal burning. Brava lettuce, which has a cycle of 50 days in summer and 60 days in winter, less curly leaves, however, larger plant, bright green, heat resistant.

Sowing was carried out in polyethylene trays containing 128 cells, two seeds were deposited in each cell, the commercial substrate PLANTMAX was used for germination. The experiment was organized in four rows 2 m long and 0.75 m wide, with a spacing between rows of 0.25 m and between plants of 0.10 m.

The experimental design for each cultivar was completely randomized with 5 treatments consisting of the blades: 6 mm, 12 mm, 16.5 mm, 19.5 mm and 31.8 mm, corresponding to stresses 6, 10, 15 30 and 50 kPa, respectively and five repetitions, totaling twenty-five plots per cultivar. Irrigation Blades were calculated according to Equation 1.

$$L = \frac{\theta_{CC} - \theta_{UC}}{10} Z \qquad \text{Eq. (1)}$$

Where:
L - irrigation blade (mm);
θcc - field capacity humidity (decimal);
θuc - crop critical humidity (decimal);
Z - effective depth of root system (cm).

The pots were irrigated with 6 mm blade, corresponding to a tension of 6 kPa, for a period of 15 days at intervals of 2 days to maintain soil moisture, all were kept in the field capacity until the beginning of the treatments. Irrigation consisted in frequencies of twice a day for the 6 kPa voltage, once a day for the 10 kPa voltage and for the other voltages (15, 30 and 50 kPa) in a 48-hour interval.

Thinning occurred 07 days after sowing (DAS) and transplanting was made when the plants presented 03 definite leaves. Weeds were removed manually and pest control was carried out by spraying 150 mL of Neem oil diluted with 1.5 L of water as a defensive, the application occurred on April 30.

Harvesting was carried out at 45 DAYS, period the culture concluded the vegetative stage. The total blades computed at the end of the experiment were 336 mm (6 kPa), 336 mm (10 kPa), 165 mm (15 kPa), 195 mm (30 kPa) and 318 mm (50 kPa) for both cultivars.

Finally, the following variables were evaluated: plant height (AP), stem diameter (DC), number of leaves (NF), root length (CR), root volume (VR) fresh root mass (MFR) and fresh shoot mass (MFPA). The shoot part and root system, after weighing separately, were dried in a forced air oven at 60 °C for 48 hours to obtain the shoot part dry mass (MSPA) and root dry mass. (MSR).

The data obtained were submitted to analysis of variance and the comparison of means by Tukey test at 5% significance level through the computer program InfoStat (DI RIENZ0, 2016).

Results and discussion

Regarding cultivar Brava, the results are shown in Table 1. The plant height was higher for the tension of 50 kPa (36.10 cm), but with similar

performance to the tensions of 10 and 30 kPa, not differing statistically.

Higher shoot dry matter yield was observed at 50 kPa, 7.68 g, with the statistically significant difference in relation to the others that presented similar performance ($p>0.05$). In a similar manner, the fresh mass of the shoot part had a higher increase in the tension of 50 kPa (65.99 g), however, no difference was found in relation to the 6 kPa. Corroborating with Magalhães et al. (2015) that with the increase of the irrigation blade (higher tension), reported an increase of fresh mass from shoot part to cv. Monica.

Table 1. Plant height (PH) (cm), Stem diameter (SD) (mm), Root volume (VR) (cm), Number of Leaves (NL), Fresh shoot mass (FSM) (g), Root length (RL) (cm), Fresh root pasta (FRP) (g), Dry shoot mass (DSM) (g), Root dry weight (RDW) (g) of Brava cultivar as a function of different irrigation blades.

Variables	Tensions/Blades					CV(%)
	6 kPa 6.0 mm	10 kPa 12.0 mm	15 kPa 16.5 mm	30 kPa 19.5 mm	50 kPa 31.8 mm	
PH	16.30b	24.10ab	16.90b	25.10ab	36.10a	35.16
SD	9.02a	10.03a	8.26a	8.07a	12.08a	22.46
VR	6,60a	6.40a	7.00a	6.20a	8.20a	43.61
NL	12.20a	14.20a	10.60a	12.80a	19.20a	34.99
FSM	49.95ab	39.75b	43.40b	38.57b	65.99a	19.56
RL	16.46a	23.30a	19.30a	19.40a	21.70a	44.03
FRP	6.48b	6.37b	6.84ab	5.72b	10.02a	24.11
DSM	3.61b	3.73b	3.91b	4.18b	7.68a	15.69
RDW	0.75bc	0.53bc	1.26a	0.47c	0.93ab	27.85

Means followed by equal letters in the lines do not differ from each other by the Tukey test at 5% significance level.

Concerning the variable fresh root mass, it found out high means to the highest tension, with an estimate of 10.02 g, being statistically equated only the tension of 15 kPa, means of 6.84 g. The root dry mass expressed higher significant yield in the 16.5 mm (15 kPa) blade but did not differ from the 31.8 mm (50 kPa) blade with averages of 1.26 and 0.93 g, respectively. The worst absolute performance was found for the 19.5 mm (30 kPa) blade.

The variables stem diameter, root volume, number of leaves and root length showed no response to the treatments ($p> 0.05$), diverging from the results obtained by Santos et al. (2015), who observed contributions in the number of leaves production, according to the different water depths. Valeriano et al. reported a significant difference between irrigation blades applied to leaf number and stem diameter.

For all treatments of Brava cultivar, it found the presence of seedlings, especially for the tension of 50 kPa (31.8 mm). It is presumed to had have occurred due to problems regarding the adaptation of the cultivar to the conditions of the growing environment.

Table 2 shows the results measured for cv. Grand Rapids – TBR cultivar. For the shoot dry mass, the treatment with the tension of 50 kPa (31.8 mm) recorded higher mean (51.03 g) differing statistically from the remaining ones. The 10, 15 and 30 kPa voltages represented intermediate performance, while the 6 kPa voltages had lower yield for this variable. Magalhães et al. (2015) reported lower dry mass of shoots in the largest irrigation blades.

Fresh shoot mass also showed a higher yield at 50 kPa (129.09 g), followed by 10 kPa (81.47 g), diverging statistically from each other. The remaining tensions expressed means with statistical similarities, according to Table 2.

The variables number of leaves, fresh root mass and root dry mass estimated higher mean values at 50 kPa, when compared to the immediately lower voltage, differing statistically from each other (Table 2). There was no significant difference between treatments for stem diameter and root length.

The plants irrigated with the tensions of 6 and 10 kPa, although subjected to different irrigation intervals, twice a day and once a day, respectively, consumed the same amount of water. Treatments with 6 mm (6 kPa) and 12 mm (10 kPa) blades required water content approximately 18 mm per plant above the 31.8 mm (50 kPa) treatment for both cultivars.

Root dry mass and shoot dry mass were the characteristics that showed higher variability in each treatment, according to the coefficient of variation. In another hand, the fresh shoot mass presented the lowest instability. Studies with hydroponic cultivation show lower values on the coefficient of variation (CV) of the characteristics of shoot dry mass and root dry mass, showing that are influential variables with the availability of available water.

Table 2. Plant height (PH) (cm), Stem diameter (SD) (mm), Root volume (VR) (cm), Number of Leaves (NL), Fresh shoot mass (FSM) (g), Root length (RL) (cm), Fresh root pasta (FRP) (g), Dry shoot mass (DSM) (g), Root dry weight (RDW) (g) of Grand Rapids cultivar as a function of different irrigation blades.

Variables	Tensions/Blades					
	6 kPa 6 mm	10 kPa 12 mm	15 kPa 16.5 mm	30 kPa 19.5 mm	50 kPa 31.8 mm	CV(%)
PH	8.90b	8.20b	9.50b	12.87ab	12.30a	24.36
SD	11.69a	13.53a	11.42a	13.66a	15.57a	25.19
VR	7.80c	12.60a	8.40bc	8.75abc	12.20ab	21.12
NL	22.80ab	24.00ab	22.40ab	20.25b	32.80a	21.84
FSM	65.50bc	81.47b	65.69bc	58.74c	129.09a	15.31
RL	20.60a	24.10a	23.10a	28.13a	25.80a	25.29
FRP	8.28ab	11.26ab	9.18ab	7.36b	12.26a	22.43
DSM	4.82c	17.49b	25.59b	23.43b	51.03a	26.74
RDW	0.91ab	0.79ab	0.61ab	0.51b	1.02a	32.12

Means followed by equal letters in the lines do not differ from each other by the Tukey test at 5% significance level.

Conclusion

The irrigation blades corresponding to 50 kPa provided the highest absolute yield of the fresh and dry shoots mass under protected environment for Brava and cv. Grand Rapids-TBR. Tensions of 6 and 10 kPa consumed an additional 18 mm per plant compared with 50 kPa for both cultivars.

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