PERFORMANCE OF LETTUCE PLANTS: EFFECT OF THE PERCENTAGE OF WATER AVAILABLE IN THE SOIL AND CULTIVARS

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ABSTRACT: It is of great interest the development of research that subsidizes its cultivation in protected environment in the different climatic regions of the country, especially those necessary for the proper management of irrigation. There fore, the objective of this study was to evaluate the effect of water stress caused by the reduction of water availability in the soil on lettuce development and production in a protected environment. The experiment was conducted in a greenhouse at the State University of Goiás - UEG, Camps Ipameri. The treatments were composed of the combination of cultivars (Lettuce Americana Delicia and Lettuce Rainha de Maio "Butter") x percentage of available water in the soil (20, 40, 60, 80 and 100 %) In four blocks, comprising 40 experimental units, consisting of $4dm^{-3}$ vessels. They were evaluated at the time of harvest: plant height; collecting diameter; number, length and width of leaves; Fresh and dry mass of shoot and root; area occupied and root length. The cultivar Alface Americana Delicia, in spite of having a smaller number of leaves presented performance in relation to the development of the aerial part under the effect of water stress. Independent of the cultivar the highest MFPA was obtained with the percentage of water replenishment of 63.97%.

KEYWORDS: Hydrical stress; water blade; management.

DESEMPENHO DE PLANTAS DE ALFACE: EFEITO DO PERCENTUAL DE ÁGUA DISPONÍVEL NO SOLO E CULTIVARES

RESUMO: É de grande interesse o desenvolvimento de pesquisas que subsidiem o cultivo da alface em ambiente protegido nas diferentes regiões climáticas do país, notadamente aqueles necessários ao adequado manejo da irrigação. Sendo assim, o objetivo deste estudo foi de avaliar o efeito do estresse hídrico provocado pela redução da disponibilidade de água no solo sobre o desenvolvimento e produção da alface em ambiente protegido. O experimento foi conduzido em casa de vegetação instalada, na Universidade Estadual de Goiás – UEG, Camps Ipameri. O delineamento adotado foi o em blocos casualizados em esquema fatorial, cujos tratamentos foram compostos da combinação de cultivares (Alface Americana Delicia e Alface

Rainha de Maio “Manteiga”) x percentual de água disponível no solo (20, 40, 60, 80 e 100%), em quatro blocos, perfazendo 40 unidades experimentais, constituídas de vasos de $4dm^{-3}$. Foram avaliados no momento da colheita: altura de planta; diâmetro do coleto; número, comprimento e largura de folhas; massa fresca e seca da parte aérea e de raiz; área ocupada e comprimento de raiz. A cultivar Alface Americana Delicia, apesar de ter menor número de folhas apresentou desempenho no que tange o desenvolvimento da parte aérea quando sob efeito de estresse hídrico. Independente do cultivar a maior MFPA foi obtida com o percentual de reposição de água de 63,97%.

PALAVRAS-CHAVE: Estresse hídrico; lâmina de água; manejo da irrigação.

INTRODUCTION

Lettuce (*Lactuca sativa*), which originated from wild species, can be found in temperate regions of Southern Europe and Western Asia (FILGUEIRA, 2003). It can be considered an excellent source of vitamins and minerals, showing its high content of vitamin A, in addition to vitamins B1 and B2, vitamins C, calcium and iron (FERNANDES et al., 2002).

Lettuce is a herbaceous, sensitive plant with a tiny stem, to which the leaves are attached. They grow in the shape of a rosette, around the stem, and can be smooth or curly, forming a head or not, (FILGUEIRA, 2003).

The culture is widely distributed in Brazil, standing out as a culture of great economic and food importance (RESENDE, et al 2003). Lettuce is the most important hardwood in Brazil with a planted area of approximately 35 thousand ha. With the great commercial competitiveness of horticulture in the world scen forced the producers to seek a better quality in their product, this goal can only be achieved with the technological changes available in the market.

Being the most appreciated hardwood crop, its consumption occurs preferably in the in natura form (SILVA et al., 2011). Protected cultivation can reduce problems with pests and diseases and suppress the risk of losses due to frost or heavy rains (DOS SANTOS, 2004). In general the vegetables have their development quite influenced by the humidity conditions in the soil. In Brazil, where there are large regions with water deficiency and irregular distribution of rainfall, the importance of the use of water for irrigation in general olive production is perceptible.

Water deficit and the limiting factor in the growth of productivity and the improvement of the quality of these products, since the excess can become harmful.

The correct use of irrigation is of extreme importance for the need of each crop, but also helps to reduce the problems of diseases, excessive energy and water costs (KOETZ et al., 2006).

The cultivation in protected environment has been a widely used alternative, presenting a good development of vegetables increasing production and maintaining its cultivation throughout the year. Crops in protected environments differs from field production systems, as it has partial control of environmental factors. The proper management of the water-soil-plant-environment system is of extreme importance in order to obtain satisfactory results in the enterprise (CARRIJO et al., 1999). In cultivation in protected environment the evapotranspiration is lower than the one verified in external environment, because the entrance of solar radiation and the wind is reduced (BANDEIRA et al ,2011).

The cultivation in protected environment became of great importance for the production of lettuce in Brazil, as the research shows different technology for each type of climatic regions presenting adapted irrigation managements becoming economically viable (VILAS BOAS et al. 2008).

This work has as purpose the commercial evaluation of the lettuce being submitted to different irrigation slides in the greenhouse.

MATERIALS AND METHODS

The experiment will be carried out in a greenhouse at the State University of Goiás - UEG, Ipameri Camps. At 17º43' South latitude and 48º22' West longitude and 800 m altitude. The climate of the region according to the classification of Köppen is defined as Tropical Humid (AW), consisting of high temperatures with rains in summer and dry in winter.

The conduction of the experiment will be in March and April 2017, where polyethylene plastic vases with a diameter of 23 cm, a diameter of 19 cm and a height of 22.5 cm will be used.

The type of soil to be used was classified as Dystrophic Red-Yellow Latosol (EMBRAPA, 2006). The soil was destorroado, passed in 2 mm sieve and homogenized. The application of chemical fertilizers in the vessels performed according to the methodology proposed by NOVAIS et al., (1991) for controlled environment.

The experiment will be installed in a randomized complete block design, analyzed in a 2 x 5 factorial scheme with four replications. The cultivars will be sown in styrofoam trays of

expanded polystyrene and after 15 days of emergency will be transplantation to the vessels. The water deficit will be started 3 days after transplanting, to allow the plants to settle.

The irrigation slides will be based on the weighing lysimetry, where a known volume of water will be placed. Irrigations will be based upon determination of the weight of each experimental unit in the field capacity. Before sowing, the vessels will be saturated with water and left in free drainage until they reach the moisture in the field capacity. Always at the end of the afternoon of each day, the experimental units will be weighed in an electronic scale, replenishing the water necessary for each treatment, ie in the 100% AD blade, water will be returned to the initial weight (weight in the field capacity), For the other irrigation slides (20, 40, 60 and 80% AD) a simple three rule will be done to obtain the amount of water to be replenished to reach the amount of available water in the desired soil.

In the experiment, the variables corresponding to the lettuce (*Lactuca sativa*).

- ✓ Mass of the fresh matter of the aerial part: The aerial part of each plant will be separated from the roots and weighed in a digital scale. Therefore, leaves and stems will be considered, as is usually sold in trade. Only the outer leaves were removed in the process of senescence.
- ✓ Fresh matter mass of the roots: Roots will be separated and weighed individually, per plant.
- ✓ Aerial part dry matter mass and roots were obtained by weighing the individual parts after drying in an oven with forced air circulation at 65ºC for 72 hours. To obtain the mass of the dry matter of the aerial part only the dry masses of leaves and stems were added.
- ✓ Stem diameter: Obtained by measuring the cross section of the root, with the aid of a digital caliper, with a precision of 0,01 mm, in sampling all stems per plot expressed in mm
- ✓ Total number of leaves: The total number of leaves obtained by counting the number of leaves of each plant.
- ✓ Root length: Obtained by quantifying the longitudinal length of the root, with the aid of a graduated ruler, in the sampling of all roots per plot, expressed in cm.
- ✓ Height of plant: Estimated through a ruler graduated in cm.
- ✓ Leaf area (CxL): Estimated by a ruler graduated in cm.

With the obtained data will be carried out statistical analyzes through the test F and when significant apply if the regression analysis.

RESULTS AND DISCUSSION

Table 1 shows the significant F values at the 5% probability level for percentages of available water in the soil (% water), cultivars and their interactions under the productive characteristics of lettuce grown in protected environment: Leaf number (LN); Fresh aerial mass part (FAMP); Area occupied by a lettuce plant (Area); Length root (LR) Sheet length (SL) Leaf width (LW).

The LN, SL, LW, FAMP and occupied area varied according to the cultivar of lettuce cultivated, regardless of the percentage of water available in the soil, as observed in Table 2. The 'Queen' Mayan 'Butter' lettuce presented a larger number of leaves, these were less long and broader than the cultivar Americana Delícia, which represented the smaller area occupied by a plant, characteristics, these are typical of the cultivars evaluated.

Figure 1 shows the quadratic adjustment equation for the effect of the percentage of available water in the soil under the FAMP of lettuce cultivars cultivated in a protected environment. It should be noted that the adjustment of the equation in relation to the observed data, given by the coefficient of determination was 0.9447, and the coefficients of the quadratic equation was significant at the 5% probability level. Evaluating the equation, it can be seen that the percentage of available water that provided the greatest accumulation of fresh mass of the aerial part was 63.97%. Result that indicates that the lettuce has losses in the accumulation of FAMP when in excess or deficiency of water available in the soil.

As reported by Lima Junior et al. (2011) excess moisture around the root system of the lettuce plant, makes it difficult to aerate, and causes physiological anomalies of origin, as well as losses of nutrients by leaching, which can considerably reduce their total production (FILGUEIRA, 2008). However, Vila Boas et al (2008) Evaluated the production of two cultivars of crisp type lettuce as a function of water replacement slides, and the maximum commercial production was obtained with the replacement of 123.7%. And this non-efficiency of 100% water absorption is justified by the authors due to the existence of losses by percolation, redistribution of water in the soil, areas with water deficit.

Figure 2 shows the equation of quadratic adjustment regarding the effect of the percentage of available water in the soil under the LR of lettuce cultivars in protected environment. It should be noted, based on the fit of the equation, that only 43.28% of the root length can be explained by the percentage of water replenishment in the soil. Evaluating the equation, we can see that the percentage of available water that provided the greatest root growth was 61.69%.

CONCLUSIONS

The cultivar Lettuce Americana Delicia, in spite of having a smaller number of leaves presented performance in relation to the development of the aerial part under the effect of water stress. Independent of the cultivar the highest MFPA was obtained with the percentage of water replenishment of 63.97%.

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Table 1. Values of F of the analysis of variance of the percentage of available water without soil (% water), cultivars and their interactions (Cultivation x% water) under productive characteristics of lettuce grown in protected environment.

SV	FD	LN	SL	LW	FAMP	Area	LR
Grow crops	1	25,79 **	13,92 **	28,49 **	20,09 **	7,71 **	2,36 ^{ns}
% water	4	3,49 ^{ns}	3,92 *	0,59 ^{ns}	2,84 *	1,69 ^{ns}	4,27 **
Grow crops x % water	4	1,09 ^{ns}	2,05 ^{ns}	1,69 ^{ns}	1,19 ^{ns}	2,03 ^{ns}	1,62 ^{ns}
Block	3	0,09 ^{ns}	1,13 ^{ns}	0,44 ^{ns}	1,14 ^{ns}	1,69 ^{ns}	0,43 ^{ns}
Error	27	-	-	-	-	-	-
CV (%)	-	24,62	19,21	23,97	44,32	35,71	17,6

SV: Source of variation; CV: Coefficient of variation; LN: Length numbrer; SL: Sheet length; LW: Leaf width; FAMP: Fresh aerial mass part; Area: area occupied by a Lettuce plant; LR: Length root. ^{ns}: Not significant, ** e *, Significant at 1% e 5%, respectively, of probability by the F test.

Table 2. Length number (LN), Sheet length (SL), Leaf width (LW), Fresh aerial mass part (FAMP), Area occupied by a lettuce plant (Area) of two cultivars cultivated in protected environment and percentage of available water in the soil.

Cultivars	LN	SL (cm)	LW (cm)	FAMP (g)	Area (cm^2)
Lettuce Americana Delicia	10,55 b	11,30 a	8,99 b	69,67 a	471,80 a
Lettuce Rainha de Maio 'Manteiga'	15,75 a	9,00 b	13,55 a	36,37 b	343,90 b

* Means followed by the same letter in the column do not differ from each other by the F-test at 5% probability.

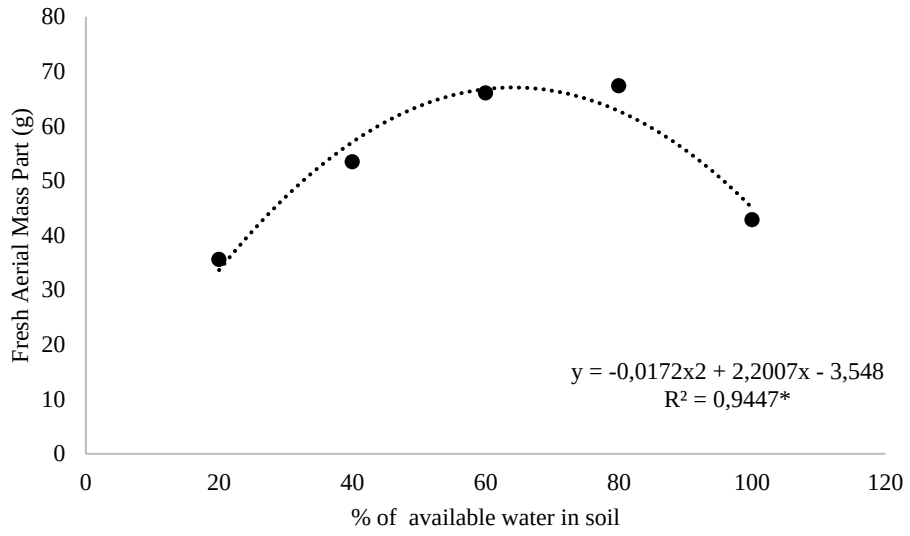

Figure 1. Fresh shoot mass of lettuce cultivars grown under protected environment under percentages of available water in the soil.

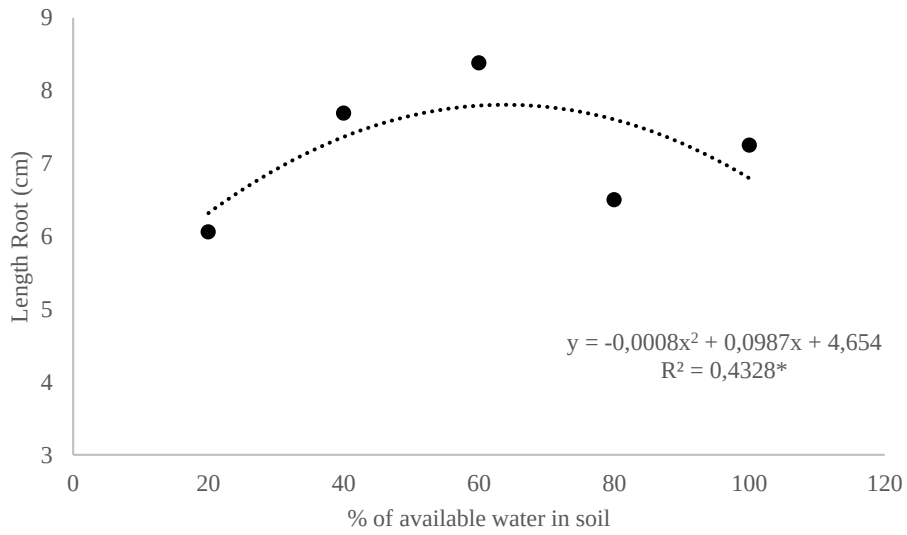

Figure 2. Root length of lettuce cultivars grown in protected environment under percentages of available water in the soil.