PRODUCTION IRRIGATED LETTUCE WITH WATERS SALINIZED

L. A. T. F. Feitoza¹, P. T. Carneiro², J. M. da Silva Júnior³, A. L. Santos Neto⁴, W. M. dos Santos⁵, J. M. dos Santos⁶

ABSTRACT: With the decline of the tobacco culture, horticulture became an agricultural activity of great economic and social importance in the arid zone of Alagoas, especially irrigated lettuce in variable quality of water are used; one of Brazil's Northeast features is the spatial and temporal variation in the quality of water resources. Still, there are few studies on the effects of water salinity in the production of vegetable crops in the region. In this work were studied in the experiment carried out in a greenhouse of UFAL/Campus Arapiraca, the effects of irrigation with salinity water on the lettuce yield 'Grand Rapids' obtained based on fresh biomass of shoot, 20 days salt stress. The five levels of electrical conductivity of the irrigation water (ECw) (ECw: 0.7, 1.4, 2.1, 2.8 and 3.5 dS m⁻¹ at 25 °C) were divided into blocks, with four replications. The yield of the lettuce dropped 9.26% per unit increase irrigation ECw from 0.7 dS m⁻¹ electrical conductivity. The value of ECw = 1.8 dS m⁻¹ was considered limit of salinity tolerance, considering a minimum yield of 90%.

Keywords: Lactuca sativa L., saline stress, water resources

PRODUÇÃO DE ALFACE IRRIGADA COM ÁGUAS SALINIZADAS

RESUMO: Com o declínio da cultura do fumo, a olericultura se tornou uma atividade agrícola de grande importância econômica e social no Agreste de Alagoas, sobretudo a alface irrigada em que são utilizadas águas de qualidade variada; uma das características do

¹ Graduanda em Agronomia da UFAL/Campus de Arapiraca, Arapiraca, AL. E-mail: layla_aniele@hotmail.com
² Prof. Adjunto da UFAL/Campus de Arapiraca, Arapiraca, AL. E-mail: ptcarneiro@yahoo.com.br
³ Prof. Voluntário da UFAL/Campus de Arapiraca, Arapiraca, AL. E-mail: jesseagronomo@yahoo.com.br
⁴ Prof. Adjunto da UFAL/Campus de Arapiraca, Arapiraca, AL. E-mail: santosneto@gmail.com
⁵ Graduando em Agronomia da UFAL/Campus de Arapiraca, Arapiraca, AL. E-mail: wellington.ca@hotmail.com
⁶ Graduando em Agronomia da UFAL/Campus de Arapiraca, Arapiraca, AL. E-mail: jms.teagricola@hotmail.com
Nordeste do Brasil é a variação espacial e temporal da qualidade dos recursos hídricos. Mesmo assim, são escassos os trabalhos referentes aos efeitos da salinidade da água na produção de olerícolas na região. Neste trabalho estudaram-se, em experimento desenvolvido em casa de vegetação da UFAL/Campus de Arapiraca, os efeitos da irrigação com águas salinizadas sobre o rendimento da alface ‘Grand Rapids’, obtido com base em fitomassa fresca da parte aérea, aos 20 dias de estresse salino. Os cinco níveis de condutividade elétrica da água (CEa) de irrigação (CEa: 0,7, 1,4, 2,1, 2,8 e 3,5 dS m⁻¹ a 25 ºC) foram distribuídos em blocos ao acaso, com quatro repetições. O rendimento da alface diminuiu 9,26% por aumento unitário de CEa de irrigação, a partir de 0,7 dS m⁻¹ de condutividade elétrica. O valor de CEa = 1,8 dS m⁻¹ é considerado limite de tolerância à salinidade, considerando-se um rendimento mínimo de 90%.

**Palavras-Chave:** Lactuca sativa L., estresse salino, recursos hídricos.

**INTRODUCTION**

The city of Arapiraca,- AL for some years stood out for its tobacco crop, which went into decline around 1990, imposing on farmers in the region to join the new agricultural activities which fitted the conditions of the region, among which the planting vegetables. Currently stands the lettuce crop (Lactuca sativa L.), coriander (Coriandrum sativum L.) and chives straw-(Allium sp.) (CAVALCANTE et al., 2012).

Lettuce is hardwood most consumed in Brazil and abroad (SANTOS et al., 2001 apud LIMA et al., 2014). It is traditionally cultivated by small farmers, hence its economic and social importance; and usually produced in greenbelts, next to large consumer centers, due to their highly perishable after harvest due to its high water content and large leaf area (Santos et al., 2001; VIDIGAL et al, 1995 cited LIMA et al., 2014). It is also a very demanding crop in water, and one should keep the water content of the soil is more than 80% of field capacity throughout the crop cycle (PEREIRA; LEAL, 1989 apud LIMA et al, 2014).

In the northeast, most of waters used for irrigation have high contents of salts with values usually found in the range from 0.1 to 5.0 dS m⁻¹ (COSTA et al., 2004 cited OLIVEIRA et al., 2011). These factors together with the lack of rainfall and high evaporative demand, characteristics of arid and semi-arid northeastern regions; hinder the leaching of salts found in the plow layer of soil contributing in this way to the emergence of salinated areas (FREITAS et al., 2014). According to research, it is estimated that in Brazil there are around
nine million hectares with salinity problems, and the largest portion of this area focuses on the irrigated perimeters of the Northeast (CARNEIRO et al., 2002 cited by FREIRE et al., 2009).

One of the main consequences of the salinization of agricultural soils is the osmotic effect experienced by plants. When salts are present in the soil solution there is an increased retention force due to the osmotic effect of the salts, becoming more intense the water shortage effect on the plant (GHEYI; DIAS; LACERDA, 2010). As a result, there is a reduction in the rate of growth of leaves and other factors which contribute to plant growth, cell development and also the process of photosynthesis are the first to be hit by salinity (MUUNNS; TESTER, 2008; ESTEVES; SUZUKI, 2008; TURAN et al, 2009; THOMPSON, 2005; TAIZ; Zaiger, 2009; PARRE; GEITMANN 2005; MUNNS et al, 2006 cited GOMES, 2011).

However, the sensitivity to salt varies between species (KUDO et al., 2010) and even within species (MENDONÇA et al, 2007; ZHU et al, 2008) and depends on several factors, such as developmental stage (BUSTIGORRI; LAVADO, 2011), intensity and duration of salt stress (NEVES et al., 2009).

Thus, given the socioeconomic importance and the wide use of lettuce among cultivated vegetable crops in the region, studies to evaluate the influence of salinity on yield components of *Lactuca sativa* species are critical of since there are few studies in this direction or are virtually nonexistent in Agreste Alagoano. Thus the objective was to, with this study was to evaluate the influence of different levels of salts in the irrigation water on the production of lettuce cv. Grand Rapids.

**MATERIAL AND METHODS**

The experiment was conducted during the months of March and April 2012, in a protected environment of the Campus Arapiraca the Federal University of Alagoas (UFAL) city of Arapiraca, AL, located in the geographical coordinates 09 ° 42 '02 "south latitude, 36 ° 41 '12 " longitude and average altitude of 325 m. It is a transition region between the forest zone and the Alagoas Hinterland and, according to the criteria of classification of Köppen, the climate is of the type 'As', tropical, with two well defined seasons, hot and dry summer with possible rains (September-March) and wet and rainy winter (April to August). The average annual rainfall varies between 700 and 1100 mm and annual average temperatures of 26.5 °C.
The treatments consisted of five levels of salinity (S) expressed in terms of electrical conductivity of water (ECw) irrigation: S1 - 0.7; S2 - 1.4; S3 - 2.1; S4 - 2.8 and S5 and 3.5 dS m\(^{-1}\) (25 °C) genotype tested in Grand Rapids lettuce (*Lactuca sativa* L.), cultivar curly leaves. The treatments, with four replications, were allotted to a completely randomized blocks, and the experimental plot consists of two pots, with one plant for each pot.

The seedlings, 25 days old and from local producers, were transplanted in two by vessel number, with cutting out the eight days after transplanting (when it confirmed the fixation of seedlings), leaving only one plant per vessel. Liming was conducted to raise the base saturation (V) to 70% using seaweed powder (highly reactive material); already fertilization was supplemented, from urea and potassium chloride in seven applications (RIBEIRO; GUIMARÃES; ALVAREZ V. (1999).

To obtain the electric conductivity of the water used in irrigation, NaCl was added in place of the water supply system CASAL (Sanitation Company of Alagoas), the amount of NaCl \(Q_{de \text{ NaCl}}\) was determined using the following equation (RICHARDS, 1954) and taking into account the initial salinity of the water:

\[
Q_{de \text{ NaCl}} \text{ (mg L}^{-1}) = 640 \times C_{Ea} \tag{1}
\]

Therefore,

ECw - electrical conductivity water desired, in dS m\(^{-1}\)

Effected up lawn watering by hand, daily and evening, based on the water consumption of the plants in the previous irrigation. The estimated volume was divided by the factor 0.8, in order to reinstate the humidity of the soil at field capacity and obtain a leaching fraction (LF) of about 20% using the following equation:

\[
VI = \frac{VA - VD}{1 - LF} \text{ (mL)} \tag{2}
\]

wherein:

VI - volume of water to be used for irrigation, in mL

VA - volume of water applied to the anterior irrigation, in mL

VD - volume of water drained in the anterior irrigation, in mL
The drain water was collected in the morning the day after the irrigation, measuring the leachate volume and electrical conductivity, using a portable conductivity and temperature correction to 25 °C.

It was evaluated at 20 days after treatment application (DAAT) - 30 days after transplanting, the yield [fresh biomass shoot (FBS)] lettuce cv. Grand Rapids. The data were submitted to analysis of variance by F test (p <0.05) and significant effects compared by regression analysis using the SISVAR® software (FERREIRA, 2011).

RESULTS AND DISCUSSION

The summary of the analysis of variance and the means observed for the fresh biomass shoots (FBS) cultivar Grand Rapids lettuce, evaluation performed 20 days after treatment application (DAAT), are presented in Table 1. Note that the salinity of irrigation water affected (at the 0.01 level of probability) negatively to fresh biomass shoots (FBS) lettuce. According to the regression studies (Figure 1), the decrease rate relative FBS (relative S1) for each unit increase of CEA was 9.26%; the income derived from plants subjected to treatment S5 was approximately 74% of that observed in S1.

Table 1: Summary of the analysis of variance and averages for fresh biomass shoots (FBS) of cultivar Grand Rapids lettuce irrigated with waters of different concentrations of salts, 20 days after treatment application.

<table>
<thead>
<tr>
<th>Variation Sources</th>
<th>DF</th>
<th>Squares Average values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity</td>
<td>4</td>
<td>2601.5071 **</td>
</tr>
<tr>
<td>Linear Regression</td>
<td>1</td>
<td>10167.8077 **</td>
</tr>
<tr>
<td>Quadratic Regression</td>
<td>1</td>
<td>17.8540 NS</td>
</tr>
<tr>
<td>Regression Desviation</td>
<td>2</td>
<td>110.1833 NS</td>
</tr>
<tr>
<td>Block</td>
<td>3</td>
<td>1236.8797</td>
</tr>
<tr>
<td>Residue</td>
<td>12</td>
<td>257.7282</td>
</tr>
<tr>
<td>CV (%)</td>
<td></td>
<td>7.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variation Sources</th>
<th>DF</th>
<th>Yield (FBS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 (0.7 dS m⁻¹)</td>
<td></td>
<td>244.67</td>
</tr>
<tr>
<td>S2 (1.4 dS m⁻¹)</td>
<td></td>
<td>234.94</td>
</tr>
<tr>
<td>S3 (2.1 dS m⁻¹)</td>
<td></td>
<td>211.73</td>
</tr>
<tr>
<td>S4 (2.8 dS m⁻¹)</td>
<td></td>
<td>193.95</td>
</tr>
<tr>
<td>S5 (3.5 dS m⁻¹)</td>
<td></td>
<td>185.45</td>
</tr>
</tbody>
</table>

** significant at 1% probability and NS not significant

Viana et al. (2004), also studying levels of electrical conductivity of the water (ECw) irrigation [ECw: 0.3; 1.0; 1.7; 2.4 and 3.1 dS m⁻¹ (25 °C)] on lettuce group "curly" (cv. Elba), verified in a similar way to this work, reducing the yield of plants with increased salinity;
according to these authors, the relative decrease rate of fresh biomass shoots (FBS) was 9.0% per unit increase of ECw, and the income derived from plants subjected to treatment S5 (3.1 dS m$^{-1}$) was approximately 75% of that observed in S1 (0.3 dS m$^{-1}$).

Figure 1. Fresh biomass of shoot (FBS) of cv. Grand Rapids lettuce, depending on the electrical conductivity of water (ECw) irrigation, 20 days after treatment application.

The linear reduction FBS with increasing irrigation water conductivity (Figure 1) is consistent with the results obtained by Gervais et al. (2000) also found that reduction of fresh biomass of the aerial part of lettuce with increasing ECw from the lower salinity (0.3 dS m$^{-1}$). Freitas et al. (2014), in his experiment developed hydroponically, they realized linear reduction FBS with increasing salinity of approximately 11.0%.

Moura et al. (2014) studied in unheated two types of brackish (saline waste and water well) on lettuce cultivars of production components, found significant effect of the types of water on the FBS plants, ranging from 15.01 to 4.65 g.

According to Ayers; Westcot (1999) as criterion for choice of a culture as salinity tolerance can be accepted a decrease in the potential yield of 10%, i.e. the maximum acceptable salinity is one that allows to produce relative minimum yield 90%. Despite the said decrease rate recorded in this study (Figure 1), ECw 1.8 dS m$^{-1}$ further provides 90% yield of cv. Grand Rapids lettuce so that value is its salinity limit.

CONCLUSIONS

The lettuce yield decreases by 9.26% increase irrigation unit CEa from 0.7 dS m$^{-1}$ electrical conductivity. The value of ECw = 1.8 dS m$^{-1}$ is considered to limit salt tolerance, considering a minimum yield of 90%.
REFERENCES


RIBEIRO, A. C; GUIMARÃES, P. T. G; ALVAREZ V., V. H. Recomendações para o Uso de corretivos e Fertilizantes em Minas Gerais: 5º aproximação. Viçosa, MG, Comissão de Fertilizantes do Solo do Estado de Minas Gerais, 1999. 177 p.
