

Effect of Salinity Stress on Yield, Number of Leaves, Leaf Area and Height Leaf of Lettuce (Red Salad Bol) in Greenhouse Conditions

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Abstract: In this research, yield of lettuce of red salad bol, under different treatments of irrigation water salinity and greenhouse cultivation, was investigated in greenhouse of College of Agriculture, Shahid Chamran University of Ahvaz. The experiment was conducted as a completely randomized design with a treatment of saline of irrigation water at three levels (S₁:2, S₂:5 and S₃:8 dS / m) in three replications. The results showed that salinity levels were significant at different levels only on leaf area at 5% probability level. The highest plant height was obtained from treatment of S₃ (30 cm) and the highest leaf and leaf area were from S₂ treatment (31 leaves per plant and 4161 cm²). The highest yield (fresh weight) was related to the treatment of S₃ (0.174 kg) and the lowest was related to the treatment of S₁ (0.154 kg).

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Keywords: Salinity stress; Lettuce; Leaf number; leaf area; Plant height; Yield

1. Introduction

Irrigation water salinity affects the soil and yield. Reduced growth in plants under salt stress conditions can be due to the reduction of energy reserves of the plant, which is affected by the reduction and disruption of the plant's biological and metabolic activities (Zare et al, 2016). Salinity reduces the performance of most agricultural products, especially vegetables. Vegetables are more susceptible to salinity than other crops. Lettuce as salt-sensitive vegetable (Fattahi et al, 2017). Lettuce, a cool-season vegetable crop, is most popular according to the consumption rate and economic importance throughout the world (Patil et al, 2013). Several studies have been done on the effect of irrigation water salinity on the growth and yield of different plants. Zare et al. (2016) investigated the effect of salinity stress on morphological characteristics of lettuce genotypes (*Lactuca sativa* L.) in three levels (0, 2 and 4 dS / m). The results showed that with increasing salinity, plant length, root length, root and shoot fresh weight and leaf length and leaf width in lettuce genotypes decreased significantly. Sgherri et al. (2017) investigated the effects of phenolic acid and flavonoids, as well as antioxidant activity in two types of lettuce, under salinity stress. The results showed that salinity and CO₂ increase, individually or in combination, can produce some phenols that increase

the health parameters of lettuce and when the salinity factor and CO₂ increase are combined, there will be no reduction in the yield of the product. Ors and Suarez (2017) investigated the effect of drought and salinity stress on spinach. The results showed that the response of spinach to drought and salinity stress was very different, so that spinach yield was initially increased with salinity and then decreased only when irrigation water salinity was 9 dS / m and above. Neocleous et al. (2014) investigated changes in photosynthesis, yield and quality of two cultivars of lettuce under salt stress and used different salinity concentrations (0, 5, 10 and 20 mM). This study was conducted in a floating system and the plants were harvested at 5-6 leaf and height 6-10 cm. The results showed that in salinity level of 20 mM fresh leaf weight in both lettuce varieties decreased compared to control treatment. Maskri et al. (2010) investigated the effect of salinity stress on lettuce parameters in different levels of salinity. The results showed that number of leaves, fresh weight of plant, shoot dry weight, root dry weight, leaf area and leaf area index had a significant effect on different levels of salinity, While the ratio of shoot to root fresh weight and ratio shoot to root dry weight did not have a significant effect on salinity response. Nagaz et al. (2013) investigated the effects of different levels of irrigation with saline water on the salinity of the soil, yield and

water use efficiency of lettuce. The highest yield of lettuce and the lowest water use efficiency were related to the control treatment (100% water requirement) and the highest water use efficiency was related to 30% water requirement.

The aim of this research was to investigate changes in leaf number, leaf area, plant height and yield of lettuce (red salad bol) under salinity stress in greenhouse conditions.

2. Materials and Methods

This research was conducted in 2017 in research greenhouse of Faculty of Agriculture, Shahid Chamran University of Ahvaz with the longitude of 48 degrees and 40 minutes east and latitude of 31 degrees and 20 minutes north with a height of 18 meters above sea level. The soil was used in the research farm of the Faculty of Water Sciences Engineering, which had a medium texture. Soil physical and chemical characteristics including, soil texture and percent of soil-forming particles (by hydrometric method), Salinity and acidity of soil by the preparation of saturated extract, bulk density by metal cylinder with an specific volume and moisture in field capacity point and wilting point were determined by pressure plate. The results are presented in Table 1. The planting date was December and the cultivation was indirect (seedling) in pots of diameter 22 and height 30 cm. The plant's growth period is about 70 days. After pouring the filter in the bottom of the pots and filling them from a certain

amount of dry soil, the transfer of transplants to the pots was conducted and treatments were performed.

The experiment consisted of three treatments of salinity of irrigation water (2, 5 and 8 dS / m, S_1 , S_2 and S_3 Respectively), in a completely randomized design with three replications. Salt water is used by mixing the water of karoon river with drainage water. For this purpose, 9 pots were used. The water used in the research was from Karoon river and the irrigation was done by manual method and by graduated bushel. Also from NPK fertilizer was used as a solution during growth period. The time of irrigation was determined by weighting method, in such a way, with daily weighing of the pots, the soil moisture content of the pots was obtained. When readily available water used by plants, next irrigation was performed. Maximum allowable depletion rate was 30%. The volume of irrigation water was varied, according to the growth stage and the water requirement of the plant due to the development of root depth during the growing season. During the growing season, the volume of water used for treatments was calculated to be 5.1 liters. At the end of the growth period, the measured parameters were investigated, including yield (fresh weight) for lettuce. Also the number of leaves per plant and its height were measured. Upper part of the yield separated by a knife and after weighing the weight of each plant, the leaf area of each plant was weighed by Leaf Area Meter and win dias software. Finally, SPSS software was used for statistical analysis and Duncan's test was conducted to compare the means.

Table 1. Experimental soil properties

pH	ECe (dS/m)	ρ_b (g/cm ³)	PWP (%) (Volume)	FC (%) (Volume)	sand percent	Silt percent	Clay percent	Soil texture
7/86	2/15	1/4	12	24	47.6	28	24.4	Sandy clay loom

3. Results

According to the results obtained from the SPSS software and the comparison of the means based on Duncan's test, the effect of different levels of salinity were investigated on the measured parameters including number of leaves, leaf area, plant height and yield (fresh weight). Based on the results of analysis of variance, (table 2) can be found, the amount of salinity affected by different levels, and at the level of 5%, it is significant only on the leaf area and was not significant for leaf number, plant height and yield (fresh weight). Accordingly, the comparison of means was performed by Duncan test to study the effects of different levels of salinity on leaf number, leaf area, plant height and yield (fresh weight). The results are shown in Table (3). According to Table 3, salinity was effective on the number of leaves, and with increasing salinity, the number of leaves per plant initially

increased and then decreased. The highest number of leaves was related to the treatment S_2 , which is close to S_1 and with a difference of about 2%. The lowest number of leaves was related to salinity treatments S_3 , which has a difference of about 7% relative to S_1 treatment, which indicates the effective relationship between salinity and product reduction. According to literature review, the results are in accordance with the results of the study of Ors and Suarez (2017) in the study of lettuce performance. The height of the plant under the influence of three salinity levels has a different process, which initially, the height of the plant decreased and then increased with increasing salinity. The highest height was related to S_3 treatment with very low difference from treatment S_1 (about 1%) and the lowest was S_2 treatment, which differs 3% from treatment S_1 . In the study of Zare et al.)2016(, in order to investigate the effect of salinity stress on

morphological characteristics of lettuce genotypes, The results showed, with increasing.

Salinity, plant height, root length, root fresh weight and plant height, leaf length and leaf width were significantly decreased in lettuce genotypes. Also the leaf area increased with salinity increase compared to S_1 treatment. The lowest leaf area was included in S_1 treatment and the highest was S_2 treatment, which is very close to S_3 salinity treatment, which indicates the positive effect of salinity on the leaf area of this number of lettuce. In study of Maskeri et al. (2010), the effects of salinity stress were significant on lettuce parameters and leaf area. Salinity on the yield (fresh weight) has not decreased and with increasing salinity, the yield (fresh weight) has also increased. The highest yield (fresh weight) was related to S_3 treatment, which differs from

S_2 treatment by about 10% and S_1 and S_2 treatments had very close results, due to insignificant amount of salinity on yield (weight). According to the results of this study, the salinity levels from S_1 to S_3 had an increasing effect on yield (fresh weight) and the lowest performance in effect of salinity was related to treatment S_1 . The results of Ors and Suarez (2017) study on the performance of spinach and its physiological response showed that spinach yield increased with salinity. Zare et al. (2016) and Neocleous et al. (2014) with study the effect of salinity stress on morphological characteristics of lettuce genotypes, different results were obtained, So that with increasing salinity stress the yield (fresh weight) decreased. The reason for the difference in results is the type used and the test conditions.

Table 2. Analysis of variance of measured parameters of lettuce under different salinity treatments

Sources Change	df	Average of squares			
		Plant height	Leaf area	Number of leaves	Performance (fresh weight)
Treatment	2	ns 1.44	ns 1424379.63	ns 5.77	0/00 ns
Salinity	2	ns 1.44	*1224379.63	ns 5.77	0/00 ns
Error	6	ns 1.55	ns 596.0/91	ns 2.00	9/872E-5 ns
Total	8				

*: Significant at the five percent level, ns: is not statistically significant.

Table 3. Comparison of the average effect of salinity on measured parameters of lettuce based on Duncan test

parameter	(percent) salinity		
	S_3	S_2	S_1
different levels			
Number of leaves	a 28.66	a 31.33	a 30.66
Leaf area (Cm^2)	b 4051	b 4161	a 2916
Plant height (Cm)	a 30.00	a 28.66	a 29.66
Performance (fresh weight) (Kg)	a 0.172	a 0.158	a 0.154

In each row, treatments with common alphabets are not significant at 5% probability level.

4. Discussions

According to the results of this study, in investigating the amount of different salinity levels on leaf number, leaf area, plant height and yield (fresh weight) leaf lettuce, the Salinity levels at designated levels and at 5% probability level, only on the leaf area was significant and did not have a significant effect on the other three parameters. According to the comparison of means based on Duncan's test, The highest number of leaves, on average, was related to treatment S_2 , the highest plant height was related to S_3 and the highest leaf area was S_2 . Which is respectively, 31 leaves in plant, 30 cm and 4161 cm^2 . The highest yield (fresh weight) was related to S_3 equal to 0.172 kg and the lowest was related to S_1 treatment equal to 0.154 kg. Thus, increasing the salinity of irrigation water increased yield. It can be said that salinity had the highest effect on leaf area than the other three parameters.

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