LETTUCE YIELD RESPONSE TO SALINITY OF SPRINKLE IRRIGATION WATER

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Abstract

The objective of this work is to study the effect of saline water on the yield of lettuce (*Lactuca sativa* L., var. longifolia Lam., cv. Nevada), under an experimental design known as double sprinkler line source (DLS), in two different soil types. A saline gradient was created, shown by an electrical conductivity from 1 up to 8 dS/m, and a precise distribution of the salt with a minimal experimental area was obtained. Experiments were carried out in the Campus of Gambelas, University of Algarve, Faro, South Portugal. Lettuce yields were expressed in ton/ha and in fresh weight per plant. It is concluded the main several aspects: 1 - A steep yield reduction from 1 up to 2 dS/m; 2 - A slow yield reduction from 2 up to 5 dS/m; 3 - From 5 up to 8 dS/m yield is very low and near constant. Regression curves had r^2 values not lower than 0. 80.

Additional index words: Double line source, irrigation, *Lactuca sativa*, salinity, yield.

1. Introduction

The salt stress induced by saline water may decrease or prevent injuries by decreasing the water loss from the plant; this would mean increased strain avoidance, resulting in a lower vapor pressure in the plant, a stomatal closure, and a decrease in specific surface of the morphological structure due to decreased growth (Levitt and Twersky, 1974). Bresler and Hoffman (1986) assume that water uptake depends on matric and osmotic potentials and on a critical root water potential about -0.3 MPa. The mechanism explaining the saline effects was simulated by Beltrão and Ben-Asher (1996), and justified that the movement of salts in the soil is solely dependent on the movement of water in soil; and it shows that the effect of salinity is simulated through its effects on the wilting point, thus reducing the available water content (Beltrão and Ben-Asher, 1997). The effect of salinity on yield is composed of two stages (Maas and Hoffman, 1977): first, yield is not decreased until a threshold value is reached; second, when this value is exceeded, it begins a linear decrease of yield as salinity increases. The objective of the present work is the use of sprinkle irrigation and the study of the additional effects of salinity due to the contact of saline water with the leaves (Beltrão *et al.*, 1993).

2. Material and methods

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The experimental plot was established in the Campus of Gambelas of the University of Algarve, Faro, South Portugal. Some soil parameters are given in Table 1. The crop selected for the study was summer lettuce *(Lactuca sativa* L., var. longifolia Lam., cv. Nevada). Sprinkler irrigation and double line source were used for water application (Lauer,

Table 1. Soil parameters (Soil types A and B). Soil permeability was very low in the sandy clay soil layer.

Parameters	Soil depth average (m)		
1st soil type (A)	0 - 0.15	0.15 - 0.35	0.35 - 0.60
2nd soil type (B)	0 - 0.15	0.15 - 0.20	0.20 - 0.60
Texture:			
Sand %	86.1	88.5	55.9
Silt %	8.4	7.5	5.4
Clay %	5.5	4.0	38.7
	Loamy-sand	Loamy-sand	Sandy-clay
θ_w (kg kg^{-1}) at ψ_m = -10kPa	0.069	0.097	0.037
θ_w (kg kg^{-1}) at ψ_m = -33kPa	0.050	0.073	0.023
pH (H_2O)	6.3	6.3	6.0
P_2O_5 (mg kg^{-1})	44	26	34
K_2O (mg kg^{-1})	7.2	7.2	7.2

1983), allowing the superposition of a continuous gradient of a sprinkler applied salt (Magnusson and Ben Asher, 1990). This geometry is shown in Figure 1. Seedbed and basic fertilization of N, P_20_5 and K_20 were made according to conventional agrotechniques and soil fertility analysis - 150 kg/ha NPK was applied. Planting space was of 0.40x0.30 m, being the planting date on the 28 th August and the harvest on the 2nd October.

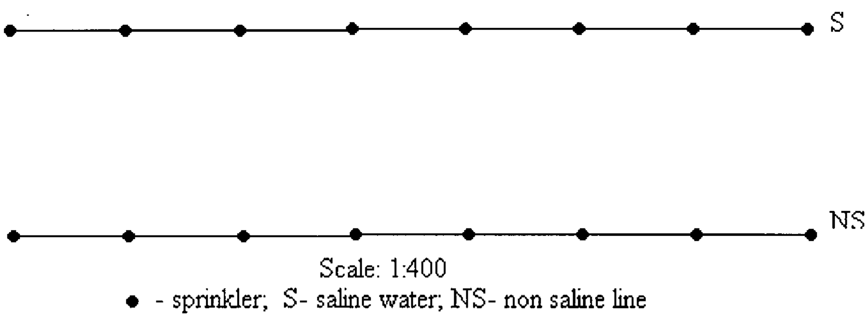

Figure 1. Experimental plot layout of DLS to produce a saline gradient.

The electrical conductivity ECw of the fresh water line was about 1 dS/m being 8 dS/m that of the saline water line, creating a saline gradient according to Figure 2. Naan 323/92 sprinklers with 0.0025 x 0.0045 mm diameter spreader nozzles were spaced along each line. The sprinklers had a wetting radius about 12 m and were mounted on risers 1 m high. Sprinkler pressure was 300 kPa and the plots were irrigated once a day, according to crop evapotranspiration ET_c as determined by a Class A evaporation tank, times a crop coefficient (FAO values). Christiansen coefficient of water distribution unifor-

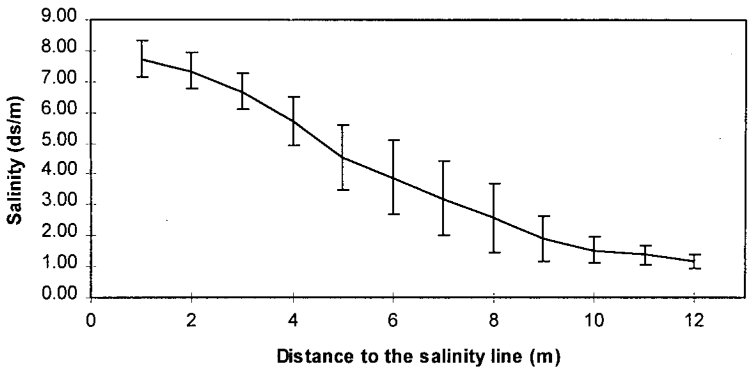

Figure 2. Measured electrical conductivity of irrigation water ECw values (dS/m) as created by the LSD system.

mity (CUC) was always above 89 %, with an average about 94 %.

According to the sprinkler lines, 12 treatments were established. The treatment number was given according to the distance to the saline line, from 1 m (T1) up to 12 m (T12). Measured ECw values were compared in Figure 2. Samples were taken from several irrigiations throughout the growing season.

3. Results and discussion

The response of lettuce to sprinkle irrigation water salinity (DLS) is given in Table 2 and and in Figure 3 (absolute yield versus salinity of irrigation water) and Figure 4 (Weight

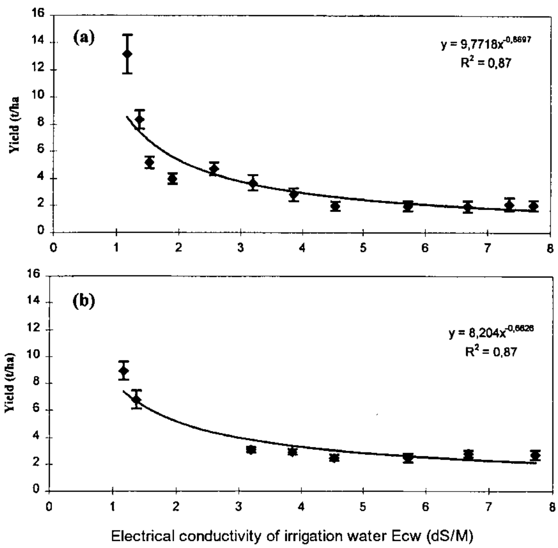

Figure 3. Response of lettuce yield to the effects of the salinity in soil type A(a) and B(b).

Table 2. Averages ± standard error of absolute yield (fresh weight) for each salinity treatments (Soil types A and B). Averages followed by the same letter are not statistically different at 95% (DMRT). In soil type B, treatments 2, 8, 9 and 10 were excluded due to soil effects. In these points, the soil profile showed that the low permeable layer was nearer the soil surface (less than 0.20 m depth) leading to destructive flooding.

Treatments	Yield (T/ha)	
	Soil Type A	Soil Type B
T1	2.0 ± 0.4 a	2.7 ± 0.3 a
T2	2.1 ± 0.5 a	-
T3	1.9 ± 0.4 a	2.8 ± 0.3 ab
T4	1.9 ± 0.4 a	2.5 ± 0.3 ab
T5	2.0 ± 0.3 a	2.6 ± 0.2 ab
T6	2.8 ± 0.5 ab	3.0 ± 0.2 ab
T7	3.7 ± 0.6 abc	3.1 ± 0.2 ab
T8	4.7 ± 0.5 c	-
T9	4.0 ± 0.4 bc	-
T10	5.2 ± 0.4 c	-
T11	8.3 ± 0.7 d	6.2 ± 0.7 c
T12	13.1 ± 1.4 e	8.6 ± 0.7 d

of each lettuce versus salinity of irrigation water). Differences between treatments were analysed by one-way ANOVA. Treatments means were compared by Duncan's multiple range test (DMRT) at 95%. A steep yield reduction from 1 to 2 dS/m (14 - 4 ton /ha), a slow yield reduction from 3 to 5 dS/m (4 - 2 ton/ha) and a constant and very low yield, from 5 to 8 dS/m, are shown in Figures 3a and 4a.

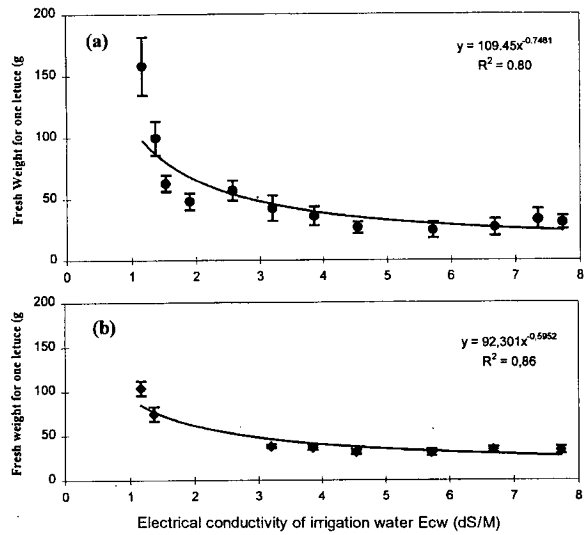

Figure 4. Response of lettuce (fresh weight per plant) to soil salinity in soil type A(a) and B(b).

Comparing these results with the model of Maas and Hoffman (1977), it may be seen: (a) Decrease of the threshold salinity value (1st stage), due to the saline effects on the leaves, according to the sprinkle irrigation method and (b) the sensitivity (decrease of yield per increase of salinity, beyond threshold, 2nd stage) is not constant, decreasing with the increase of salinity. Sensitivity is defined here as the slope of yield with respect to salinity.

Considering the differences between both soil types - soil type A (sandier soil) and soil type B (clayer soil), it may be seen that (a) apparently, soil texture has no effect or very small effect in the threshold salinity value; (b) on soil type A, yield is more sensitive to salinity comparing with soil type B; this is shown by the moderate slope of yield reduction with respect to salinity; (c) yield is reduced about 50% from its potential at about 1.5 dS/m on the soil type A and on soil type b, at about 3 dS/m; and finally (4) about 75% of the yield is lost when salinity increases from 1 dS/m to 4 dS/m on the soil type A and from 1 dS/m to 8 dS/m on the soil type B.

As concluding remarks, it may be seen that at 1 dS/m, yield was 14 t/ha in soil type A (well drained) and 9 t/ha in soil type B (worse drained); in this case yield is reduced due to aeration problems. On the other hand, for high salinity values (8 dS/m), there was not differences on yield for both soil type, showing that in this case, the salinity is the limiting factor for yield.

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