THE EFFECT OF NaCl ON SOME PARAMETERS INFLUENCING THE SOIL–PLANT INTERACTIONS IN *SALICORNIA HERBACEA*

H. H. Mert[1], Y. Dogan[1*], S. Baslar[1], H. Aydin[1], N. Yorek[1]

[1]Dept. of Biology, Buca Faculty of Education, Dokuz Eylul University, Buca–Izmir, Turkey

Summary. Plant samples of *Salicornia herbacea* were collected from different localities around the northern costal part of Izmir, during the months of June, July, August and September. Salinity and pH of the soils and plants was investigated and the relationship between these parameters tested statistically. The soil salinity values showed that the highest values were obtained in August, but after the rainfall in September these values started to decrease. The plant salinity values showed a parallel variation with the soil salinity values. The correlation between these two parameters was found to be positive and linear. No statistical relationship was obtained between soil–plant salinity and pH.

Key words: *Salicornia herbacea*, NaCl, soil–plant interaction.
Abbreviations: Electrical conductivity-EC.

INTRODUCTION

Salinity affects 7 % of the world's land area (approximately 930 million ha) (Munns, 2002; Kefu et al., 2002). It does not include the secondarily salinized soils in cultivated areas. Salinity affects at least 20 % of world's arable lands and more than 40 % of irrigated lands to various

*Corresponding author, e-mail: yunus.dogan@deu.edu.tr

degrees (Rhoades and Loveday, 1990). In Turkey 3,639 760 ha of the land are not suitable for farming due to salinity and high subsoil water. According to Dizdar (1993), Turkey has more than 1.5 million ha of saline soils which are equal to almost 2 % of its total area. These areas are covered with halophytic plants and this type of vegetation is seen throughout the coastal parts of Turkey as well as on inland saline habitats in Central Anatolia. Soil salinity affects all basic physiological processes necessary for the plant to survive. Even lower concentrations of salt in the soil that have no toxic effect can be an indirect barrier for the plant to take enough amount of water by increasing the osmotic pressure. Schimper (1898) has defined this effect as "physiological aridity" and Arroyo et al. (1999) regards it as one of the main limiting factors for soil–plant interactions on saline habitats. The problem of rehabilitation of these saline lands in suitable farming areas is a topic of great importance and needs studies involving detailed investigations on soil–plant interactions on such habitats. In Turkey very little work has been done in this direction (Zeybek, 1969; Zeybek et al., 1972; Sheikh et al., 1976a,b; Mert 1977; Bahadır et al., 2001). Therefore, this was the reason to undertake this study on *Salicornia herbacea*.

MATERIAL AND METHODS

In all three different *Salicornia herbacea* L. (Syn: *S. europaea* L., *S. virginata* L., *S. perensis* Mill., *S. annua* SM., *S. acetaria* Pall.) (Chenopodiaceae) localities were selected differing vertically and horizontally from the Aegean Sea inwards. The localities were from the Northern part of Izmir coast. Locality A is situated around Cigli, opposite to the Tuzla (saltern), station B is located between Semikler and Cigli, marshy area, and station C is around recreation areas of Bayrakli.

It is an annual, 5–50 cm long, light or dark green and especially after July dirty red, succulent and leafless (leaf prints are scaly).

Small profiles (0–25 cm) from densely covered *S. herbacea* localities were dug out and soil samples taken. These were placed in polyethylene bags, sealed and labelled, brought to the laboratory and left for air drying under room temperature and free air current. Dried soil samples were passed through a 2 mm sieve and soil saturation paste prepared by mixing 100 g of the sieved soil with distilled water. Latter was filtered through a Buhner funnel to obtain the saturation extract (Jackson, 1958).

Plant samples collected from different localities were carefully removed from the soil together with roots, placed in labelled polyethylene bags and brought to the laboratory. The stem and branches of the collected samples were broken into pieces, put in the polyethylene bags and deepfreezed. For extraction the samples were left for a while at room temperature then placed in a clean muslin and extract obtained by using a hand press (Zeybek, 1969). The latter was used for the measurement of electrical conductivity with the help of "Wheatstone Bridge" conductivity apparatus ($E.C._{25°C}$= mm.hos.cm^{-2}). The values were read at 25 °C as (mm.hos.cm^{-2}) (Anonymous, 1954). The same method was used for the soil extracts. pH measurements of soil saturation and plant extracts were determined using a "Beckman" pH meter.

RESULTS AND DISCUSSION

Soil and plant samples collected from different localities (A, B and C)

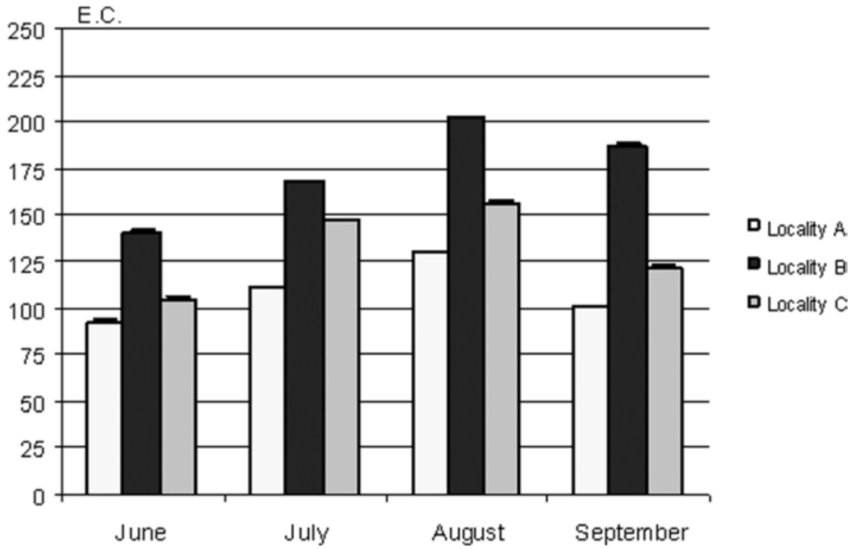

Fig. 1. Electrical conductivity ($E.C._{25°C}$= mm.hos.cm^{-2}) values of soil saturation extracts.

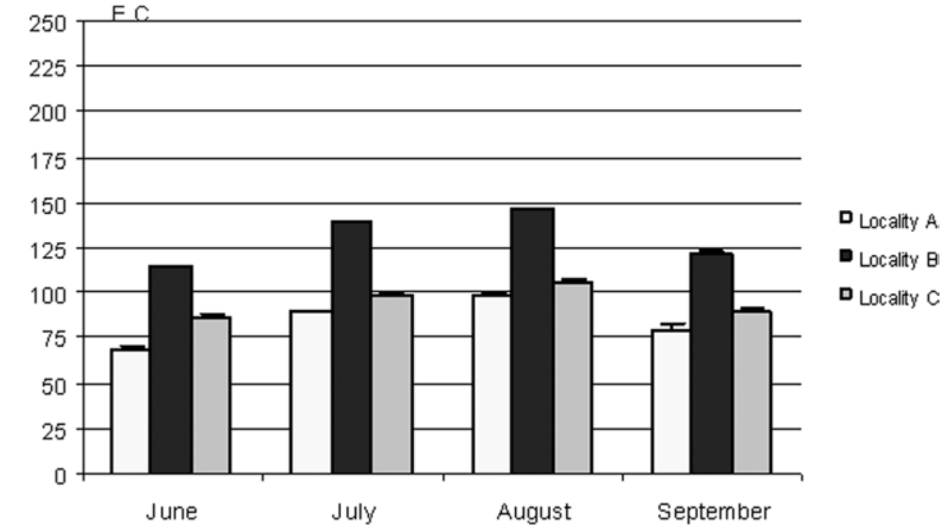

Fig. 2. Electrical conductivity (E.C.$_{25°C}$= mm.hos.cm^{-2}) values of plant extracts.

during June, July, August, and September showed that electrical conductivity values in soil saturation extracts varied between 90–204 mm.hos.cm^{-2} (Fig. 1). The soil salinity value in July was 19.78 % higher than in June, but in September, it was 21.64 % lower than in August, in locality A. Similarly in

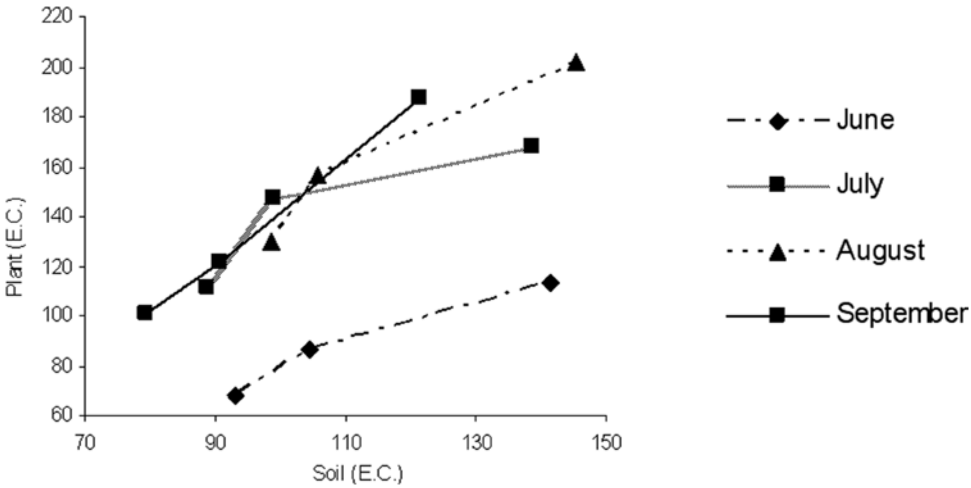

Fig. 3. Interrelationship of soil and plant salinity values.

locality B, soil salinity value in July was 18.84% higher than in June, and in September it was 6.84 % lower than that in August. A similar situation can be seen in locality C, where soil salinity value in July was 40.64 % higher than in June and it was 22.00 % lower in September than in August. The similarity among the results in all three investigations showed that an increase in temperature during August caused aridity and due to evaporation of minerals from the groundwater reached the surface forming a crust at the top. The rains during September washed the soil profile and salinity was reduced.

Salinity values of the plant extracts are presented in Fig. 2. In locality A the salinity value was 29.73 % higher in July than in June. The value in September was 19.63 % lower than in August. In locality B, the salinity value was 22.00 % higher in July than in June, and it was 16.50 % lower in September than in August. Similar situation was observed in locality C where the value was 3.68 % higher in July than in June and 14.36 % lower in September than in August. The salinity values of the soils and the plants showed a good correlation. A positive correlation existed between the two parameters and relation progressed linearly during the investigation period (Fig. 3). Zeybek (1969) has carried out studies on the relationship between soil and plant salinity. Our results fully coincide with his findings, but go against those of Onal (1966) who denied that salinity level increased in plants with increasing NaCl in the soil.

Table 1. pH values of soil saturation and plant extracts obtained from samples collected in different localities during the investigation period.

Month	Soil			Plant		
	Mean ± standard error			Mean ± standard error		
	Locality A	Locality B	Locality C	Locality A	Locality B	Locality C
June	6.81±0.01	6.48±0.02	6.61±0.00	5.49±0.02	5.34±0.03	5.37±0.03
July	6.95±0.03	6.40±0.01	6.59±0.00	5.65±0.03	5.43±0.01	5.59±0.01
August	7.16±0.01	6.86±0.01	6.91±0.01	5.70±0.01	5.73±0.01	5.88±0.01
September	6.75±0.00	6.07±0.01	6.25±0.02	5.68±0.01	5.90±0.01	5.87±0.01

pH is a parameter which affects distribution and ecology of plants. The results on pH are given in Table 1. In general, all three localities showed neutral values, however, pH of plant extracts in the three localities varied between 5.34 and 5.90. No relationship was determined between these two parameters.

The halophytes like *S. herbacea* absorbed enough of minerals to survive. The ratio of the absorption was higher in plants growing in highly saline habitats (Figs. 1, 2). This could lead to toxic effects on the plant. To overcome this effect, plants can increase absorption power and absorb more water and accumulate it in the vacuoles for protection against the negative effects of salt on enzymatic activity (Munns, 2002).

References

Anonymous, 1954. Diagnosis and improvement of saline and alkali soils, U.S.D.A. Handbook 60, U.S. Government Printing Office, Washington.

Arroyo, M.T.K, L.A. Cavieres, C. Castor, A.M. Humaña, 1999. Persistent soil seed bank and standing vegetation at a high alpine site in the central Chilean Andes. Oecologia, 119, 126–132.

Bahadir, H., S. Sakcali, M. Ozturk, 2002. Studies on the Soil Plant Interactions in *Salicornia europaea* L. In: DRC Proc. of the Inter. Conf. On Optimum Resources Utilization in Salt Affected Ecosystems in Arid and Semi–Arid Regions. DRC Cairo–Egypt, 158–160.

Dizdar, M.Y., 1993. Soil degredation in our country. Tarim ve Koy, 88, 25–27.

Jackson, M.L., 1958. Soil Chemical Analysis. Prentice Hall. Inc., Englewood, NJ.

Kefu, Z., F. Hai, I.A. Ungar, 2002. Survey of halophyte species in China. Plant Sci., 163(3), 491–498.

Mert, H.H., 1977. Osmotic pressure and transpiration relationships of *Salicornia herbaceae* in its natural habitat. Phyton, 18(1–2), 71–78.

Munns, R., 2002. Comparative physiology of salt and water stress. Plant Cell Environ., 25, 239–250.

Onal, M., 1966. Comparative ecological studies on halophytic and non–halophytic plants around Napoli. Istanbul Univ. Fen Fak. Istanbul.

Rhoades, J.D., J. Loveday, 1990. Salinity in irrigated agriculture. In: Irrigation of agricultural crops. Eds. B.A. Stewart, D.R. Nielsen, Monograph, ASA, Madison, WI, 1089–1142.

Schimper, A.F.W., 1898. Pflanzengeographie auf physiologischer Grundlage, Fischer, Jena.

Sheikh, K.H., N. Zeybek, M.A. Ozturk, 1976a. Coastal halophytes of the Aegean region. In: CENTO Symposium, Adana, 148–153.

Sheikh, K.H., N. Zeybek, M.A. Ozturk, 1976b. Performance of *Inula graveolens* in saline soils. In: CENTO Symposium, Adana, 154–164.

Zeybek, N., 1969. Chromosome numbers of *Salicornia* species of Western Coastal Parts of Anatolia. Ege Univ. Fen Fak. İlmi Rap. Ser. No 83, Bornova–Izmir.

Zeybek, N., H.H. Mert, T. Kesercioglu, 1972. Die Chromosomenzahlen von *Salicornia*–Arten aus Anatolien. Separatdruck aus den Verhandlungen der Scweiz, Neturforsch. Geselschaft. 134–142.