TÍTULO DEL TRABAJO

"Cultivos que eliminan sales como técnica de fitoremediación"

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FIGURAS Y TABLAS

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SALT REMOVING CROPS AS A PHYTOREMEDIATION TECHNIQUE

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ABSTRACT
Salt accumulating crops and halophytes have a potential role in reuse of saline waters and in salt-affected soils provided that their sustainable use is promoted.

A pot trial was performed with three salinity levels – 0.65, 3.5, 6.5 dS/m – and three salt removing crops, purslane (Portulaca oleracea), New Zealand spinach (Tetragonia tetragonoides) and Beta maritima grown in perlite medium. The fertigation was made by half strength Hoagland solution. The vegetative growth, salt (Na, Cl) concentrations and their uptakes were determined.

High salt uptake and vigour of the tested species at salinity level of 6.5 dS/m prove that these crops could be integrated into cultivation/rotation programmes. Owing to its dense planting, short vegetation period and higher biomass production, purslane is accepted as the most promising salt removing crop. Purslane was also the highest in Na accumulating capacity. New Zealand spinach and purslane are widely used as leafy vegetables in various Mediterranean countries, and Beta maritima is used as animal fodder.

KEY WORDS: Phytoremediation, salt removing crops, Turkey

CULTIVOS QUE ELEMINAN SALES COMO TÉCNICA DE FITOREMEDIACIÓN

RESUMEN
Los cultivos capaces de acumular sal, así como las plantas halófitas, presentan un papel potencial en la reutilitzación de aguas salinas. Asimismo, se promueve el uso sostenible de suelos con alta concentración en sales.

Se realizaron ensayos de laboratorio utilizando tres niveles de salinidad – 0,65; 3,5; 6,5 dS/cm – y tres tipos de cultivos que eliminan sales plantados sobre un medio de perlita: verdolaga (*Portulaca oleracea*), espinaca de Nueva Zelanda (*Tetragonia tetragonoides*) y *Beta marítima*.

Las especies estudiadas han mostrado una importante absorción de sales a un nivel de salinidad de 6,5 dS/cm, demostrando que estos cultivos pueden integrarse en programas de cultivo/rotación. Debido a su densa plantación, corto periodo de vegetación y alta producción de biomasa, la especie *Portulaca oleracea* se presenta como el cultivo más idóneo para la eliminación de sales. Esta especie también mostró la más alta capacidad de acumulación de Na. *Portulaca oleracea* y *Tetragonia tetragonoides* se utilizan comúnmente como hortalizas en diferentes países Mediterráneos, y *Beta marítima* se usa como forraje para animales.

PALABRAS CLAVE: Fitoremediación, cultivos que eliminan sales, Turquía

1. INTRODUCTION

Phytoremediation is defined as the use of plants to remove pollutants from the environment or to render them harmless (Salt et. al., 1998). It is an emerging technique for environmental remediation which offers promise as a low-cost and versatile method. Phytoremediation is also appropriate to use against a number of various types of contaminants in a variety of media.

Salt accumulating crops and halophytes have a potential role in reuse of saline waters and salt-affected soils for phytoremediational purposes, provided that their sustainable use is promoted. These plants could also provide a viable opportunity for wastewater reuse, since the most important problem in reuse of treated wastewaters is their high salt content.

2. MATERIAL AND METHOD

Pot experiments were carried out to examine the performance of salt accumulating crops in the plastic houses at Ege University, Izmir, Turkey. The tested varieties were purslane (Portulaca oleracea), New Zealand Spinach (Tetragonia tetragonoides) and Beta maritima accession 54603 which was selected as a most promising line from the preliminary screening experiments (Kukul et al., 2001). Purslane seeds were provided commercially; Beta maritima from the gene bank at Ege Agricultural Research Institute in Turkey, and New Zealand spinach from Portugal.

Purslane and Beta maritima were subjected to enhanced salinity levels of 0.65 dS/m (S_0), 3.5 dS/m (S_1) and 6.5 dS/m (S_2) in 25 liter pots, while New Zealand spinach to same salinity levels in sand. The pot sizes were 24 cm of width, 75 cm of length and 16 cm of depth. Irrigation was by half strength Hoagland solution. The duration of the experiment was 31 days for purslane and 54 days for New Zealand spinach and Beta maritima.

Fresh and dry weights, Na and Cl concentrations (%) and Na and Cl uptakes (g/plant) and the harvestable yield per liter water consumed (water use efficiency, WUE) were determined.

3. RESULTS

Purslane and New Zealand spinach are consumed as leafy vegetables in various Mediterranean countries and Beta maritima is used as animal fodder. Purslane is particularly very widely used in Turkish cousine. The cultivated forms have longer leaves compared to the wild varieties. Purslane is harvested and marketed as whole plant with the roots to eliminate rapid water loss from the shoots.

Results related to purslane have shown that edible fresh weight decrease fom 16.3 g/plant to 7.3 g/plant as the salinity levels increase from 0.65 to 6.5 dS/m (Fig. 1). Total Na uptake per plant was high in the control (0.65 dS/m) and 3.5 dS/m treatments (Fig. 2). Owing to the restricted plant growth and consecutive fresh weight reduction, Na uptake was less in the 6.5 dS/m application. In this regard, Na concentrations (%) in the shoots increased by saline water applications compared to the control (Fig. 3). Similarly, Cl concentrations also increased with increased salination compared to that of control treatment. However, Cl uptake by purslane tended to decline like Na uptake. The harvestable yield per liter water consumed was the highest in S_1 treatment, followed by S_0 and S_2 (Fig. 4).

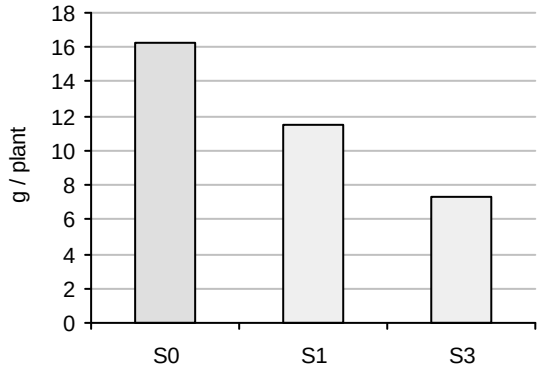

Figure 1. Above ground parts – fresh weight of purslane (P.O).

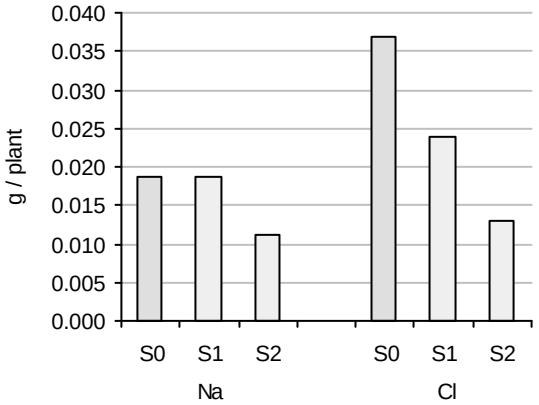

Figure 2. Total Na and Cl uptakes of purslane.

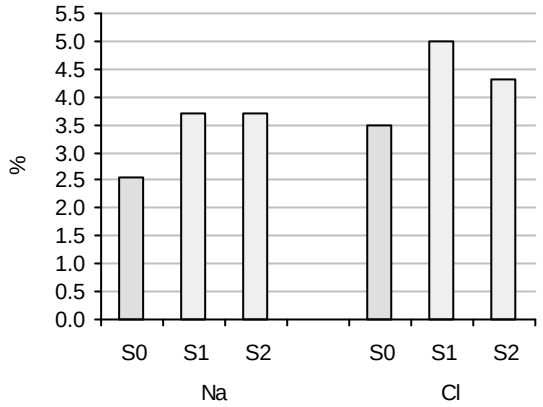

Figure 3. Na and Cl concentrations of the above ground parts of purslane.

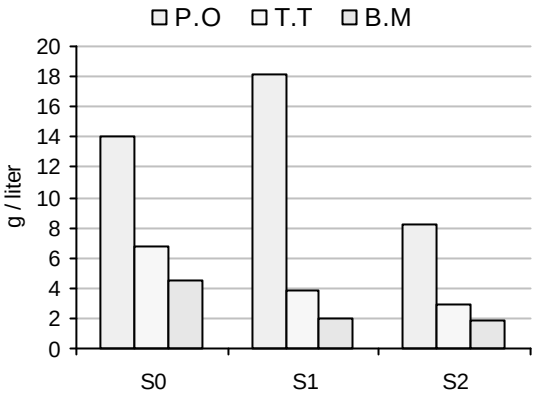

Figure 4. Harvestable yield per liter water consumed (WUE).

Results related to the New Zealand spinach have revealed that the fresh weights consistently decline from 302 g/plant to 121 g/plant as affected by enhanced salinity (Fig. 5). On the other hand, the Na concentration of plants increased from 1.8% to 2.4% in accordance with increased salinity levels (Fig. 6). The harvested yield per liter consumed water was 6.7 g/L in control pots and declined to 2.9 g/L at 6.5 dS/m treatment (Fig. 4).

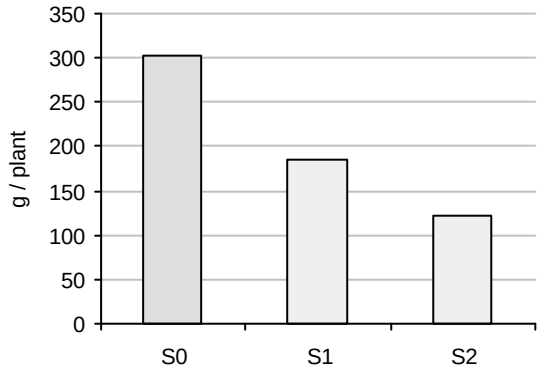

Figure 5. Fresh weight of N. Z. spinach (T.T) (whole plants).

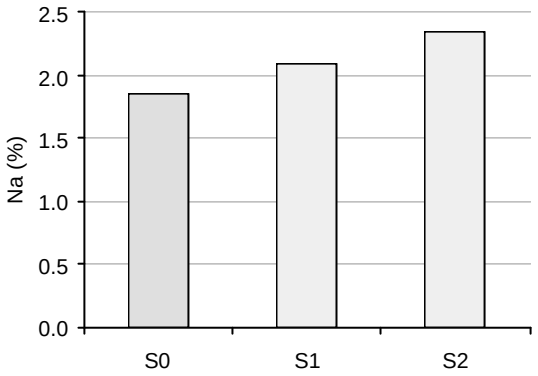

Figure 6. Na concentrations of N. Z. spinach (whole plants).

Regarding to the Beta maritima, the dry weight per plant was found the highest (28.5 g/plant) at the highest salinity applications (Fig. 7). The Na concentration increased from 4.5% to 5.3% at 6.5 dS/m level (Fig. 8). The same tendency was also observed in Na uptake measurements at the harvest (Fig. 9). The Cl concentrations of the plant reached its highest point (5.3%) at the 3.5 dS/m treatment. In accordance with the dry weight findings, the Cl uptake was found the highest as the salinity levels enhanced. The harvestable yield per liter water consumed was similar to the results obtained from New Zealand spinach.

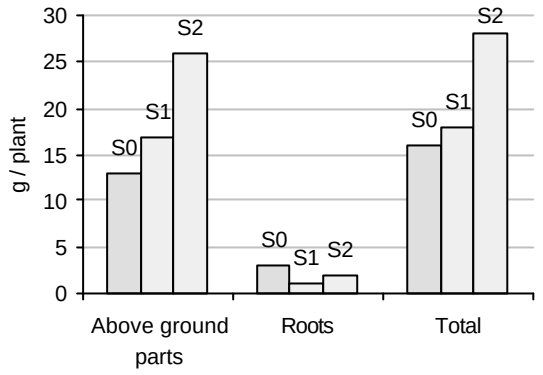

Figure 7. Dry weight of Beta maritima (B.M).

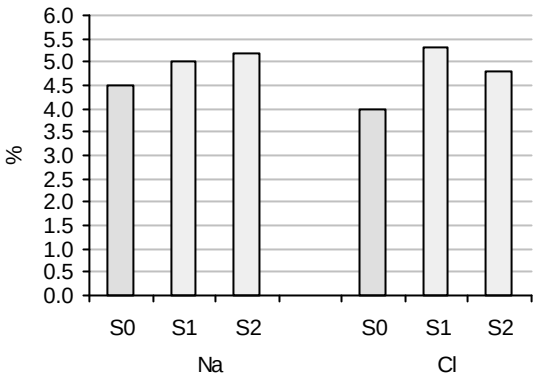

Figure 8. Na and Cl concentrations of above ground parts of Beta maritima.

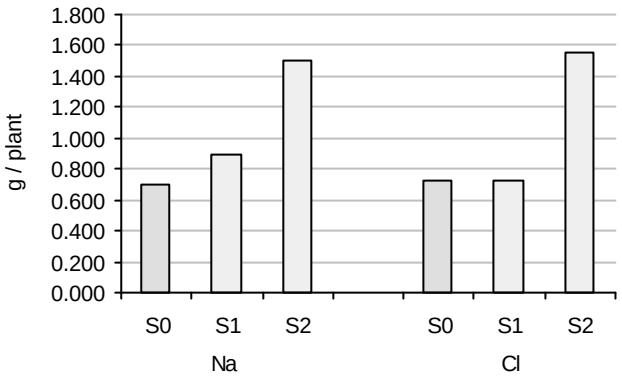

Figure 9. Total Na and Cl uptakes of Beta maritima.

4. DISCUSSION

The ideal plant to remediate salt affected soils would be a high biomass producing crop that can not only tolerate but also accumulate the salts (Ebbs and Kochian, 1997; EPA, 2000). The fast-growing, short-rotation salt removing crops potentially could create economical solutions, provided that they can be used as vegetables, ornamentals or fodder (Lieth, 1999).

High salt uptake and vigour of the tested species prove that these crops could be integrated into cultivation/rotation programmes. All of the results obtained from this study suggest that purslane is the most promising salt removing crop due to its high plant density, short vegetation period and higher biomass production per unit water consumed.

5. ACKNOWLEDGEMENTS

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