

PHYTOREMEDIATION OF SALT- AFFECTED SOILS AT AL- JAZEERA NORTHERN IRRIGATION PROJECT/ NINAVAH/ IRAQ

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ABSTRACT

Soil salinity is one of the most serious limiting factors that affect plant growth and productivity of various crops in arid regions. Methods commonly used to combat salinity are either classical or new using halophytes. This study was conducted at plastic house in order to evaluate the efficiency of *Atriplex halimus* in salt removal from saline, saline-sodic soils of Al-jazeera project in Ninawa province. Plantation with *A. halimus* decreased electrical conductivity for saline- sodic soil from 39.2 to 26.5 dS.m⁻¹ and from 6.2 to 4.9 dS.m⁻¹ for saline soil. Sodium adsorption ratio declined to half and 28.6% for saline- sodic and saline soils respectively. The current study revealed an increased efficiency of *Atriplex halimus* with increasing salinity which suggest it a good candidate for soil desalination in arid and semiarid regions.

Keywords: Phytoremediation , Salinity , Atriplex , SAR .

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INTRODUCTION

Salinity and sodicity are among the main causes of land degradation that retards plant growth and productivity worldwide (Qadir & Schubert, 2002), and affects roughly 7% of the world's total land area, particularly in arid and semi-arid regions. Such an extensive area emphasizes the need for efficient inexpensive and environmental acceptable management strategies to enhance crop productivity and sustainability of the ecosystems. There are two major approaches to the problem of salinized soils, (i) control of salinity level by soil, water and crop management practices and/ or (ii) biological or genetic management through the use of high salt tolerant species (Pasternak, 1987). Leaching salts from the root zone usually requires large amounts of water. In a country like Iraq where the availability of fresh water is becoming a serious problem, this method is not recommended. The utilization of halophytes in salt-affected soils in arid and semi- arid regions is the only economic solution presently available for soil reclamation. (Khan and Duke, 2001). *Atriplex* constitutes an essentially cosmopolitan genus of more than 417 species (Osmond et al. 1980). *Atriplex halimus* is a perennial native shrub with an excellent tolerance to drought and salinity (Ortiz- Rodon et al. 2005). Boyko (1964) was the first to suggest that halophytic plants could be used to desalinate soil and water. In Iraq, studies on phytoremediation are very scarce and concentrated on using halophytes to tolerate aridity and in recent years an agreement was established between Iraqi Ministry of Agriculture, ICARDA and University of Mosul within a soil preservation agriculture program.

Accordingly, three *Atriplex* species namely *A. halimus*, *A. nummularia* and *A. canescens* were entered Iraq and employed in an agricultural program at Ninawa province to tolerate aridity and their value as a livestock forage crops. The aim of this study was to investigate salt removal from salt- affected soils at Al- jazeera northern irrigation project/ Ninawa, cultivated with *Atriplex halimus*.

MATERIALS AND METHODS

Atriplex halimus was selected among four *Atriplex* species (*A. halimus*, *A. nummularia*, *A. canescens* and *A. leucoclada*) from a previous experiment (not published) using more closely related indices of identifying salt tolerant plants. Soil samples were collected from two irrigation units ,saline soils (G10) and saline-sodic soils (N16) of Al- jazeera project at Rabia district of Ninawa Province. They were collected from 0-30cm depth, dried in air, homogenized and passed through a sieve of 2mm before filling the pots with a capacity of 6 kg of dry soil. Some general chemical and physical characteristics of the soils are shown in table(1). The experiment was carried out in a plastic house which lasted for ninety days with four replicates for each soil and one plant per pot . Soil samples were also analyzed for specific parameter at the start and the end of the experiment on samples collected randomly from several depths of the pots like electrical conductivity, soluble sodium, calcium, magnesium and choride using standard procedures outlined by Tandon (1999). Sodium adsorption ratio (SAR), was calculated from concentrations of cations ($\text{mmol}_e \text{ l}^{-1}$) in the extract by the equation:

$$\text{SAR} = \frac{\text{Na}^+}{\sqrt{\frac{\text{Ca}^{++} + \text{Mg}^{++}}{2}}}$$

Plant received tap water , divided in upper parts and roots at the end of the experiment, oven dried at 65° for 48h : The dried plant material was subjected to wetted digestion with a 4 : 9(V:V) sulphuric- perchloric acid mixture as described by Tandon (1999). Na^+ and K^+ were determined in the extract by flame photometer. Cl^- was measured by titration against AgNO_3 . (Richards, 1954). Ca^{++} and Mg^{++} by EDTA titrimetry (Lanyon and Heald, 1982).The results were analyzed through variance analysis and L.S.D test ($p < 0.005$) using the Genstat program.

Table(1): Some chemical and physical properties of the studied soils.

Parameter		location	
		Saline-Sodic Soil (N16)	Saline Soil (G10)
pH		7.2	7.8
EC(dS.m ⁻¹)		39.2	6.2
CaCo ₃	gm.kg ⁻¹	155	189
Organic matter		16.0	18.6
Sand		320	250
Silt		475	625
Caly		205	125
Texture		Loam	Silt loam

RESULTS AND DISCUSSION

Some selected properties of the studied soils before and after the end of halophyte plantation are shown in table (2). It is clear the EC values were reduced from 39.2 dS.m⁻¹ to 26.5 dS.m⁻¹ for saline-sodic soil with a percentage decrease of 32.4%. The corresponding figures for saline soil are 6.2 to 4.9 dS.m⁻¹ and 21% .SAR is an important parameter to understand the equilibrium between soluble salts and exchangeable cations, also declined to half its original value for calcareous saline-sodic soil and from 2.1 to 1.5 (mmol/l)^{1/2} with a percentage decrease of 28.6% for saline soil .Na⁺ and Cl⁻ concentration decreased from 250 and 372 mmol.l⁻¹ to 119 and 234 mmol.l⁻¹ at the end of the experiment for saline-sodic soil. For saline soil, they decreased from 10 and 47 mmol.l⁻¹ to 7 and 45 mmol.l⁻¹ for sodium and chloride respectively. Concerning NaCl removal from the soil, it is clear from table (2) that NaCl removed from the soil ranged between 3052 Kg/ha for saline- sodic soil to 70 Kg/ha for saline soil through the period of the experiment.

Table (2): Some chemical properties of salt- effected soils before planting and after harvesting *A. halimus*.

location	Before planting				After harvesting			
	EC dS.m ⁻¹	SAR (mmol/l) ^{1/2}	Na ⁺	Cl ⁻	EC dS.m ⁻¹	SAR (mmol/l) ^{1/2}	Na ⁺	Cl ⁻
			mmol _c ⁻¹				mmol _c ⁻¹	
N16	39.2	30.4	250	372	26.5	15.2	119	234
G10	6.2	2.1	10	47	4.9	1.5	7	45

The sharp decrease in salinity was reflected in the highest concentration in the halophyte at the end of the experiment as shown in table (3) especially for Na⁺ and Cl⁻ ions concentration as it reached 40.98 and 71 mg.gm⁻¹ dry weight for saline- sodic soil and 23.38 , 42.6 mg.gm⁻¹ for saline soil. Statistical analysis revealed that the main ion concentration with the exception of K⁺ were significant between saline- sodic and saline soils for the upper part and for Na⁺ and Cl⁻ for the roots. The efficiency of *Atriplex halimus* for salt removed increased with increasing salinity especially for calcareous- sodic soils. As outlined by Qadiretal. (2005) where they found that phytoextraction is driven by (i) enhanced Na⁺ and salt uptake in the shoots and at harvest (ii) ability of plant roots to increase the dissolution rate of calcite, resulting in enhanced levels of Ca⁺⁺ in soil solution to replace Na⁺ from the cation exchange complex. This process is enhanced by the pressure of CO₂ within the root zone.

The results of the present study are in agreement with those reported by Al-Nasir (2009) in Jordan, Saritaetal. (2008) for various salt hyperaccumulator plant in india and in Egypt for forage production using halophytes (Ashouretal. 1999) and salt removed by *Atriplex halimus* (Anonymous, 2003).

Table(3): Dry and fresh weight, ion concentration in shoots and roots of *Atriplex halimus* at the end of experiment.

Soil type	Plan part	Mg ⁺⁺	Ca ⁺ ₊	K ⁺	Na ⁺	Cl ⁻	Fresh weight	Dry weight
		mg.g ⁻¹					gm	
Saline-Sodic soil(N16)	Shoots	21.25	8.25	33.80	40.98	71.00	24.00	7.26
Saline soil(G10)		18.75	5.25	32.10	23.38	42.6	85.70	22.13
L.S.D _{0.05}		0.86	0.86	7.62	4.34	3.69	15.14	3.47
Saline-sodic soil(N16)	Roots	10.50	4.50	11.73	3.67	53.25	5.80	2.17
Saline soil(G10)		10.75	4.50	17.63	2.01	35.5	16.86	6.86
L.S.D _{0.05}		0.39	0.99	3.82	0.70	3.50	8.46	2.27

المعالجة البايولوجية للترب المتأثرة بالأملاح في مشروع ري الجزيرة الشمالي/ نينوى/ العراق

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الخلاصة

تعد ملوحة التربة أحد أهم المشاكل الموجودة في المناطق الجافة وشبه الجافة من حيث تأثيرها على نمو وإنتاجية المحاصيل المختلفة. ولحد من هذه الآثار السلبية، هناك العديد من الطرق المتبعة نذكر ما هو تقليدي ومنها ما هو حديث تتمثل بزراعة نباتات الهالوفاييت المحبة للملوحة. نفذت الدراسة في البيت البلاستيكي بهدف تقييم كفاءة الرغل الملحي (*Atriplex halimus*) في إزالة الأملاح من ترب ملحية وملحية صودية في مشروع ري الجزيرة في محافظة نينوى. زراعة الترب بالرغل الملحي أدى إلى خفض قيم التوصيل الكهربائي للتربة الملحية الصودية من 39.2 إلى 26.5 ديسي سيمنيز.م⁻¹ ومن 6.2 إلى 4.9 ديسي سنميز للتربة الملحية. قيم نسبة إمتزاز الصوديوم انخفضت إلى النصف في التربة الملحية الصودية وبنسبة 28.6% في التربة الملحية. نتائج الدراسة بينت أن كفاءة الرغل الملحي تزداد مع إرتفاع الملوحة ويعتبر مرشح جيد لمعالجة الملوحة بايولوجياً في ترب المناطق الجافة وشبه الجافة. كلمات دالة : المعالجة البايولوجية ، الملوحة ، أترليكس ، نسبة إمتزاز الصوديوم .

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REFERENCE

- Al- Nasir F. (2009). Bioreclamation of a saline- sodic soil in a semi-arid region/ Jordan. *American Eurasian Journal Agricultural and Environmental Science*. 5: 701- 706.

- Anonymous (2003). Find Report Salt Control Project. Control of Salinization and Combating Desertification Effects In the Mediterranean Region: 1-70.
- Ashour, N., S.M. Arafat, A. Abd Eh- Haleem, M. Serag, S. Mandor and B. Kekki (1999). Growing halophytes in Egypt for forage production and desertification control. *Bulletin of Natural Resource Council, Egypt*, 24(3): 349- 360.
- Boyko H.(1964). Basic ecobgical principles of plant growing by irrigation with high saline seawater. In: Boyko, H.(Ed.), Salinity and Aridity. D.W. Junk Publisher, The Huger.
- Khan, M.A. and N.C. Duke (2001). Halophytes- A resource for the future. *Wetlands Ecology and Management*. 6:455- 456.
- Lanyon, Les E. and W.R. Heald (1982). Magnesium, Calcium, Strontium and Barium. In A.L. Page (ed.) Methods of Soil Analysis. Agronomy 9: 247- 262. Am. Soc. Of Agronomy , Inc., Madison, Wisconsin.
- Ortiz- Dorda, J., C. Martinez- Mora, E. Correal, B. Simon and J.L. Cenis (2005). Genetic structure of *Atriplex halimus* population in the Mediterranean Basin. *Annual Journal of Botany* , 95: 827- 834.
- Osmond, CB, O. Bjorkman and D.J Anderson. (1980) Physiological Processes in Plant Ecology: Towards a Synthesis with Atriplex. Springer- Verlag, Berlin.
- Pasternak, D. (1987). Salt tolerance and crop production. A comprehensive approach. *Annual Review Phytopathology* , 25: 271.
- Qadir M. & S. Schubert (2002). Degradation processes and nutrient constraints in sodic soil. *Land Degradation and Development*, 13: 275- 294.
- Qadir M., A.D. Noble, J.D. Oster, S. Schubert & A Ghafoor. (2005) Driving forces for sodium removed during phytoremediation of calcareous sodic and saline-sodic soils: a review. *Soil use and Management*. 21, 173-180.
- Richards L.A. (1954). Diagnosis and Improvement of Saline and Alkali Soils. United States Government Printing office , Washington , Handbook No. 60.
- Sarita, Devi, RaniC., Datta K.S, Bishnoi S.K., Mahala S. C., R. Angrish. (2008). Phytoremediation of soil salinity using salt hyperaccumulator plants. *Indian Journal of plant physiology*. 13(4): 226-236.
- Tandon, HLS (1999). Methods Analysis of Soils, Plants, Waters and Fertilizers Fertiliser Development and Consultation Organisation. New Delhi.