Management, Conservation and Utilization of Saline Soil and Saline Water Using Nuclear Techniques

J.Rastegari, M.Farhangi-sabet
Nuclear Research Center for Agriculture and Medicine, Karaj, Iran
jrastegari@yahoo.com

Abstract
More than 25 Mha of salt affected land exists in Iran. Considering that about 90% of the country is arid and semi-arid, the fresh water resources are limited. Population growth of the country and the consequent increase in food demands makes utilization of saline land and water resources for increased food production and socio economic improvement of the salt- affected areas, an important task. Haloculture can offer an economic and practical alternative towards achieving these goals. Haloculture is economical production of highly salt tolerant plants and halophytes in highly saline lands with saline irrigation water. The main objective of this study is to evaluate the adaptability of several local and imported salt tolerant plants with harsh environmental conditions of Iran. Other objectives of this project include utilization of Nutron Prob for irrigation scheduling of plants. Chah Afzal area in Yazd province was selected as experimental site. Plantation of salt tolerant species and irrigation had profound effect on reduction of soil PH, EC, and SAR. Results of neutron meter study revealed that some species consumed about half of water than other species. The results of this project revealed that haloculture can be utilized effectively in Iran to produce different salt tolerant species with different economical potentials.

Keyword: Salinity, Nuclear Techniques, Haloculture

Introduction

Iran is located between 25 and 40 North latitude and is predominately an arid and semi-arid country. About %15 or 25 million hectares of the country are affected by salinity. According to data published by UNESCO, IRAN ranks 3rd in Asia only after Russia and China and ranks fifth in the world in total salt affected land areas. Reclamation of salt affected land is being practiced using different combinations of leaching and drainage. Beside the high cost of these works, this solution has some other difficulties such as removal of drained water and environmental issues. Use of salt tolerant plant species while utilizing saline ground water is more effective alternative for this purpose.

Halophytes are plant species that grow naturally in saline habitats. They are represented by several thousand species of grasses, shrubs and tress, which are distributed throughout different ecosystems; from coastal areas to mountains and lowland deserts. Halophytes can be utilized for rehabilitation of degraded lands, combating desertification, fuel wood and timber production, shade and shelter, industrial crops, and animal fodder. Thus, halophytes with proper management can make a significant contribution to mankind and to human food security. Millions of hectares of soils too salty for normal crops and pasture lie idle. Salt tolerant plants, particularly halophytes maybe grown on these types of soils. (Breckle, 1986- Le Houerou, 1993 – Malcolm, 1994- Squires, 1994).

Material and Methods

The study site was located at Cha- Afzal Research Station 90 km from Yazd in central Iran. The study area's climate is harsh dry and desert-like. Annual rainfall and the evaporation rates are 60-80mm and 4000mm respectively. Annual temperature ranges from – 16 to 45°c. About 90% of the land surfaces are heavily affected by salinity.

In order to perform management practices and lower salt accumulation in top soil, 21 salt–tolerant species were selected to test in the site of Yazd. The quality of water available for irrigation is presented in table 1 and soil characteristics of the experimental site are given in table 2. In order to measure soil water content, monitoring its changes with time and make suitable schedules for irrigation, ten access tube (in two replications) were installed up to about 180cm soil depth, in 5 selected plots. Irrigation was started when the soil water depletion was about 50% of volumetric soil water content at F.C. Amount of irrigation water calculated based on difference between soil moisture prior to irrigation and the soil moisture at field capacity. In order to compare salt tolerance of different species and for their ability to reduce soil salinity, one hectare plots of different species were considered. Soil salinity was measured twice (before planting and 3 years later). Survived plant populations were counted 1 and 2 years after plantation, and their percent of survival rates were calculated.

Results

The results of soil EC, PH and SAR changes are given in Fig1, 2, 3. Fig1, 3 illustrate electrical conductivity and sodium absorption ratio at upper layer of soil profile have decreased due to leaching of sodium salts and chloride ions.Fig2 demonstrates that soil PH has been improved. This attributes to cultivation of salt tolerance species which added organic matter to the soil. Organic acids, the by product of O.M biological decomposition lowered the soil PH. The results showed that out of 21 selected salt tolerant plants, 12 species, and sub- species performed adequately. These species have potential uses for orchard products (Pistachio, Pomegranate, and wild olive), for forage (Acacia, Atriplex, Sesbania, Kochia and Kallar grass), and for wood (Eucalyptus, wild olive, Haloxylon and Tamarix). Results of neutron meter study revealed that Eucalyptus and Sesbania consumed 2.5 times more water than Pistachio, wild olive, Atriplex, Haloxylon, Tamarix, Acacia and Kochia, and 2 times more than pomegranate. Plantation of species with low water requirement for arid region of Chah Afzal is more desirable.

Discussion

In order to screen among salt-tolerant species for the local conditions, adaptation trials are necessary. Such trials were successfully implemented in this project. The site served very well to demonstrate the capabilities and usefulness of Biosaline Agriculture to local farmers and research scientists. The application of neutron probe as a means of nuclear technique for irrigation management was also successfully demonstrated.

Based on the resutls of this study, Punica grantum, Elaegnus angustifolia, Acacia ampliceps, Pistacia Vera, Eucalyptus camaldulensis, Haloxylon aphyllum, Tamarix and Atriplex were the most suitable salt-tolerant species among the ones tested for the local conditions. However, more salt-tolerant species should be trialed. The appropriate agronomic practices for maximum production of these species need to be studied further.

References

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Table 1. Quality of water available for irrigation at the selected site of Yazd during Feb.1999 till Oct. 1999

Date	2-1999	6-1999	10-1999
EC 10^6	9217	8104	7039
PH	7.4	7.3	7.1
R.S.C	-	-	-
S.A.R	17.7	17.1	16.3
S.I.	1.46	1.42	1.05
	44	41	33.4
Classificaion	C4-S4	C4-S4	C4-S4

Table 2. Soil characteristics of the selected site of Yazd at initial stage

Sample 1				Sample 2	
Depth		0-35cm	35-70cm	0-35cm	35-70cm
EC	ds/m	126.38	50.64	200.2	75.2
PH	paste	8.2	8.1	8.2	8.2
P.W.	%	17.75	22.53	21.37	26.8
S.A.R.	-	283	116	544	247.2
E.S.P.	%	95	90	98	94.1
E.S.R.	-	21	8.9	44	16.8
Texture		L	S.L.	Clay	C.L.

P.W. = Soil moisture
S.A.R. =Sodium Absorption Ratio
E.S.P. = Exchangeable Sodium Percentage ($Na/_{CEC}$ 100)
S.P. = Saturation percentage
E.S.R.= Exchangable Sodium Ratio ($^{Na}/_{CEC}$-Na)
R.S.C. = Residual Sodium Carbonate
S.I. = Saturation Index= $8.4 – (pK_2\text{-}pK_{sp}) + p\,(Ca + Mg) + P\,(CO3 + HCO3)$
$S.A.R.adj=Sar_{irr}[1.0+(8.4–pH_c)]$

Table 3: Some of the soil characteristics 3 years after cultivation of salt tolerance species at 0-30

Plot	**pH**	**EC*10^3**	**SAR**
Punica grantum	8.1	9.1	3.47
Elaegnus angustifolia	8.03	8.88	12.89
Acacia ampliceps	8.12	9.65	12.75
Pistachia vera	8.2	12.7	21.78
Atriplex lentiformis	8.2	11.87	20.319
Atriplex halimus	8.2	15.81	24.28
Haloxylon aphyllum	8.04	30.4	53.92
Eucalyptus	7.8	8.68	13.3
Tamarix	8.08	10.8	16.8

cm depth

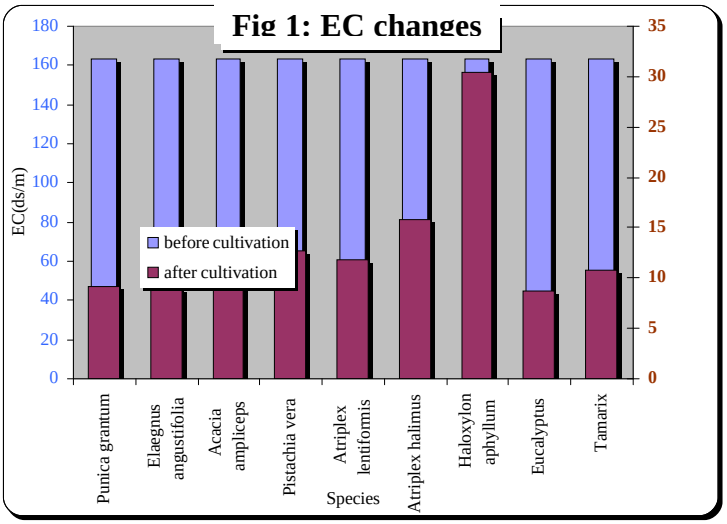
Fig 1: EC changes
EC(ds/m)
before cultivation
after cultivation
Punica grantum
Elaegnus angustifolia
Acacia ampliceps
Pistachia vera
Atriplex lentiformis
Atriplex halimus
Haloxylon aphyllum
Eucalyptus
Tamarix
Species

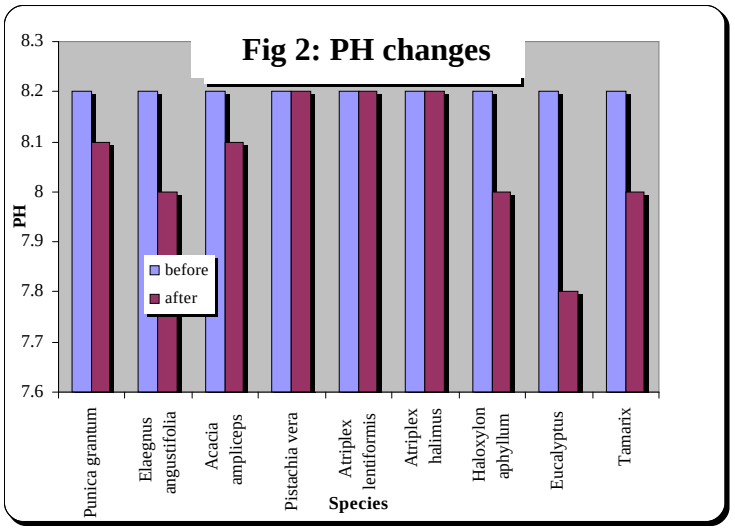
Fig 2: PH changes
PH
before
after
Punica grantum
Elaegnus angustifolia
Acacia ampliceps
Pistachia vera
Atriplex lentiformis
Atriplex halimus
Haloxylon aphyllum
Eucalyptus
Tamarix
Species

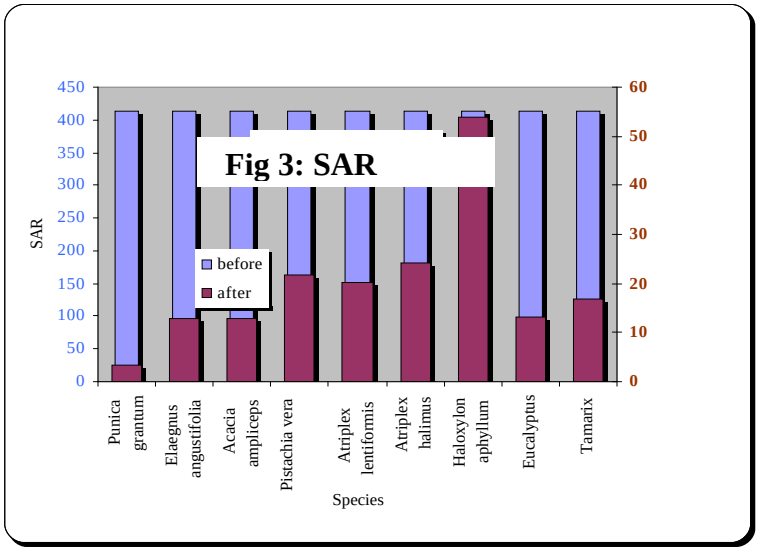
Fig 3: SAR
SAR
before
after
Punica grantum
Elaegnus angustifolia
Acacia ampliceps
Pistachia vera
Atriplex lentiformis
Atriplex halimus
Haloxylon aphyllum
Eucalyptus
Tamarix
Species

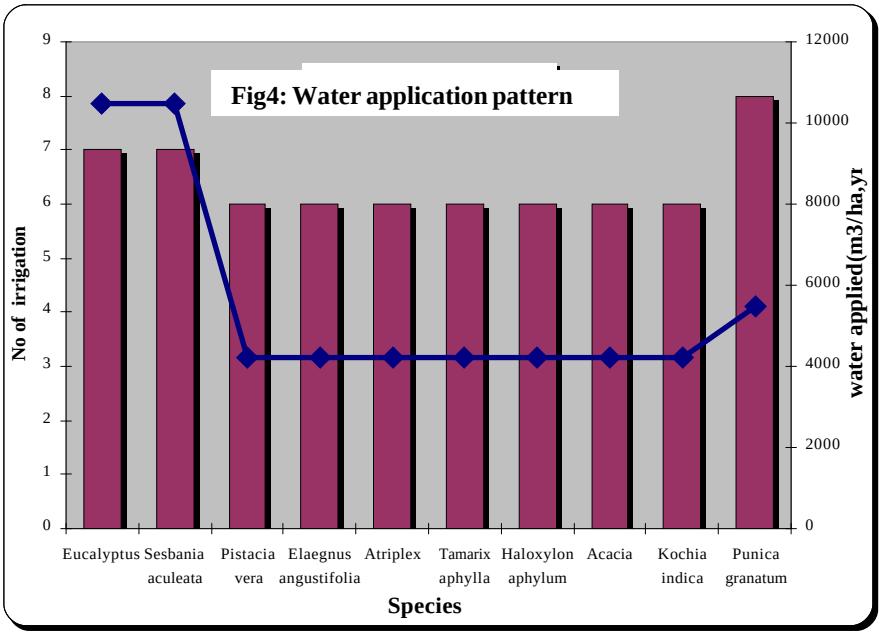
Fig4: Water application pattern
No of irrigation
water applied(m3/ha,yr
Eucalyptus
Sesbania aculeata
Pistacia vera
Elaegnus angustifolia
Atriplex
Tamarix aphylla
Haloxylon aphylum
Acacia
Kochia indica
Punica granatum
Species