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Relationship between Growth of *Atriplex* species and Some Soil Properties in Khoor (Iran)

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ABSTRACT

Atriplex **species are planted in the desert area of central of Iran for prevent the spread of blowing sand.** ***Atriplex*** **species have tremendous ability to grow in saline conditions. The study was carried out to investigate the effects of soil properties on growth of** ***Atriplex*** **species in Khoor plain (Iran). Khoor plain is in Naeen area and is located in the Eastern of Isfahan province (the center of Iran). Soil properties such as electrical conductivity (EC), soil reaction (pH), the percentage of clay and sand, the percentage of calcium carbonate and gypsum, sodium ions, chloride ions, potassium, phosphorus and total nitrogen were measured.** ***Atriplex*** **physiological parameters including height and top were measured. The evidences provided by this experiment that the soil EC, pH, sodium ions, chloride ions and the percentage of clay had negative effects on** ***Atriplex*** **physiological parameters but the percentage of sand and calcium carbonate had positive effects on** ***Atriplex*** **physiological parameters. The percentage of gypsum, potassium and total nitrogen did not have significant effects on plant physiological parameters.**

Key Words: ***Atriplex*****, Desert, Physiological parameters, Soil properties**

INTRODUCTION

Due to its special geographic condition, Iran is a dry and semidry zone of the world (Honarjoo et al., 2010). A major constraint for plant growth in arid, semi-arid and seasonal dry coastal areas is of salinity, which imposes a stress on crop growth that results in decreased yield and complete crop failure in extreme cases. This problem is further intensified when marginal land is brought under cultivation by artificial irrigation.

Halophytes accumulate large amount of Na^+ and Cl^- in higher concentration for osmotic adjustment within their tissues to keep the water potential at desired level. Chenopodiaceae are found in arid and halophytic plant communities worldwide, and probably include more halophytic species than other plant families. Chenopods are therefore particularly suited for erosion control and rangeland rehabilitation in salt-affected and degraded areas (Asghari et al., 2005). *Atriplex* species have tremendous ability to grow in saline conditions by taking up salts from soil and accumulating in their different vegetative parts. These species have great potential for improving saline rangelands because they are highly tolerant to drought and salinity and thus, have an excellent role to play in biological reclamation (Ullah et al., 2008).

In semi-arid climatic conditions, desertification is becoming a serious problem, with a progressive reduction of the vegetation cover coupled with rapid soil erosion. Drought resistance is a complex trait involving several interacting properties and there is increasing interest in studying the physiological behavior of xero-halophyte species in order to identify and understand drought-resistance mechanisms. Several species belonging to the genus *Atriplex* are well adapted to harsh environmental conditions (Martinez et al., 2005).

Ullah et al. (2008) investigated the correlation of *Atriplex amnicola* and soil properties. This result showed that the correlation between soil ECe and volume/fresh yield of *Atriplex amnicola* was positive and generally significant. However, all other correlations like between soil pHs and plant parameters, SAR and plant parameters and chemical composition (Na: K & Cl content) and plant parameters were found to be non-significant.

Mojiri et al. (2011a) reported that the electrical conductivity, sodium ions, HCO_3^- and the percentage of clay had negative effects on *Haloxylon sp.* physiologic parameters whilst the percentage of calcium carbonate had a positive effect on plant physiologic parameters.

The aim of the study was to investigate the effects of soil properties on growth of *Atriplex* species.

MATERIALS AND METHODS

Study Area, Field Operation

Based on the status of vegetation in the region, a total of 7 profiles were studied in Khoor plain (Iran) in 2010. Then each depth different profiles (0-30, 30-60 and 60-90 cm) was sampled. Soil samples were air dried in a greenhouse at a temperature between 25ºC and 30ºC and sifted through a 2-mm mesh sieve for preparation of

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soil samples (Mojiri et al., 2011b). In the study area all the *Atriplex* species plants were the same age. Plant physiologic parameters, including plant height and top were measured.

Khoor plain is in Naeen area and is located in the Eastern of Isfahan province (the center of Iran). The climate of the zone using the De Martonne & Gowsen methods is dry and semi-desert, respectively. Average annual temperature of Khoor is about 19.6 °C. Average annual rainfall of this plain is about 70.8 mm (Varesi et al., 2010).

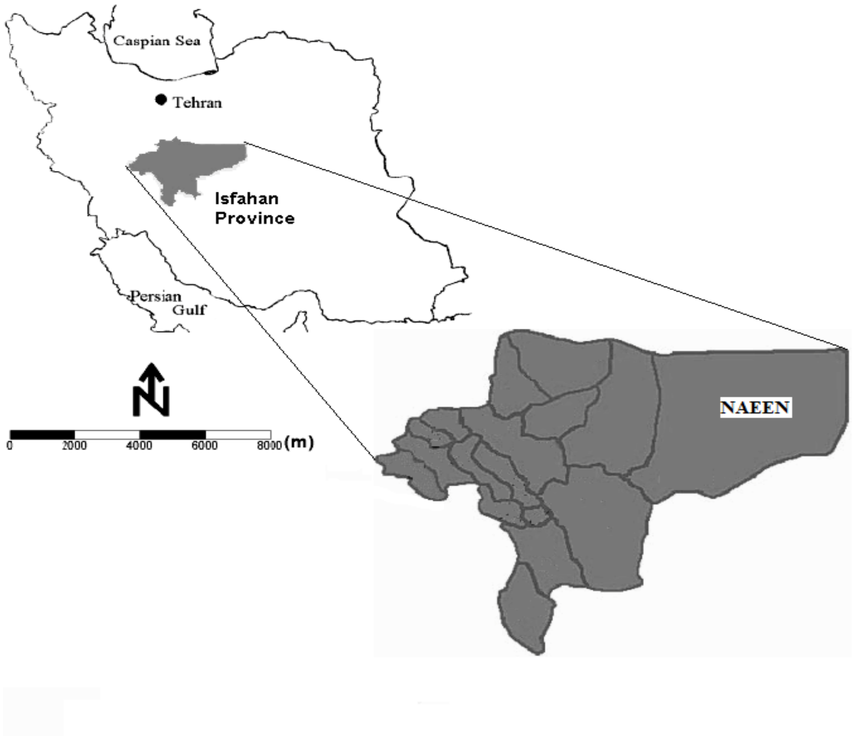

Figure 1. Isfahan province in the center of Iran.

Laboratory Analysis

Soil pH was measured on saturated soil paste, the electrical conductivity (EC) was measured on saturation extracts, the percentage of gypsum was obtained by precipitation with acetone method, the percentage of calcium carbonate was determined by titration method and chloride ions were measured by titration method with silver nitrate (Richards, 1954). Total nitrogen was measured by Kjeldahl method (ASA, 1982). Phosphorus was measured by Olsen method (Ludwick and Reuss, 1974). Soil texture was determined by the Bouyoucos hydrometer method (Gee and Bauder, 1986). Sodium ions and potassium were measured by Flamephotometry (Zarinkafsh, 1993).

Statistical Analysis

The SPSS software was used to analyse and compared the statistics and averages.

RESULTS AND DISCUSSION

The soil properties and *Atriplex* physiological parameters are shown in Table 1 and Table 2. The Table 3 shows the correlation between soil properties and plant parameters.

Table 1. Soil properties of vertical transect.

Depth (cm)	pH	EC (dS/m)	Cl (me L^{-1})	Na (me L^{-1})	K (me L^{-1})	TN (%)	P (mg kg^{-1})	$CaSO_4$ (%)	$CaCO_3$ (%)	Clay (%)	Sand (%)
Profile 1											
0-30	7.75	58.26	662	831	14.1	0.057	14.0	24.8	21.1	14.4	39.7

30-60	7.49	39.51	541	778	12.4	0.068	13.8	20.4	20.0	22.6	31.4
60-90	7.11	38.32	510	789	10.8	0.063	13.4	20.4	18.0	27.7	30.9
Profile 2											
0-30	7.48	54.05	590	731	13.6	0.056	13.6	24.1	20.7	15.9	36.1
30-60	7.21	40.10	487	704	12.7	0.066	14.0	20.1	20.7	22.7	35.6
60-90	7.19	35.40	481	613	11.1	0.069	13.6	19.7	18.0	29.1	34.1
Profile 3											
0-30	7.59	53.08	601	695	13.9	0.052	14.1	21.9	20.1	14.8	41.3
30-60	7.40	44.04	432	500	10.9	0.064	13.9	19.6	19.6	22.5	33.7
60-90	7.37	38.12	392	487	10.4	0.064	14.0	19.4	19.1	23.1	30.9
Profile 4											
0-30	7.61	41.18	356	591	13.3	0.052	13.8	24.7	22.4	14.2	49.8
30-60	7.39	24.04	301	507	12.9	0.063	14.0	20.5	19.8	19.7	34.1
60-90	7.43	20.30	277	444	11.0	0.068	14.0	21.5	19.1	21.0	33.2
Profile 5											
0-30	7.40	29.66	333	509	13.0	0.057	14.0	22.5	23.3	13.5	53.2
30-60	7.29	21.40	295	433	12.6	0.066	14.6	19.9	19.9	19.7	43.9
60-90	7.18	21.30	203	403	10.8	0.062	13.8	19.2	18.8	20.8	40.1
Profile 6											
0-30	7.20	31.23	338	483	13.1	0.060	13.9	23.8	23.7	13.0	53.0
30-60	7.14	20.11	273	309	12.6	0.072	14.0	21.5	20.0	18.9	41.5
60-90	7.00	18.51	200	268	9.9	0.070	14.1	18.9	19.6	19.4	38.1
Profile 7											
0-30	7.29	22.40	297	480	13.8	0.059	13.4	20.2	25.4	11.0	54.3
30-60	7.01	18.55	212	325	12.2	0.070	13.9	19.6	21.2	17.6	40.1
60-90	7.00	17.09	195	246	10.8	0.071	14.0	20.1	19.5	18.8	39.2

Table 2. Plant parameters around of profiles

Profile	**Height (cm)**	**Top (cm)**	**Profile**	**Height (cm)**	**Top (cm)**
Profile 1	0	0	Profile 5	73	151
Profile 2	0	0	Profile 6	85	170
Profile 3	0	0	Profile 7	97	188
Profile 4	62	121			

*0 = *Atriplex* cultivated did not have any growth in these profiles.

Table 3. Pearson correlation (r) between soil properties and plant parameters.

Soil properties	Plant physiologic parameters		Soil properties	Plant physiologic parameters		Soil Properties	Plant physiologic parameters	
	Height (cm)	Top (cm)		Height (cm)	Top (cm)		Height (cm)	Top (cm)
EC_1	-0.973**	-0.974**	K_1	-0.612	-0.634	$Sand_1$	0.972**	0.975**
EC_2	-0.986**	-0.988**	K_2	0.376	0.381	$Sand_2$	0.778*	0.795*
EC_3	-0.985**	-0.984**	K_3	-0.259	-0.267	$Sand_3$	0.848*	0.859*
pH_1	-0.757*	-0.760*	TN_1	0.500	0.505	$Gypsum_1$	-0.406	-0.399
pH_2	-0.665	-0.656	TN_2	0.469	0.466	$Gypsum_2$	0.230	0.236
pH_3	-0.552	-0.552	TN_3	0.451	0.427	$Gypsum_3$	-0.056	-0.708
Cl_1	-0.978**	-0.979**	P_1	-0.378	0.355	Calcium $Carbonate_1$	0.954**	0.948**
Cl_2	-0.963**	-0.960**	P_2	0.364	0.394	Calcium $Carbonate_2$	0.285	0.256
Cl_3	-0.956**	-0.960**	P_3	0.648	0.642	Calcium $Carbonate_3$	0.771*	0.764*
Na_1	-0.947**	-0.951**	$Clay_1$	-0.823*	-0.813*			
Na_2	-0.862*	-0.862*	$Clay_2$	-0.989**	-0.983**			
Na_3	-0.872*	-0.869*	$Clay_3$	-0.892**	-0.891**			

* & ** significance at level of five and one percent respectively.
Index 1, 2 and 3show first, second and third depth from the soil surface, respectively.

According to Table 3, electrical conductivity (EC), chloride ions, sodium ions and the percentage of clay had negative effects on *Atriplex* physiological parameters in all depths. Soil reaction (pH) had a negative effect on plant parameters in the first depth. The percentage of sand had a positive effect on plant parameters in all depths. The percentage of calcium carbonate had a positive effect on plant parameters in the first and third depths. The percentage of gypsum, total nitrogen and phosphorus did not have significant effect on plant physiological parameters.

Soil electrical conductivity (EC)

The soil EC had a negative effect on plant physiological parameters. This is in line with findings of Zehtabian et al. (2010), Mojiri et al. (2011a) and Mojiri and Jalalian (2011).

Chloride ions (Cl)

The chloride ions had a negative effect on plant physiological parameters. This is in line with findings of Mojiri et al. (2011a) and Mojiri and Jalalian (2011).

Sodium ions (Na)

The soil sodium ions had a negative effect on plant physiological parameters. This is in line with findings of Zehtabian et al. (2010), Mojiri et al. (2011a) and Mojiri and Jalalian (2011).

Soil reaction (pH)

The soil pH had a negative effect on plant physiological parameters. This is in line with findings of Zehtabian et al. (2010), Mojiri et al. (2011a) and Mojiri and Jalalian (2011).

Salinity is the presence of excessive amount of soluble salts in the growth medium of plants. The salts responsible for causing salinity are mostly chlorides and sulfates of sodium, calcium and magnesium. Smaller quantities of potassium, ammonium and nitrate may also occur. These salts affect the plant growth either by reducing the osmotic potential of the soil (Ashraf et al., 2006). Salinity has a dual effect on plant growth via an osmotic effect on plant water uptake, and specific ion toxicities. By decreasing the osmotic potential of the soil solution, plant access to soil water is decreased, because of the decrease in total soil water potential (Sheldon et al., 2004).

A soil with an alkaline to strongly alkaline reaction can have a number of nutrient deficiencies including phosphorus, nitrogen, copper, zinc, manganese and iron (Moore, 2004). Soil sodium increases soil reaction, encourages low uptake in some types of micronutrients and destroys the physical properties of soils, thereby reducing soil permeability and growth of plants (Mojiri and Jalalian, 2011).

Potassium (K)
Potassium did not have any significant effect on plant physiological parameters.

The percentage of clay
The percentage of clay had a negative effect on plant physiological parameters. This is in line with findings of Zehtabian et al. (2010).

The percentage of sand
The percentage of sand had a positive effect on plant physiological parameters. This is in line with findings of Zehtabian et al. (2010).

In investigating the effects of soil texture on plant physiologic parameters, Mojiri and Jalalian (2011) and Mojiri et al. (2011a) found the same results about a negative effect of the percentage of clay and a positive effect of the percentage of sand on plant physiologic parameters. If soil texture is lighter, root penetration into the deep soil is easier (Mojiri and Jalalian, 2011). Zehtabian et al. (2010) reported that the natural regeneration of *Haloxylon aphyllum* in soils with light structure is higher than in soils with heavy structure.

Total nitrogen (TN)
Total nitrogen did not have any significant effect on plant physiological parameters. This is in line with findings of Mojiri et al. (2011a).

Phosphorus
Phosphorus did not have any significant effect on plant physiological parameters. According to Table 1, phosphorus in all depth of the study area was high.

The percentage of gypsum ($CaSO_4$)
The percentage of gypsum did not have any significant on plant physiological parameters. This is line with finding of Mojiri and Jalalian (2011).

The percentage of calcium carbonate ($CaCO_3$)
The percentage of calcium carbonate had a positive effect on plant physiological parameters. This is in line with findings of Mojiri and Jalalian (2011).

Calcium carbonate is a common mineral in semi-arid and arid soils. Calcium carbonate is non-toxic to plants, although it may affect nutrient uptake (Moore, 2004). Calcium carbonate causes the creation of appropriate soil structure and induces changes to soil acidity (Mojiri and Jalalian, 2011).

CONCLUSIONS

In semi-arid climatic conditions, desertification is becoming a serious problem, with a progressive reduction of the vegetation cover coupled with rapid soil erosion. *Atriplex* species are planted in the desert area of central of Iran for prevent the spread of blowing sand.

Pearson correlation showed that the EC, pH, Cl, Na, the percentage of clay had negative effects on plant physiological parameters but the percentage of sand and calcium carbonate had positive effects on plant parameters.

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