The Journal of Animal & Plant Sciences, 21(4): 2011, Page: 686-691
ISSN: 1018-7081

EFFECTS OF SELECTED SOIL PROPERTIES ON GROWTH OF *HALOXYLON SP.* IN SEGZI PLAIN (IRAN)

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ABSTRACT

This study evaluated the effects of soil properties on growth of *Haloxylon sp*. in Segzi plain in the Eastern of Isfahan province (center of Iran). One way to prevent the spread of blowing sand in a desert area is the biological fixation such as *Haloxylon sp*. For this research, a total of 12 profiles were studied. Depth of hardpan from the soil surface was determined. Then the soil samplings of 0-30, 30-60, 60-90, 90-120 cm depth were done. Plant physiological parameters, including plant height and top were measured. In the study area, *Haloxylon sp.* plants were all of similar age. Soil physical and chemical characteristics such as soil texture, total nitrogen (TN), pH, electrical conductivity (EC), chloride ions (Cl) and sodium absorption ratio (SAR) were measured. For analysis of the SPSS software was used to compare the statistics and averages. These results showed that the EC, SAR, Cl, pH and the percentage of clay had negative effects on plant physiologic parameters. The percentage of sand and depth of hardpan from the soil surface had positive effects on plant parameters.

Keywords: Alkalinity, Chloride ions, *Haloxylon sp*., Pearson correlation, Salinity, Soil.

INTRODUCTION

Due to its especial geographic condition, Iran is a dry and semi-dry zone in the world (Honarjoo *et al*. 2010). Most parts of Iran extent located in sensitive ecosystems of arid and semi arid zones. Management of these zones are so difficult because of their special characteristics and low ecologic abilities, problems and obstacles about performance of various ecosystems improving and rehabilitating projects (Jafari *et al*. 2009).

Desertification in Iran was recognized between the 1930s and 1960s (Amiraslani and Dragovich 2011). Some studies indicated that the salinization of soil and water resources, climate, wind erosion, inappropriate land management and destruction of vegetation were the most important factors affecting desertification process in the dry land ecosystems of Iran (Honardoust *et al*. 2011).

Desert regions are called as brittle ecosystems. In order to abatement of desertification expanding in natural resources lands are used various biologic practices (Jafari *et al*. 2009). One way to prevent the spread of blowing sand in a desert area is through biological fixation such as *Haloxylon sp.* (Mokhtari 2002).

Soil play an important role in plant growth as it supports the palnts to stay and provides muterients and other growth factors. (Karimi 1997).

Jafari *et al*. (2004) studied effective environmental factors in the distribution of vegetation types in Poshtkouh rangelands of Yazd province (IRAN). The results showed that the vegetation distribution pattern was mainly related to soil characteristics such as salinity, texture, soluble potassium, gypsum and lime.

Chahoki and Safizade (2008) investigated environmental effective factors on distribution of arid plants. The results showed that the vegetation distribution was mainly related to soil characteristics such as gravel, saturation moisture, EC, pH, and lime.

Azarnivand *et al*. (2006) investigated the effects of salinity stress on germination of *Haloxylon aphyllum*, *Seidlitzia rosmarinus* and *Hammada salcornica* and reported that the percentage of germination, germination rate, plumule and radical length were decreased with increasing of salinity. *Hammada salicornica* is the most resistant species.

Karimpur (2005) studied the effects of soil physic-chemical properties on *Haloxylon apyllum* density in Tabas region (IRAN). The results revealed that there was significant relationship between vegetation density and the soil properties.

In this study the effects of soil properties on growth of *Haloxylon sp*. in Segzi plain has been investigated.

MATERIALS AND METHODS

Study area: Segzi plain is located in the Eastern of Isfahan province in the center of Iran and about 40 kms from Isfahan center (31˚ 23'N, 51˚7'E to 32˚ 55'N, 51˚ 56'E). The maximum elevation is 1640 m and the minimum elevation Above Sea Level (ASL) is 1510 m. Then the high difference is 130 m and because of the

slope between 0 to 2 percent, it is flat (Mojiri *et al*. 2011). The climate of the zone using the De Martonne and Gowsen methods is dry and semi-desert, respectively (Mojiri, 2010).

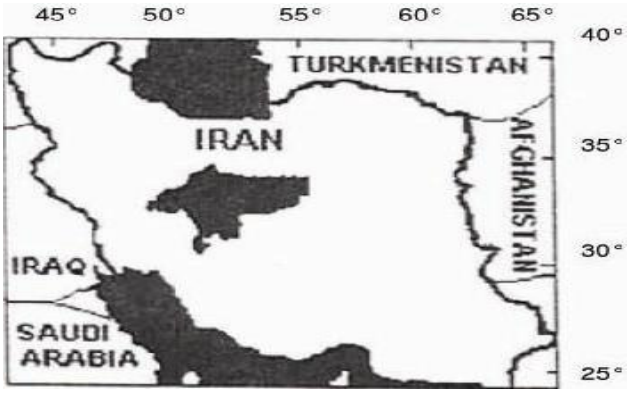

Fig. 1. Isfahan province in the center of Iran

Field Operations: A total of 12 profiles as horizontal and vertical transect were studied (5 profiles in horizontal transect and 7 profiles in vertical transect). Depth of hardpan from the soil surface was determined. Then the samplings of 0-30, 30-60, 60-90, 90-120 cm depth were done. Plant physiological parameters, including plant height and top were measured. . In the study area, *Haloxylon sp.* plants were all of similar age (nearly 18 years old, they were planted on 18 years ago).

Analytical methods: 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, chloride ions were measured by titration method with silver nitrate (Richards 1954). Nitrogen was measured by Kjeldahl method (ASA 1982). Soil texture was determined by the Bouyoucos hydrometer method (Gee and Bauder 1986). Calcium and magnesium were measured by direct titration with EDTA method. Sodium ion was measured by Flamephotometry (Zarinkafsh, 1993). The sodium absorption ratio (SAR) was measured by

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

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

RESULTS AND DISCUSSION

Soil properties, plant physiological parameters and Pearson correlation (r) between soil properties and plant parameters are shown in Tables 1, 2, 3 and 4, respectively.

First depth (0 – 30 cm): Minimum pH equal to 7.00 was recorded in profile 12, and maximum pH equal to 7.95 was found in profile 8. Minimum EC (dS/m) equal to 4.08 was measured in profile 2, and maximum EC equal to 195.48 was recorded in profile 11. Minimum chloride ion (me/l) equal to 13.1 was measured in profile 3, and maximum chloride ion equal 3126.6 was found in profile 11. Minimum SAR equal to 6.51 was recorded in profile 2, and maximum SAR equal to 868.61 was recorded in profile 11.

Second depth (30 – 60 cm): Minimum pH equal to 7.05 was recorded in profile 12, and maximum pH equal to 7.99 was measured in profile 2. Minimum EC (dS/m) equal to 17.00 was measured in profile 2, and maximum EC equal to 41.04 was measured in profile 11. Minimum chloride ion (me/l) equal to 67.2 was found in profile 9, and maximum chloride ion equal 508.3 was recorded in profile 3. Minimum SAR equal to 47.78 was found in profile 3, and maximum SAR equal to 256.94 was recorded in profile 11.

Third depth (60 – 90 cm): Minimum pH equal to 7.15 was recorded in profile 6, and maximum pH equal to 8.23 was determined in profile 2. Minimum EC (dS/m) equal to 11.21 was measured in profile 12, and maximum EC equal to 45.02 was found in profile 3. Minimum chloride ion (me/l) equal to 82.0 was found in profile 12, and maximum chloride ion equal 474.5 was found in profile 11. Minimum SAR equal to 22.74 was found in profile 12, and maximum SAR equal to 245.35 was recorded in profile 5.

Forth depth (90 – 120 cm): Minimum pH equal to 7.10 was recorded in profile 12, and maximum pH equal to 8.17 was determined in profile 2. Minimum EC (dS/m) equal to 8.65 was found in profile 12, and maximum EC equal to 48.94 was found in profile 11. Minimum chloride ion (me/l) equal to 53.1 was measured in profile 12, and maximum chloride ion equal 585.0 was found in profile 11. Minimum SAR equal to 16.52 was found in profile 12, and maximum SAR equal to 263.00 was recorded in profile 11.

Growth of *Haloxylon sp.* in profile 12 is better than other profiles.

Fig. 2. *Haloxylon sp.* in profile 12

Table 1. Soil properties of horizontal transect

Depth (cm)	Depth hardpan (cm)	pH	EC (dS/m)	Cl (me L^{-1})	SAR	N (%)	Clay (%)	Sand (%)
Profile 1								
0-30	95	7.61	10.53	71	30.59	0.038	6.70	57.51
30-60		7.52	17.12	120	62.49	0.024	8.33	38.24
60-90		7.55	17.12	120	78.44	0.028	10.20	25.50
90-120		7.67	15.92	120	27.37	0.071	17.36	23.55
Profile 2								
0-30	104	7.75	4.08	18.6	6.51	0.023	5.98	73.84
30-60		7.99	17.00	131.0	48.98	0.064	10.64	32.24
60-90		8.23	11.77	95.0	68.75	0.080	20.83	31.20
90-120		8.17	12.04	97.6	187.99	0.068	19.91	27.45
Profile 3								
0-30	66	7.88	18.82	13.1	39.80	0.035	7.45	59.51
30-60		7.62	46.29	508.3	47.78	0.044	11.50	24.05
60-90		7.49	45.02	420.0	105.85	0.024	14.10	21.87
90-120		7.76	32.04	304.3	90.15	0.050	20.57	22.67
Profile 4								
0-30	109	7.38	86.30	1143.1	198.72	0.063	15.37	35.84
30-60		7.93	29.50	498.1	115.85	0.023	21.94	29.17
60-90		7.62	26.82	377.5	157.78	0.029	26.33	25.40
90-120		7.53	26.10	332.1	162.62	0.031	28.65	23.16
Profile 5								
0-30	102	7.46	59.12	725.0	229.95	0.034	26.17	31.20
30-60		7.94	40.10	428.3	211.89	0.028	31.94	23.40
60-90		8.14	28.37	338.3	245.35	0.055	31.40	22.06
90-120		8.01	24.97	340.0	171.52	0.068	40.54	20.42

According to Table 4, EC_3, EC_4, pH_1, SAR_3, SAR_4, Cl_3, Cl_4, $clay_1$, $clay_2$, had negative effects on plant parameters. The percentage of sand and depth of hardpan from the soil surface (soil depth) had positive effects on plant parameters. The percentage of total nitrogen did not have any significant effect on plant parameters.

Effects of salinity and alkalinity: Soil reaction and sodium absorption ratio represent alkalinity of soil, and electrical conductivity and chlorine ions represent salinity of soil. Salinity and alkalinity had negative effects on plant parameters. This is in line with findings of Karimpour (2005).

The plants in saline environments are faced with two main elements. The first element is the high salts in soil solution which decrease the soil osmotic potential and also water absorption, so make water shortage. The second element is the lot of sodium ions and chloride ions which reduce the absorption essential ions such as potassium, calcium and nitrate (Abdolzadeh and Safari 2004).

Effect of soil texture: The percentage of sand and the percentage of clay represent soil texture. The percentage of sand in the second, third and forth depth had a positive effect and the percentage of clay in the first and second depth had a negative effect on plant parameters. These results showed *Holoxylon sp*. requires light texture. This is in line with findings of Zandi *et al*. (2007) and Mojiri and Jalalian (2011).

Effect of depth of hardpan from the soil surface: The depth of hardpan from the soil surface had a positive effect on plant parameters. This is in line with findings of Zandi *et al*. (2007). The beginning hardpan from horizons near to surface causes vertical development root of *Haloxylon sp*. stop and then decreased the growth of *Haloxylon sp.* (Zandi 2007).

Table 2. Soil properties of vertical transect

Depth (cm)	Depth hardpan (cm)	pH	EC (dS/m)	Cl (me L^{-1})	SAR	N (%)	Clay (%)	Sand (%)
Profile 6								
0-30	74	7.48	57.39	555.0	127.51	0.110	19.83	40.50
30-60		7.20	32.83	228.3	86.38	0.110	22.78	29.92
60-90		7.15	29.80	213.0	104.32	0.081	22.46	27.57
90-120		7.23	27.65	220.0	126.89	0.056	22.91	27.39
Profile 7								
0-30	122	7.18	48.06	462.0	218.30	0.088	15.41	42.39
30-60		7.41	39.00	360.0	174.24	0.130	22.50	31.80
60-90		7.55	38.28	321.3	139.35	0.081	27.04	28.61
90-120		7.43	36.67	293.3	141.59	0.073	27.20	26.94
Profile 8								
0-30	123	7.95	76.55	730.0	337.36	0.079	9.60	60.51
30-60		7.36	34.43	286.0	162.27	0.110	14.54	41.02
60-90		7.23	35.39	304.0	159.54	0.100	15.82	29.52
90-120		7.70	28.69	220.0	116.53	0.042	26.00	25.60
Profile 9								
0-30	154	7.68	31.96	229.0	122.46	0.062	10.52	41.27
30-60		7.69	18.10	67.2	103.03	0.056	14.53	30.08
60-90		7.50	15.34	91.0	80.48	0.056	16.83	29.80
90-120		7.48	14.40	126.9	56.23	0.042	19.04	27.74
Profile 10								
0-30	127	7.23	45.37	643.6	251.98	0.093	9.85	43.65
30-60		7.27	27.50	315.0	65.13	0.098	12.50	32.50
60-90		7.53	21.50	259.0	77.29	0.056	16.70	30.74
90-120		7.65	18.94	235.0	82.50	0.038	18.50	29.60
Profile 11								
0-30	112	7.56	195.48	3126.6	868.61	0.056	29.75	35.37
30-60		7.10	41.04	412.5	256.94	0.091	27.51	27.83
60-90		7.24	42.82	474.5	220.45	0.073	28.41	24.01
90-120		7.53	48.94	585.0	263.00	0.056	29.25	22.52
Profile 12								
0-30	143	7.00	44.91	562.0	136.73	0.105	7.17	64.54
30-60		7.05	32.46	327.0	80.11	0.056	12.00	34.40
60-90		7.46	11.21	82.0	22.74	0.072	18.32	29.17
90-120		7.10	8.65	53.1	16.52	0.098	26.97	29.06

Table 3. Plant parameters in horizontal and vertical transects

Profile	Height (cm)	Top (cm)	Profile	Height (cm)	Top (cm)
Profile 1	85	175	Profile 6	0	0
Profile 2	95	200	Profile 7	18	54
Profile 3	50	114	Profile 8	110	215
Profile 4	28	85	Profile 9	195	500
Profile 5	0*	0	Profile 10	205	570
			Profile 11	0	0
			Profile 12	500	800

*0 = *Haloxylon sp* cultivated did not have any growth in these profiles

Table 4. Pearson correlation (r) between soil properties and plant parameters

Soil properties	Plant physiologic parameters		Soil properties	Plant physiologic parameters	
	Height (cm)	Top (cm)		Height (cm)	Top (cm)
EC_1	-0.263	-0.309	N_1	0.402	0.387
EC_2	-0.267	-0.373	N_2	-0.085	-0.049
EC_3	-0.621**	-0.648**	N_3	0.107	0.048
EC_4	-0.664**	-0.689**	N_4	0.423	0.218
Cl_1	-0.235	-0.277	$Clay_1$	-0.533*	-0.575*
Cl_2	-0.231	-0.308	$Clay_2$	-0.532*	-0.585*
Cl_3	-0.604*	-0.609*	$Clay_3$	-0.416	-0.481
Cl_4	-0.623*	-0.622*	$Clay_4$	-0.223	-0.356
pH_1	-0.435*	-0.390	$Sand_1$	0.455	0.374
pH_2	-0.374	-0.315	$Sand_2$	0.531*	0.484*
pH_3	-0.078	-0.067	$Sand_3$	0.489	0.575*
pH_4	-0.418	-0.346	$Sand_4$	0.494*	0.542*
SAR_1	-0.222	-0.236	Start Hardpan from the Soil Surface	0.624*	0.701**
SAR_2	-0.387	-0.445			
SAR_3	-0.690*	-0.714**			
SAR_4	-0.661*	-0.682*			

* & ** significance at level of five and one percent respectively.
Index 1, 2, 3 and 4 show first, second, third and fourth depth from the soil surface, respectively.

Conclusion: Electrical conductivity, pH, chloride ions, sodium absorption ratio and the percentage of clay had negative effects on plant physiologic parameters but the percentage of sand and depth of hardpan from the soil surface (soil depth) had positive effects on growth of *Haloxylon sp*. Therefore, it is recommended that these factors should be examined before planting *Haloxylon sp*.

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