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# Investigation of the Variations of Soil Factors under *Haloxylon aphyllum* Cultivation

B. Rasooli [a*], M. Jafari [b]

[a] *Faculty Member, Faculty of Agriculture, Rasht Islamic Azad University, Rasht, Iran*
[b] *Professor, Faculty of Natural Resources, University of Tehran, Karaj, Iran*

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**Abstract**

Determination of the relationships between soil and plant cover indispensible in the in planning and management of the arid regions, the aim being to revitalize plant cover, conserve soil and to combat desertification. Among factors affecting plant cover, particularly in arid and semiarid areas are soil traits. During the present study, the effect of *Haloxylon aphyllum* Cultivation on soil physiochemical properties (at different depths) was investigated. A split plot design was employedin the study, in which cultivated and non-cultivated areas were considered as inter-related factors, whereas soil depths of(0-10), (10-30) and (30-60) cm as intra- related factors. Soil texture, EC, pH, nitrogen, phosphorous and organic matter was assessed. Soluble salts of Na, Ca, Mg, Cl, K, carbonate and bicarbonate were measured. *Haloxylon aphyllum* has led to a significant difference between Ca, Mg and bicarbonate in the first layer as compared with the third. A significant difference has been observed between nitrogen in the first soil layer in comparison with that in the second layer. Significant differences were also observed among all *Haloxylon aphyllum* cultivated soil layers as to the contents of Soluble K, absorbable K as well as phosphorous.

*Keywords*: Soil; Physiochemical properties; *Haloxylon aphyllum*; Split plot

## 1. Introduction

A great part of Iran is located in the dry belt of the northern hemisphere. The especial climate conditions have caused limitation for plant growth, particularly in the country's central plateau. Among measures taken in such areas is the plantation of drought resistant plant species in the saline alkali soil land and in sand dunes. That would lead to improvement of plant cover in these areas [7]. Plant cover amendment in degraded lands can lead to considerable constructive changes in the process of erosion. A revitalization of plant cover in damaged lands can enhance soil reclamation, improve the texture and structure of soil in the long run as well as increase soil essentially needed nutrients of nitrogen, phosphorus and potassium [3].

* Corresponding author. Tel.: +98 912 5417032,
Fax: +98 21 66400923.
*E-mail address:* brasooli@gmail.com

Afkhamoshoara (1994) demonstrated an increase of organic matter, phosphorus and potassium in areas under the cultivation of *Haloxylon sp.* Jeihooney (1994) found out the better root taking of *H. aphyllum* in sandy clay soils. An increase in soil alkalinity and EC, phosphorus fixation, potassium, a decrease in the range of changes in sodium, as well as a difference in organic matter content in surface as against deeper soil is demonstrated by Nick nahad (2002) to occur in an area under *H. aphyllum* in Hoessin Abad of Qom, Iran. Xiaoling (2003) in a study of plant habitats demonstrated that *H. aphyllum* well grows on moderately saline soil. Jafari et al. (2003), in their studies of the effect *H. aphyllum* cultivation on soil mineral properties(at different depths) concluded that this species' cultivation brings significant changes in percent N, K, P as well as in soil acidity, electrical conductivity and texture, the changes being more pronounced in the surface layer of the soil.

## 2. Materials and Methods

The area under study is the surrounding of the city of Qom. About 1100 ha of the area has been planted by *H. aphyllum* in 1990 by the Department of Forestry. The average annual rainfall of the area is 155.7 mm. The area is considered as desert according to Emberger method and on the basis of Demartton method it is among dry areas. Sampling was carried out through a split plot design according to Table 1. Cultivated and uncultivated areas (distinguished on the basis of presence or absence of planted samplings) were considered as interrelated factors, whereas the depths (0-10), (10-30) and (30-60) cm as intra-related factors. For analysis of data ANOWA (mixed factorial) along with pair comparison tests were employed using SPSS software.

Table 1. Statistical model of the plan based on split plot design

| Interrelated factors | | A1 | | | A2 | |
|---|---|---|---|---|---|---|
| Intrarelated factors | B1 | B2 | B3 | B1 | B2 | B3 |
| *H. aphyllum* planted (A1) | S1 | S1 | S1 | S1 | S1 | S1 |
| Control (A2) | S2 | S2 | S2 | S2 | S2 | S2 |
| Depth 1 (B1) | S3 | S3 | S3 | S3 | S3 | S3 |
| Depth 2 (B2) | S4 | S4 | S4 | S4 | S4 | S4 |
| Depth 3 (B3) | S5 | S5 | S5 | S5 | S5 | S5 |
| Replication (Si) | S6 | S6 | S6 | S6 | S6 | S6 |
| | S7 | S7 | S7 | S7 | S7 | S7 |
| | S8 | S8 | S8 | S8 | S8 | S8 |
| | S9 | S9 | S9 | S9 | S9 | S9 |
| | S10 | S10 | S10 | S10 | S10 | S10 |
| | S11 | S11 | S11 | S11 | S11 | S11 |
| | S12 | S12 | S12 | S12 | S12 | S12 |

Soil factors assessed include: texture, OM, pH, Ca, Mg, K, Na, N, P, Cl, EC, carbonate and bicarbonate

## 3. Results

Results are presented in two sections. In the first section, the differences among various factors at different soil depths in the cultivated area and uncultivated soils are stated and presented in Table 2. The second section is comprised of a pair comparison of means that are of a difference of significance. The results of pair test are presented in Table 3.

Table 2. The significance of the difference among the assessed factors in two areas (three depths)

| Assessed factor | Intra-effect | | | Inter-effect | | | Interaction | | |
|---|---|---|---|---|---|---|---|---|---|
| | df | F | Sig | df | F | Sig | df | F | Sig |
| pH | 2 | 1.914 | 0.16 | 1 | 0.103 | 0.75 | 2 | 2.119 | 0.132 |
| EC(dsm-1) | 2 | 2.73 | 0.07 | 1 | 0.093 | 0.763 | 2 | 3.48 | 0.039* |
| Na(meq.gr.l-1) | 2 | 1.2 | 0.3 | 1 | 0.001 | 1 | 2 | 1.52 | 0.23 |
| Ca(meq.gr.l-1) | 2 | 4.2 | 0.01** | 1 | 0.094 | 0.762 | 2 | 1.3 | 0.28 |
| Mg(meq.gr.l-1) | 2 | 3.87 | 0.028* | 1 | 0.008 | 0.932 | 2 | 1.212 | 0.307 |
| P(meq.gr.l-1) | 2 | 9.31 | 0.001** | 1 | 1.87 | 0.185 | 2 | 6.657 | 0.003** |
| Absorbable K(ppm) | 2 | 9.01 | 0.001** | 1 | 0.001 | 0.997 | 2 | 3.1 | 0.053 |
| OM% | 2 | 1.249 | 0.297 | 1 | 0.166 | 0.688 | 2 | 1.059 | 0.355 |
| Silt% | 2 | 1.247 | 0.297 | 1 | 0.028 | 0.868 | 2 | 10.844 | 0.001** |
| Clay% | 2 | 2.2 | 0.123 | 1 | 0.517 | 0.480 | 2 | 5.234 | 0.001** |
| Sand% | 2 | 0.108 | 0.898 | 1 | 0.029 | 0.867 | 2 | 3.02 | 0.059 |
| Dissolved K(meq.gr.l-1) | 2 | 10.11 | 0.001** | 1 | 4.167 | 0.05 | 2 | 1.88 | 0.164 |
| Carbonate(meq.gr.l-1) | 2 | 0.543 | 0.585 | 1 | 0.002 | 0.963 | 2 | 1.61 | 0.211 |
| Bicarbonate(meq.gr.l-1) | 2 | 3.5 | 0.05* | 1 | 0.007 | 0.935 | 2 | 0.763 | 0.472 |
| Cl(meq.gr.l-1) | 2 | 2.031 | 0.143 | 1 | 0.172 | 0.683 | 2 | 1.2 | 0.311 |
| N% | 2 | 5.2 | 0.001** | 1 | 6.533 | 0.018* | 2 | .569 | 0.57 |

According to Table 2, the factors N and soluble K are significantly different for cultivated and non- cultivated areas at a 95% level of significance. This indicates the efficacy of *H. aphyllum* cultivation on intereffectual factors. As far as intra-effectual factors (various depths of cultivated areas) are concerned, there are significant differences observed for Ca, N, P, absorbable K and soluble K at 99% level and for Mg and bicarbonate at 95% level. As for interaction between species and depth, it is demonstrated that interaction exists between depth and species of *H. aphyllum*, for the variable factors of EC, P, silt and clay.

Table 3. The paired comparison of the means which were significantly different in the study

| Factor | Depth | Depth compared | Mean Difference | Standard deviation | Sig | Factor | Depth | Depth compared | Mean Difference | Standard deviation | Sig |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Calcium | 1 | 2 | -2.571 | 6.072 | 0.676 | Soluble potassium | 1 | 2 | 0.577* | 0.168 | 0.002 |
| | | 3 | -27.1* | 15.64 | 0.027 | | | 3 | 0.494* | 0.147 | 0.003 |
| | 2 | 1 | 2.571 | 6.072 | 0.676 | | 2 | 1 | -.577* | 0.168 | 0.002 |
| | | 3 | -24.529 | 17.012 | 0.055 | | | 3 | 0.8333 | 0.090 | 0.364 |
| | 3 | 1 | 27.1* | 15.64 | 0.027 | | 3 | 1 | -0.494 | 0.147 | 0.003 |
| | | 2 | 24.529 | 17.012 | 0.055 | | | 2 | 0.8333 | 0.090 | 0.364 |
| Magnesium | 1 | 2 | -1.612 | 6.988 | 0.820 | HCO3 | 1 | 2 | 2.979 | 1.918 | 0.135 |
| | | 3 | -27.456* | 16.826 | 0.037 | | | 3 | 2.958* | 1.730 | 0.032 |
| | 2 | 1 | 1.612 | 6.988 | 0.820 | | 2 | 1 | -2.979 | 1.918 | 0.135 |
| | | 3 | -25.843 | 19.044 | 0.073 | | | 3 | 0.979 | 1.134 | 0.397 |
| | 3 | 1 | 27.456* | 16.826 | 0.037 | | 3 | 1 | -2.958* | 1.73 | 0.032 |
| | | 2 | 25.843 | 19.044 | 0.073 | | | 2 | -0.979 | 1.134 | 0.397 |
| Phosphorous | 1 | 2 | 2.074 | 1.219 | 0.103 | Nitrogen | 1 | 2 | 7.95* | 0.019 | 0.001 |
| | | 3 | 4.569* | 0.861 | 0.001 | | | 3 | 3.87 | 0.028 | 0.180 |
| | 2 | 1 | -2.074 | 1.219 | 0.103 | | 2 | 1 | -7.950* | 0.019 | 0.001 |
| | | 3 | 2.496* | 1.073 | 0.03 | | | 3 | -4.079 | 0.026 | 0.129 |
| | 3 | 1 | -4.569* | 0.861 | 0.001 | | 3 | 1 | -3.871 | 0.028 | 0.180 |
| | | 2 | -2.496* | 1.073 | 0.03 | | | 2 | 4.079 | 0.026 | 0.126 |
| Absorbable potassium | 1 | 2 | 165.00* | 69.973 | 0.028 | | | | | | |
| | | 3 | 236.25* | 64.005 | 0.001 | | | | | | |
| | 2 | 1 | -165* | 69.973 | 0.028 | | | | | | |
| | | 3 | 71.250* | 28.090 | 0.019 | | | | | | |
| | 3 | 1 | -206.25* | 64.005 | 0.001 | | | | | | |
| | | 2 | -71.250* | 28.090 | 0.019 | | | | | | |

Paired comparisons indicate the amounts of Ca, Mg and HCO3 were significant (95%) at the first and third depths in the *H. aphyllum* area. This test also revealed that nitrogen content were significant in the first and second depths. show also calcium, magnesium, bicarbonate were significant in the first and the third depths. Soil nitrogen content in the *H. aphyllum* area was significantly more the first depth (0-10cm) as compared with the 2nd and 3$^{rd}$ depths. N contents in the 2nd and 3rd depths soil depth were not significantly different. Absorbable K was shown to be significantly (95%) high in the first layer of soil as compared with the 2nd and 3rd depths. Also bicarbonate content in the *H. aphyllum* treated soil was significantly (95%) high in the first as compared with the second and third depths of soil. These variations are presented in Fig. 1.

## 4. Discussion and conclusions

A survey of soil in the *H. aphyllum* cultivated area indicates the fact that the surface layer contains the highest amounts of N, soluble K, absorbable K as well as bicarbonate, the amounts being significantly different than those in the 2nd and 3rd soli layers. *H. aphyllum* cultivation has not had any considerable effect on the mentioned features, as far as lower depths of soil are concerned. A uniform decreasing trend of the above soil chemical contents from the upper to lower soil depths has also been observed. Afkhamoshoara (1994), Niknehad (2002) have also demonstrated increase in N and soluble as well as absorbable K in the surface layer of soil. This could be due to decomposition of plant remains on the surface soil and micro organism' activity on the one hand and the surface soil in the central parts of Iran being alkaline as well as high in K on the other. Calcium and Mg contents are high in the 3$^{rd}$ depth than the other two layers. In contrast with other soli chemicals, plantation of *H. aphyllum* has not had any effect on surface soil Ca and Mg content. The amounts of Ca and Mg have showed an increasing trend towards the bottom layers of soil. This could be due to solubility of these elements in water leading to their immigration to and accumulation in the lower soil layers. There is an irregular trend observed in phosphorous variation in different soil layers: while Afkhamoshoara (1996) and Niknahad (2002) have observed in Hossein Abad (Qom) that plantation of *H. aphyllum* has caused an increase in P content as well as its fixation in soil.

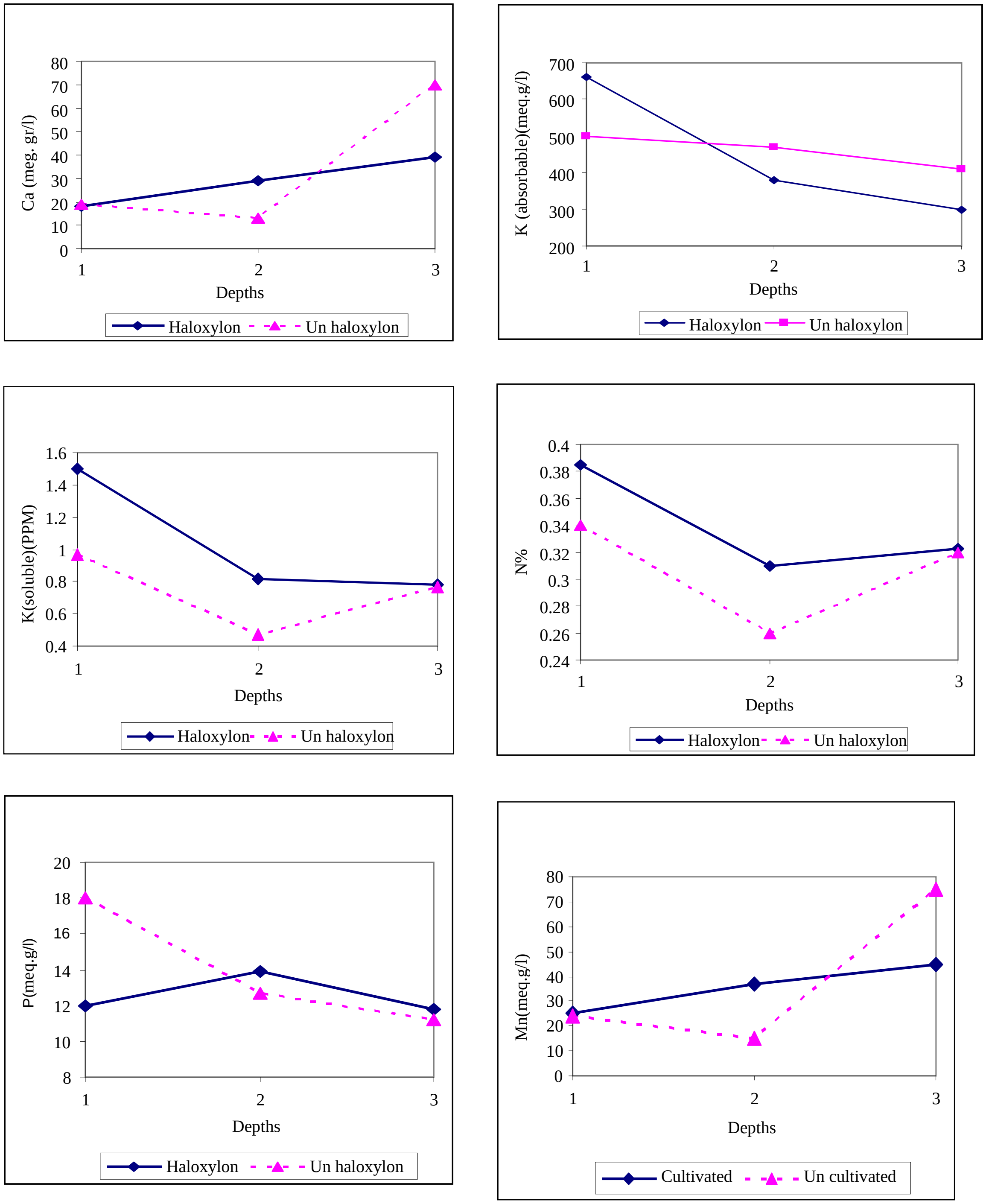


Fig. 1. Trend of variation factors at different depths

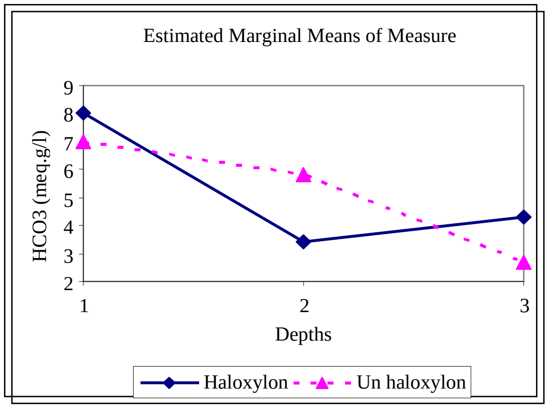


Fig. 1. Continued

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