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Original Article

Relationship between soil factors and vegetation type by Canonical Correspondence Analysis (CCA)

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S.Aleemahmoodi[1*]
R.Basiri[2]
H.A.sarabi[3]

1-Forestry and forest economics MS student, Department of Natural Resources, Tehran University.
2-Assistant Professor faculty of Natural Resources, Industrial Behbahan of university
3-Head of the Department of Natural Resources and Watershed city Baghmalek
sajadali9@yahoo.com

Abstract

Forest soils, one of the main factors in forest ecology are the interaction with other component of this complex ecological system, one of the main providers of the pattern and dispersion plant in this collection. Two vegetative type(Amygdalus orientalis Duh and Quercus brantii Lindl) located in Golzar Susan, Khuzestan province, with the area of 78 ha, was selected in order to investigate the relationship between soil characteristics and vegetative types. Systematic random method was used for achieving this purpose, 40 sample plots with an area 1200 square meter in each sample was taken. In each sample plot, cover percentage of the tree species, litter percentage and cover percentage of herbs with the estimated of in every 0.5 square meters, Soil samples and percentage of rock cover were taken. Some of the variables such as soil acidity, soil salinity, calcium carbonate, carbon, organic material, nitrogen, phosphor, potassium and the saturation percentage were measured. The data was analyzed by independent sample T-test was performed. The results showed that there was significant differences between the soil acidity, percent of rock cover and calcium carbonate in the soil of two site. The CCA analysis was performed for determined the relationships between vegetation and the environmental factors. The results of CCA analysis showed that there is a significant difference among the soil variables of the three groups; soil acidity, the percentage of calcium carbonate and the amount of phosphor. The first axis has a negative correlation with the variables of rock cover percentage (r=-0.749), acidity (r= -0.627) and calcium carbonate (r=-0.533) and has a positive correlation with the litter percentage variable (r=0.446). The phosphor variables (r=-0.374) and the litter percentage (r=0.432) have the most correlation with the second axis than other variables.

Keywords: *vegetation, soil characteristics, CCA, Khuzestan, Golzar, Iran*

INTRODUCTION

The west forests of the country as an extensive part of our country created a unique growing area because of having its special characteristics. These forests have a very important role in water and soil conservation, regulation of the surface and underground waters hydrology, producing the non-wood etc. [Fattahi at al., 2001]. The forest soil is one of the basic factors in the forest ecology that in addition to having a mutual effect with other component of this complex system ecology is one of the providers of the original model and the herb dispersion besides the other factors like climate, live and physiographic factors [Salehi, 2004]. The effect of the forest soil on the growing model and the plant dispersion and specially the tree species was long been considered by a lot of different scientists [Salehi, 2002]. The dispersion of the plant species was affected by the complex environmental condition and in other words there is a deep correlation between the vegetation and environmental condition [DJavanshir 1993]. Beno [1998] considered the plants as an index of the soil

characteristics. From the environmental factors, soil is one of the most important factors that has a role in dispersion and density of vegetation cover [Haj Abbasi 1999]. Many studies performed on species distribution. A study was conducted on the Cerasus Mahaleb in the Switzerland in the natural forests. This study showed that the species dispersion was mostly determined by the local topography. Theses trees were dispersed on the border of the natural forests between the sparse rocks and the beech forests and also the mixed oak forests in the deep soils. Also some of the trees were dispersed in the rocks of without tree and the gravel slopes [Kollmann at all, 2005]. Brotherson and Fairchild [1980] believe that the difference between North Arizona habitats is mostly related to the soil depth. Dowling et al., [1986] observed that the percentage of the canopy of *Acacia harpophylla* will increase with greater than ever the factors like organic material, Azoth, sulfur, potassium, phosphor, exchanging calcium and the soil depth. Veladimir and Legender [2002] studied the effects of the soil humidity and the surface reflection of the sun light on the percentage of *Calmagrostis epigejus* and *Crynephorus canscens* species and showed that *C.epigejus* is the index of humid soils and *C.canscens* is the index of the dry soils.

The results of the study on the *Quercus brantii Var. Persica* in the forests of Chahar Mahale bakhtiari province in Iran showed that the *Q. brantii* is a light prefer species, which has the most presence in the south west with the altitude of 1800 to 2000 upper than the sea level [Talebi et al., 2006]. Knowing the ecologic needs of the species and applying them in action can be a big help in recognition and developing the species, which are growing in the special site [Claessens et al., 1999]. According to the stated issues, we can say that each of the soil factors has a role in established and dispersion of the plant species. Having complete information about the growing trees on the different soils and site is very important and vital, that, this issue can help us much in aforestation. The purpose of this study to determine soil factors that most important effective on the separation two types of *Quercus brantii* Lindl and *Amygdalus orientalis Duh* in the Susan Golzar area so that we can select the proper species for afforestation by recognition of the existed relations and generalizing the results to the similar site.

MATERIAL & METHODS

Study area

The study area is located in the north of Khuzestan, 40 km of the Izeh town with the area of 78 hectare which is in the longitude between 49 degree and 44 minutes and 10 seconds to 49 degree and 44 minutes and 39 seconds of east longitude and 32 degree and 7 minutes and 54 seconds of the north latitude. The rainiest month was December that the rainfall will increase gradually from October and is considered medium semi arid according to the Amberger formula. The warmest month is August with the medium temperature of 33.39 c and the coolest month is February with the medium temperature of 8.64 c. the amount of minimum evaporation is 50.28 mm and maximum 449.58 mm [August]. The maximum relative humidity is related to December and January months and its minimum is in July.study area is located in fig [1].

Method

The method of sampling in this study was systematic random. 40-sample plot were determined according to the pilot sampling. The area of each sample plot was selected 1200 square meter, according to the vegetation condition, applying the pilot sampling and the minimal area method [Cain, 1932]. Two transect with 40 meters long and 10-meter interval from each other is put in the 30 meter wide of every sample plot [fig.2]. The sample plot shape is considered a 30*40 m rectangular. A soil sample was taken from every four corner of the sample plot from the depth of 0 to 20 cm and then was combined with each other so that a composite sample soil is achieved from each 1200 square meter sample.

Data and the method of their analysis

The data were taken as following: a. the percentage of cover was calculated for tree species in each plot with the area of 1200 square meter. The vegetation data involved the cover percentage that the Brown-Blanquet compound method was used. 0.5 square meters was estimated for the herbal cover in each plot. b. the soil data were taken from the 0 to 20 cm depth [Roberston et al, 1999]. Some of the variables like soil acidity [pH], soil salinity [EC] to [ds/m], calcium carbonate percentage, organic carbon [%], organic material [%], nitrogen [%], c/N, phosphor [$mg.kg^{-1}$], potassium[$mg.kg^{-1}$], saturation percentage c. the data of the rock cover were measured in the 0.5 square meter micro plots.

Data analysis method

For determining the percentage of tree species cover, first two perpendicular diameters of each base was measured. Then the area of crown in sample plot was obtained based on the crown image in each sample plot. The area of cover in each sample plot converted to cover surface in hectare and then, the cover was calculated for total area and was estimated for herbaceous cover in the area of 0.5 m2 in each plot. Some of the variables such as: soil acidity [PH], soil salinity [EC] in [ds/m], calcium carbonate the percentage, organic carbon [%], organic material [%], nitrogen [%], C/N, phosphor [$mg.kg^{-1}$], potassium [$mg.kg^{-1}$] and saturation percentage were measured.

After data obtaining, from Excel 2005 it had been used for data entering. First the obtained data were investigated normalization by using the Kolmogorov- Smirnov test and the data of two tree types of *Quercus brantii* Lindl and *Amygdalus orientalis Duh* were analyzed by using the two independent sample *t*-test.

For analyzing the relation between environmental variables and ecological groups its used from direct changes gradient or canonical correspondence analysis or CCA ordination .[Ter Braak., 1986]. CCA examined the relation between species and environmental factors as a linear compound [Palmer, 1993].

RESULTS & DISCUSSION

First taking into account to presence of quite distinct of two tree types in the area, two independent sample *t*-test was performed. Results showed that there is a significant difference between soil variables of two types; variables included soil acidity [$p< 0.01$] and calcium carbonate [$p< 0.01$].[table 1] .

Canonical Correspondence Analysis]CCA]

In this area, the results of CCA showed two vegetation types, *Amigdalus orientalis* and *Quercus brantii*. The results of CCA analysis have been shown in figure 5and 6. According to eigen values of axis 1, 0.42 [for figure 5], 0.66 [for figure 6] and for axis 2, 0.28 [for figure 5] 0.29 for figure 6 and also importance of first and second axes from the view point of ecological information, it was used from these two axes for analyzing.

According to the obtained diagrams, the axes are representative of significant environmental variables and are effective on cover type's distribution. Distribution pattern of tree types is dependent on two environmental variables including soil acidity and calcium carbonate percentile. The first axis shows a negative correlation with acidity [r= - 0.68] and calcium carbonate variables [r=- 0.55]. The second axis failed to establish a significant correlation with a special variable. Axis 1 has a role in *Quercus brantii* type and *Amygdalus orientalis* distinguishing. So that *Quercus brantii* has a significant correlation with the left side of axis 1. *Amygdalus orientalus* shows a significant correlation with the right side of axis 1.

According to different ecological demands of species, various species will be established in different soils and identification the relation among these groups and environmental factors especially in relation to soil has an important role in their management and distinction.

According to the results, different correlations was observed between cover types and the measured soil parameters that could be due to edaphic parameters such as Ec, pH and so on or their interaction on each other or other characteristics which was not included in this research. According to this research the *Quercus brantii* is appeared in regions that have deep or semi deep soil but in areas where the soil is eroded the species of *Amygdalus orientalis* have been appeared. *Amygdalus orientalis* grows in destractive habitat with enormous rock coverage but *Quercus brantii* grows in higher soil depth. *Q. brantii* is a deep to mean root species that requires to deep or mean depth soils. *A. orientalis* is a shrub species with a high strength which grows in soils with a minimum depth. this results are coincides with the reseach of Fairchild and Brotherson [1980] who stated differences in site of north Arizona were more related to the soil depth. The results of *t* test shown that there were significant differences among the level of acidity and calcium carbonate of two sites. The correlation of two types and the environmental factors, which are effective in their separation, has been considered more accurately in CCA analysis. Also in this analysis the factors such as pH and calcium carbonate percentage were known respectively the most important effective environmental factors in separating of tree types of *Amygdalus orientalis* and *Quercus brantii*. Low level of calcium carbonate in *Q. brantii* type can be due to high leaching because in this site the soil erosion is lower and the soil condition is more suitable. In areas where the amount of calcium carbonate and acidity were decreased the *Q. brantii* is appeared and with increasing of Caco3 and pH *A. orientalis* is appeared. Jafari et al., [

2002] showed that the most important soil properties affected on presence or absence of species, were Ec, texture, potassium salts, gypsum and calcium carbonate [$CaCo_3$]; these indices helpe to separate the cover types of two regions. Cusmas et al., [2000] shown that pH and depth of soil, Ec, exchangeable sodium and potassium was known as a main factor in finding distinguish between perennial herbs. Calcium carbonate causes a proper structure and changes in soil acidity. However, if the lime percentage over the limit increase creates problems in the range of plant roots for the plants by creating mineral layer and high level of acidity and salts. So the results of the research shown that *Q. brantii* presents in the soils with the main to deep depth, low acidity and lime and the *A. orientalis* presents in low depth soils and higher level of acidity and calcium carbonate than the *Q. brantii* and this factors caused the *A. orientalis* would have beter adjustment in this situation and the *Q. brantii* would have not ability to compete with *A. orientalis*.

Recognition of site soil properties of each plant species has an effective role in recommendation of adjusted species with soil condition in the similar regions or selecting the appropriate species for forestation in the region.

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Table1. Results of independent t test in relation to soil

Soil factors	spacies	sd	df	P- value
sp	Q. branti	56.9 ± 1.8	38	0.5
	A. orientalis	55.2 ± 1.1		
EC	Q. branti	0.59 ± 0.01	38	0.49
	A. orientalis	0.61 ± 0.01		
pH	Q. branti	7.24 ± 0.02	38	<0.01
	A. orientalis	7.34 ± 0.01		
$Caco_3$	Q. branti	11.24 ± 2.24	38	<0.01
	A. orientalis	14.73 ± 0.89		
OM	Q. branti	3.20 ± 0.16	38	0.27
	A. orientalis	3.74 ± 0.27		
C	Q. branti	1.94 ± 0.13	38	0.39
	A. orientalis	2.19 ± 0.15		
N	Q. branti	0.18 ± 0.01	38	0.64
	A. orientalis	0.19 ± 0.01		
P	Q. branti	5.51 ± 0.65	38	0.09
	A. orientalis	7.24 ± 0.02		
K	Q. branti	3.59 ± 1.56	38	0.40
	A. orientalis	3.93 ± 0.57		
R	Q. branti	5.75 ± 1.05	38	<0.01
	A. orientalis	26.19 ± 1.35		

sp	**pH**	**Caco3**	**om**	**C**	**K**	**P**	**R**	**EC**	**N**
saturation percentage	acidity	calcium carbonate	organic material	organic carbon	potassium	phosphor	Rock	salinity	nitrogen

There is no significant deference between percentage of *Q. brantii* and *A. orientalis* cover, also the percentage mean of A. orientalis cover (29.26) is more than oak (22.97).(table 2)

Table2. Results of *T*- test in relation to percentage of two types cover

type	Percentage mean of cover	df	p-value
Q. brantii	22.97	38	0.22
A. orientalis	29.26	38	0.14

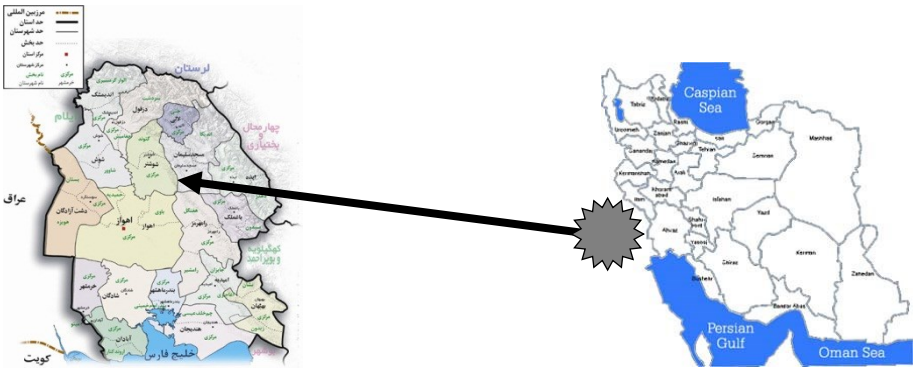

Fig1. study area in khuzestan province

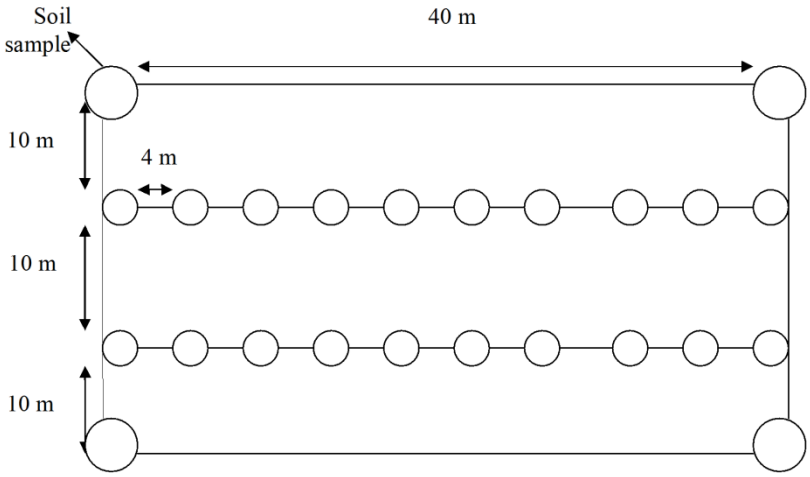

Fig2. Schema of the shape of the piece, micro plots and soil samples

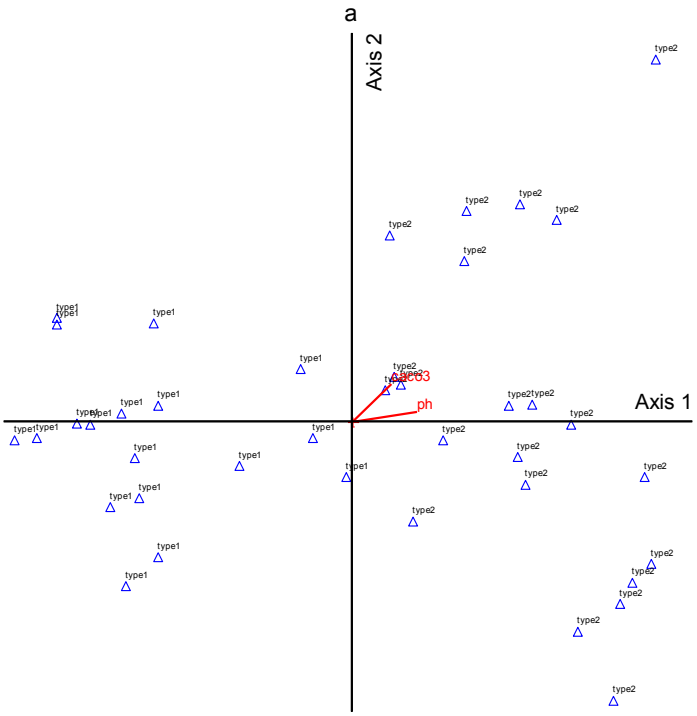

Fig5. two dimensional diagram of CCA ordination for two types of *Quercus brantii* Lindl and *Amygdalus orientalis Duh* of Izeh Golzar (Type 1: indicator of *Quercus brantii* and Type2 indicator of *Amygdalus orientalis*).

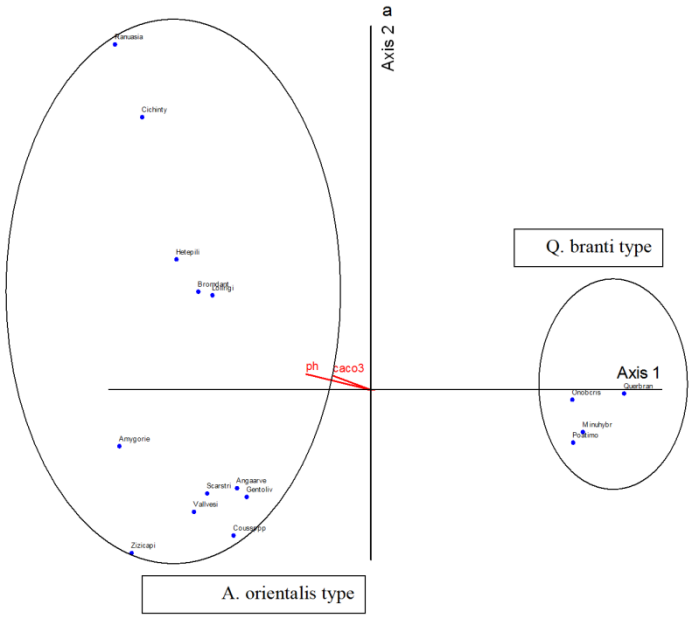

Fig6. diagram of CCA ordination for index species of ecologic groups of Izeh Golzar area (the indicated characters in figure is equivalent of the species name abbreviated).

The *Quercus brantii* with the characteristic species such as *Poa timoleontis* is established in the area which has a high amount of litters. The *Amygdalus orientalis* with characteristic species such as *Anagallis arvensis*, *Olivier Gentiana*, *Onobrychis crista-galli* and *vesica Valeriana*, and *Heteranthelium piliferum* groups with index species such as *Lolium rigidum, Cichorium intybus* and *Ranuculus asiaticus* that has a high amount of calcium carbonate and PH.