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Using Ordination Method for Determination of Effective Environmental Factors on *Astragalus parrawinus* Species Establishment in Semi-Arid Regions of Iran

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Abstract: The objective of this research was to study using Ordination method for finding the effect of important variables on *Astragalus parrawinus* species quantitative and qualitative changes in Karchambo rangelands of Fereidan Province, Iran. Sampling of soil and vegetation were performed with randomized-systematic method. Vegetation data including density and cover percentage of *Astragalus parrawinus* species were estimated quantitatively within each quadrat and using Ordination method to determination the effective environmental factors on establishment of *Astragalus parrawinus* species. The topographic conditions were recorded in quadrat locations. Soil samples were taken in A (0-30 cm) and B (30-60 cm) depths in each quadrat. The measured soil variables included; texture, saturation moisture (SP), acidity (pH), electrical conductivity (EC), sodium absorption ratio (SAR), C/N ratio, organic matter (%OM) and soluble ions (Na^+, Ca^{2+}, Mg^{2+}, Cl^-). Multivariate techniques including canonical analysis (CA) was used to analysis the collected data. The results show that there is meaningful correlation between density and cover percentage with soil factors. The results implicate that C/N factor in A horizon and SAR in B horizon have the most effect on *Astragalus parrawinus* density and cover percentage. EC, pH and etc. factors don't have much effect on *Astragalus parrawinus* species characteristics.

Key words: Canonical analysis, soil characteristics, classification, rangelands, Karchambo rangelands

INTRODUCTION

In order to have a proper management in rangeland ecosystems, the relationships between ecological factors in nature should be understood. Ecological factors include climate, soil, topography, vegetation and organisms. One of the main components of rangeland ecosystem is vegetation and composition of plant species that in large quantities is controlled by environmental factors. In fact, these factors help the plants to determine their habitats. On the other hand, the natural habitat of plants is determined by these factors (Amiri *et al*., 2008a).

Iran is the homeland of diverse plant and animal species. Knowledge of the environmental factors affecting these species distribution will help to develop more efficient range improvement plans in time and money. Ordination is the part of statistical ecology which has developed and integrated in recent years. Finding environmental factors which important in ecological structure determination of plant species is the final purpose of ordination (Amiri *et al*., 2008b). Among different environmental factors, soil is a function of climate, organisms, topography, parent material and time. Soil characteristics play major role in distribution of plant species (Zare Chahouki *et al*., 2002). Plants growing in different sites well represent the climatic and topographic characteristics of their natural habitats. This will help to develop range improvement plans based on ecological demands of different plant communities (Escudero *et al*., 2000). To achieve this goal, different statistical methods such as regression and ordination analysis are employed. These methods help to identify the ecological demand similarities among different vegetation communities. By redundancy dethroned analysis (CA) and detrended canonical correspondence analysis (DCA), it is possible to define and identify the most effective environmental factors which help to differ and separate plant communities with different ecological demands. Allen *et al*. (1995) found a significant correlation between soil and topographic properties. The results of cluster analysis indicated that incomplete correspondence of plant community, land element and soil characteristics. Habitat types considered useful indicators of land use potential were derived from the classification of sample

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plots by topographical, soil and cover characteristics. Together, land element and plant community could predict habitat type with acceptable accuracy for assignment of appropriate land uses to sites in the Conroy land system, without the need for extensive soil tests. Makarenkov and Legendre (2002) investigated the effects of water content and reflection of soil radiation on the vegetation cover percentage of *Calmagrostis epigejos* and *Corynephrous canscens* using multivariate analysis such as CCA, RDA and non-linear regression. The results of this study show that *Calmagrostis epigejos* is the indicator of wet sites while *Corynephraus canscens* indicates dry sites. Amiri *et al.* (2008a, b) studied the environmental factors (edaphic, climatic and topographic factors) in habitat of range species namely *Festuca ovina*, *Cachrys ferulacea*, *Astragalus parrawinus* and *Bromus tomentellus* in Karchambu rangeland using ordination methods (PCA, RDA, CA). The results of this study show that the edaphic factors are the most important environmental factors in separation of three habitats. EL-Ghareeb and Shabana (1990) investigated the correlation between soil and vegetation cover characteristics. The effective factors on establishment and growth of plant species were classified in two categories. The first group consisted of soil moisture and the second group belonged to soil fertility characteristics. Gonzalez and Clark (1989) studied thirteen metal elements quantities in soils of *Minuaria verna* and *Thalaspi alpestra* habitats in England. Results indicated that only Ca, Cd, Pb and Zn quantities were the major indicators of the presence of these species in these sites. Khajeddin (1995) in a study on Jazmourian vegetation cover indicated that by measuring the physical and chemical soil properties it is possible to classify the vegetation cover of the site.

It seams that by identifying the most effective environmental factors on establishment of a particular vegetation cover, it is possible to make more proper range improvement decisions. In the present study ten different plant community and edaphic factors were measured and analyzed to identify their role and importance in *Astragalus parrawinus* establishment and its distribution in Faridan range sites, Iran. By knowing that, it is possible to apply these results for similar region and recommend the suitable guidance for management, reclamation and development of rangelands. The other aims were to identify limiting factors in *Astragalus parrawinus* establishment in order to determine the suitable methods for land reclamation and also introduce this species according to the characteristics in the study area.

MATERIALS AND METHODS

Study area: The study area was located in Karchambu rangeland, Faridan, 200 km west of Isfahan Province in center of Iran. The total Karchambu rangeland area is about 11000 ha which geographically is located between 49° 50' and 50° 36' eastern latitudes and 32° 2' and 33° 11' northern altitudes. The minimum and maximum elevations from the sea level are 2360 and 3710 m, respectively (Fig. 1). The climatic conditions of the study area are

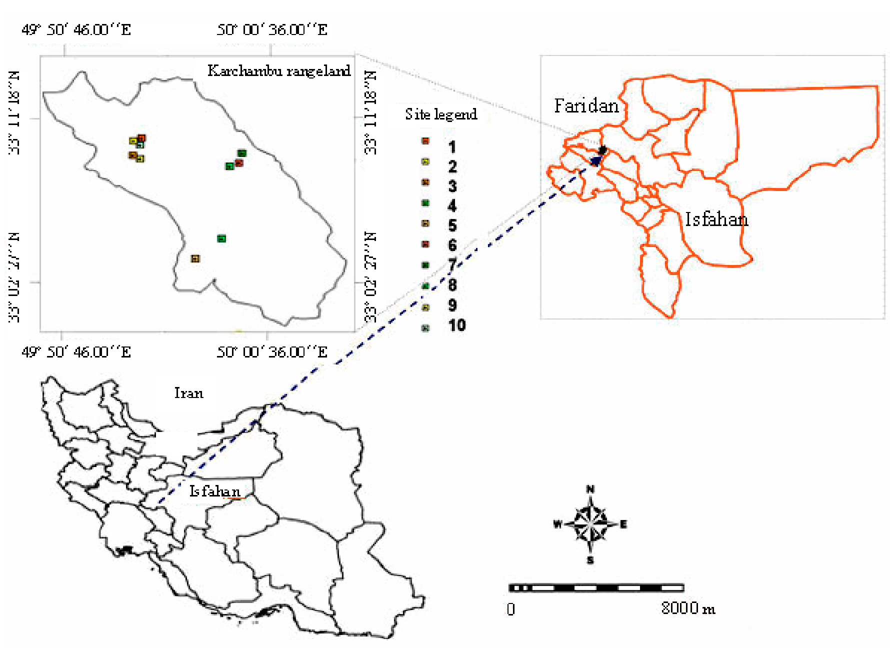

Fig. 1: Location of study area within the Karchambu District

Fig. 2: The site sample of *Astragalus parrawinus* distribution in Karchambu District

categorized as warm and dry Mediterranean type according to Goshen classifications. The mean annual precipitation and temperature are 410 mm and 10°C, respectively (Amiri *et al*., 2008b). Meteorological data were calculated for a ten year period.

Sampling methods: A quantitative survey of the vegetation is carried out during 2006-2007. To identify the most important edaphic factors contributing in *Astragalus parrawinus* establishment and distribution in the range, Based on field surveys, 10 different sites with uniform cover of mentioned species were identified and selected (Fig. 2). In each sites, soil and vegetative attributes were described within quadrats. Samples number was determined for each site using the Eq. 1:

$$N = \frac{t^2 \times s^2}{(\bar{x} \times k)^2} \quad (1)$$

Where:

N = No. of essential samples
T = t-student value with n-1 and α = 5%
S = Standard variation
X = Mean vegetation cover
N = Primary sample number
K = Precision coefficient (10%) (Bonham, 1989)

Sampling method was randomized systematic. According to Eq. 1, in each sites sampling was done in 30 plots and the distance of plots was determined 50 m. Method of sampling was randomized-systematic.

Quadrate samples of one square meter (1 m^2) were used (Mueller-Dombois and Ellenberg, 1974) to measure density and canopy cover percentage of *Astragalus parrawinus* were recorded using ordinal scale of Van-der-Maabel (1979). Soil physical and chemical characteristics on transacts representing the highest diversity of *Astragalus parrawinus* ecotypes were taken from A (0-30 cm) and B (30-60 cm) layers. All the soil samples were carried to the laboratory in separate plastic bags. Measured soil factors included texture (determined by Bouyoucos hydromerter), Carbon-Nitrogen ratio (determined using Walkely and Black rapid titration, Black, 1965), organic matter were determined by drying and ignition at 600°C for 3 h (Wright, 1939), pH in saturation extract (determined by pH meter), electrical conductivity (EC) (determined by conductivity meter), soluble calcium and magnesium (determined by titration with solution EDTA method), soluble chlorine (determined by titration with $AgNO_3$) and soluble sodium (determined by flame photometry method). Soil texture was measured by hydrometric method (Black, 1965). Sodium absorption ratio (SAR) was calculated by the Eq. 2 (Miller and Keeney, 1986);

$$SAR = Na^{+}/[(Ca^{2+} + Mg^{2+})/2]^{1/2} \quad (2)$$

Saturation moisture (determined by weighting method) was measured by the Eq. 3 (Jafari *et al*., 2003a);

$$SP\ (\%) = \frac{\text{Soil saturation weight}}{\text{Dry soil weight}} \times 100 \quad (3)$$

Data analysis methods: Data matrix of environmental factors and *Astragalus parrawinus* characteristic was made. The relationship among all measured edaphic attributes with *Astragalus parrawinus* establishment and distribution in all 10 range sites was explained by normal ordination grouping of CA categories using CANOCO software (Ter Braak, 1987, 1988). CA is the new technique that selects the linear combination of environmental variables that maximizes the description of the species scores. On the other hand, CA chooses the best weights for the environmental variables (Zahedi, 1998). This gives the first CA axis. In CA, composite gradients are linear combinations of environmental variables, giving a much simpler analysis and the non-linearity enters the model through a unimodal model for a few composite gradients, taken care of in CA by weighted averaging. Canonical ordination is easier to apply and requires less data than regression. It provides a summary of the species-environment relations (Jongman *et al*., 1995). Significance of species-environment correlation was tested by the distribution-free Monte Carlo test (1000 permutations). In the Monte Carlo test, the distribution of the test statistics under the null hypothesis is generated by random permutations of cases in the environmental data.

RESULTS

Correlation among soil characteristics by CA method: CA is a kind of technique that shows non-linear relations between species with environmental factors and chooses the best weights for environmental variables. The analysis of variance showed that there was a significant correlation among species and soil axis. Taking samples from 10 study sites provides at least 10 values for each soil character (Table 1). The t-value (correlation index) among the soil and vegetation cover characteristics was calculated using the Eq. 4.

$$t = r\left[(n-2)/(1-r^2)\right]^{1/2} \qquad (4)$$

Where:

r = Correlation coefficient
n = Samples number
t = Correlation index

Only t-values of $-0.64\% \le r \le +0.64\%$ at 1% probability level and $-0.5\% \le r \le +0.5\%$ at 5% probability levels were significant according to the t student table. There was a strong and significant correlation between the first axis of soil with the first axis of plant characteristics (r = 1). The same correlation was calculated between the second axis of plant and soil characteristics (r = 0.97). The correlation coefficient between species, ordination and soil properties axis show in Table 2. According to Table 3 and 4, first axis (eigenvalue = 0.711) accounted for 57.1% variation in environmental factors data. Correlation between the first axis and species-environmental variables was 0.95 and Monte Carlo permutation test for the first axis was highly significant (p = 0.01). The second axis (eigen value = 0.498) explained 40% variation in data set. Correlation between the second axis and species-environmental variables was 0.99. In addition, the Monte Carlo test for the second axis was highly significant (p = 0.01). The results of CA ordination are presented in Fig. 3. Four group sites were determined in relation to the environmental factors.

Analysis of plant parameters relationship with soil characteristics by CA method: The relationship of plant parameters with soil characteristics were identified by CA method. This method was applied to demonstrate these relationships graphically (Fig. 3). For interpretation diagram and explanation reasons distribution of *Astragalus parrawinus* species, besides attention to the soil characteristics, should be noted the points as mentioned below:

- In the diagram, distance between the cover and density of *Astragalus parrawinus* species showed the degree of similarity and dissimilarity in soil factors

Table 1: Soil physical and chemical characteristics of study area (in different sites)

Site	Depth	Gravel	Clay	Silt	Sand	pH	EC	Na^+	Ca^{2+}	Mg^{2+}	Cl^-	OM	C/N	SP	SAR
1	0-30	25.00	36.60	37.50	25.90	7.10	0.767	0.540	4.40	3.60	6.50	0.530	0.50	40.40	0.300
	30-60	22.60	41.30	38.90	19.60	7.03	0.892	0.590	2.70	3.86	10.67	0.740	1.67	48.60	0.290
2	0-30	35.00	53.56	3.51	45.85	7.53	0.992	0.826	3.58	5.78	16.97	1.680	6.50	33.10	0.772
	30-60	59.00	25.24	18.58	59.20	7.78	1.010	0.704	1.65	11.00	5.95	0.829	6.92	31.34	0.825
3	0-30	34.00	52.88	2.51	44.59	7.10	0.870	0.526	2.50	5.00	16.25	1.019	5.50	32.10	0.272
	30-60	58.00	24.34	17.62	58.02	7.20	0.901	0.504	0.00	10.00	5.00	0.529	6.00	30.02	0.225
4	0-30	10.00	36.10	34.41	29.49	7.90	0.895	8.660	4.00	2.00	25.00	0.310	5.00	40.20	0.217
	30-60	42.50	43.65	28.12	28.19	7.85	0.490	5.435	3.50	0.00	27.50	0.135	2.00	46.14	0.1805
5	0-30	25.20	35.60	36.40	26.90	7.20	0.780	0.740	4.30	3.80	6.87	0.590	0.70	41.02	0.400
	30-60	22.90	42.20	37.60	20.10	7.10	0.871	0.590	2.50	3.59	10.34	0.710	1.45	47.90	0.300
6	0-30	33.00	51.88	1.87	43.30	7.01	0.764	0.586	2.01	4.95	15.02	1.100	4.64	31.05	0.372
	30-60	57.00	23.50	16.85	57.01	7.01	0.805	0.404	0.00	9.86	4.97	0.429	5.54	29.56	0.525
7	0-30	25.00	36.60	37.50	25.90	7.10	0.767	0.540	4.40	3.60	6.50	0.530	0.50	40.60	0.300
	30-60	22.60	41.30	38.90	19.60	7.03	0.892	0.590	2.60	3.86	10.67	0.740	1.67	48.60	0.300
8	0-30	18.00	26.50	22.00	51.50	7.00	0.833	10.700	0.80	2.00	5.00	50.000	4.50	49.05	0.393
	30-60	39.67	33.16	19.00	48.16	7.20	0.421	7.060	0.60	1.67	6.00	48.000	1.67	54.50	0.315
9	0-30	21.00	38.50	21.50	42.23	8.70	0.792	0.552	4.30	2.40	5.80	0.791	2.86	42.50	0.473
	30-60	43.60	43.50	18.10	32.50	7.50	0.720	0.833	4.50	2.76	4.60	0.694	2.92	39.20	0.447
10	0-30	20.00	37.77	20.98	41.23	8.00	0.592	0.452	4.00	1.50	5.00	0.591	2.135	41.19	0.273
	30-60	42.60	42.80	17.34	39.83	7.67	0.558	0.633	4.00	2.166	4.00	0.594	2.115	38.40	0.367

For sites abbreviations and soil characteristics units (Appendix A)

Table 2: Correlation coefficient between species, ordination and soil properties axis

	SPEC AX1	SPEC AX2	GravelA	GravelB	SandA	SandB	SiltA	SiltB	ClayA	ClayB	SPA	SPB	ECA	ECB	pHA
SPEC AX1	1.00														
SPEC AX2	0.23	1.00													
ENVI AX1	1.00	0.23													
ENVI AX2	0.0003	0.97**													
GravelA	0.29	-0.19	1.00												
GravelB	0.35	-0.05	0.34	1.00											
SandA	0.25	-0.01	0.32	0.73**	1.00										
SandB	-0.03	-0.15	0.52*	0.65**	0.60	1.00									
SiltA	0.13	-0.04	-0.54*	-0.50	-0.28	-0.78**	1.00								
SiltB	0.28	-0.44	-0.16	-0.24	-0.11	-0.41	0.76**	1.00							
ClayA	-0.02	-0.44	0.37	0.38	0.07	0.51*	-0.64**	-0.11	1.00						
ClayB	-0.14	0.33	-0.63*	-0.52*	-0.55*	-0.78**	0.58*	0.01	-0.67**	1.00					
SPA	-0.25	0.15	-0.67**	-0.51*	-0.11	-0.38	0.42	0.21	-0.21	0.24	1.00				
SPB	0.04	0.49	-0.64**	-0.40	-0.34	-0.69**	0.54*	0.17	-0.50	0.61*	0.58*	1.00			
ECA	0.20	-0.16	0.17	0.29	0.20	0.36	-0.37	-0.07	0.54*	-0.54*	-0.01	-0.16	1.00		
ECB	0.15	-0.59*	0.68**	-0.04	-0.10	0.20	-0.12	0.37	0.49	-0.48	-0.36	-0.57*	0.23	1.00	
pHA	-0.32	0.03	-0.31	0.02	0.01	-0.15	-0.03	-0.39	-0.10	0.45	0.08	-0.12	-0.04	-0.29	1.00
pHB	-0.01	-0.16	-0.17	0.45	0.45	0.22	0.01	-0.04	0.02	0.01	-0.11	-0.29	0.26	-0.32	0.57*
OMA	-0.16	0.41	-0.28	0.01	0.36	0.20	-0.04	-0.15	-0.25	-0.11	0.53*	0.46	0.15	-0.52*	-0.27
OMB	-0.17	0.41	-0.30	-0.01	0.34	0.18	-0.02	-0.15	-0.25	-0.10	0.56*	0.48	0.14	-0.52*	-0.27
C/NA	0.32	0.30	0.22	0.75**	0.49	0.41	-0.29	-0.33	-0.13	-0.15	-0.56*	-0.11	0.17	-0.25	-0.01
C/NB	0.23	-0.19	0.74**	0.81**	0.51*	0.75**	-0.72**	-0.27	0.55*	-0.65**	-0.78**	-0.66**	0.43	0.38	-0.07
ClA	0.10	-0.26	0.04	0.51	0.12	0.31	-0.04	0.16	0.17	-0.25	-0.55*	-0.36	0.35	0.12	-0.08
Clb	-0.22	0.02	-0.45	-0.16	-0.28	-0.48	0.57*	0.50	-0.19	0.17	0.26	0.34	0.08	-0.09	-0.13
CaA	0.35	0.02	-0.11	-0.22	-0.41	-0.72**	0.49	0.26	-0.25	0.59*	-0.07	0.24	-0.29	0.10	0.33
Cab	-0.05	0.16	-0.61*	-0.36	-0.58*	-0.64**	0.35	-0.02	-0.21	0.80**	0.32	0.47	-0.34	-0.29	0.56*
MgA	0.22	-0.46	0.81**	0.25	0.23	0.51*	-0.26	0.23	0.34	-0.67**	-0.59*	-0.71**	0.30	0.83**	-0.40
Mgb	0.14	-0.56*	0.73**	0.35	0.35	0.69**	-0.37	0.18	0.50	-0.78**	-0.49	-0.82**	0.27	0.79**	-0.34
NaA	-0.32	0.60	-0.57*	-0.12	-0.09	-0.10	0.06	-0.35	-0.45	0.33	0.32	0.58*	0.14	-0.77**	0.02
Nab	-0.15	0.23	-0.50	0.16	0.38	0.05	0.29	0.09	-0.45	0.09	0.28	0.36	0.17	-0.63*	-0.02
SARA	0.42	-0.13	0.41	0.43	0.43	0.40	-0.26	0.01	-0.28	-0.42	-0.11	-0.25	0.42	0.40	0.02
S ARB	0.59*	0.01	0.37	0.38	0.19	0.27	-0.36	-0.12	0.39	-0.34	-0.13	-0.12	0.23	0.31	-0.05

	pHB	OMA	OMB	C/NA	C/NB	ClA	Clb	CaA	Cab	MgA	Mgb	NaA	Nab	SARA	S ARB
pHB	1.00														
OMA	-0.10	1.00													
OMB	-0.12	0.99**	1.00												
C/NA	0.35	0.11	0.91**	1.00											
C/NB	0.27	-0.20	-0.23	0.62**	1.00										
ClA	0.46	-0.29	-0.31	0.57*	0.47	1.00									
Clb	0.01	-0.17	-0.16	0.01	-0.40	0.38	1.00								
CaA	0.05	-0.65**	-0.64**	-0.06	-0.24	-0.04	0.43	1.00							
Cab	0.05	-0.26	-0.25	-0.25	-0.51*	-0.25	0.24	0.66**	1.00						
MgA	-0.03	-0.33	-0.35	0.17	0.63*	0.41	-0.12	-0.16	-0.66**	1.00					
Mgb	0.05	-0.25	-0.27	0.08	0.65**	0.36	-0.25	-0.36	-0.66**	0.92**	1.00				
NaA	0.03	0.65**	0.65**	0.30	-0.32	0.06	0.18	-0.28	0.09	-0.55*	-0.61*	1.00			
Nab	0.41	0.67**	0.66**	0.36	-0.17	0.29	0.16	-0.40	-0.20	-0.29	-0.27	0.71**	1.00		
SARA	0.26	0.57*	0.04	0.32	0.51*	0.09	-0.12	-0.01	-0.12	0.45	0.45	-0.27	-0.10	1.00	
S ARB	-0.01	-0.81**	-0.08	0.24	0.43	-0.02	-0.01	0.15	0.08	0.25	0.25	-0.30	-0.38	0.84**	1.00

*, **The same letter(s) are not significantly different at 5 and 1% level, respectively

- The distance between the cover and density of *Astragalus parrawinus* species with axis is representative of the relationship power in explanation of variations. Whatever the length of vector that is indicator the cover and density of *Astragalus parrawinus* species is bigger and angle between vector with axis is smaller, correlation between *Astragalus parrawinus* characteristic with axis and relation power is more. According to Fig. 3, the results of these analysis in 10 sites showed that there is strong correlation between the two plant characteristic (density and cover percent) which was demonstrated by Eq. 4 with the same distribution and in the same direction in Fig. 3

Table 3: Eigen values for each axis in CA method

	Axis			
CA method	1	2	3	4
Eigen values	0.711	0.498	0.034	0.003
Variance in species data				
% of variance explained	57.100	40.000	2.700	0.200
Cumulative % explained	57.100	97.100	99.800	100.000

Table 4: Monte Carlo test for species-environment correlations

Axis	Spp-envt corr.	Mean	Minimum	Maximum	p-value
1	0.950	0.730	0.420	0.930	0.01
2	0.990	0.470	0.150	0.920	0.01

The increment of these two parameters is exactly in direction of high density plant sites with over 2, 5, 6 and 10 which well indicate the strong *Astragalus parrawinus*

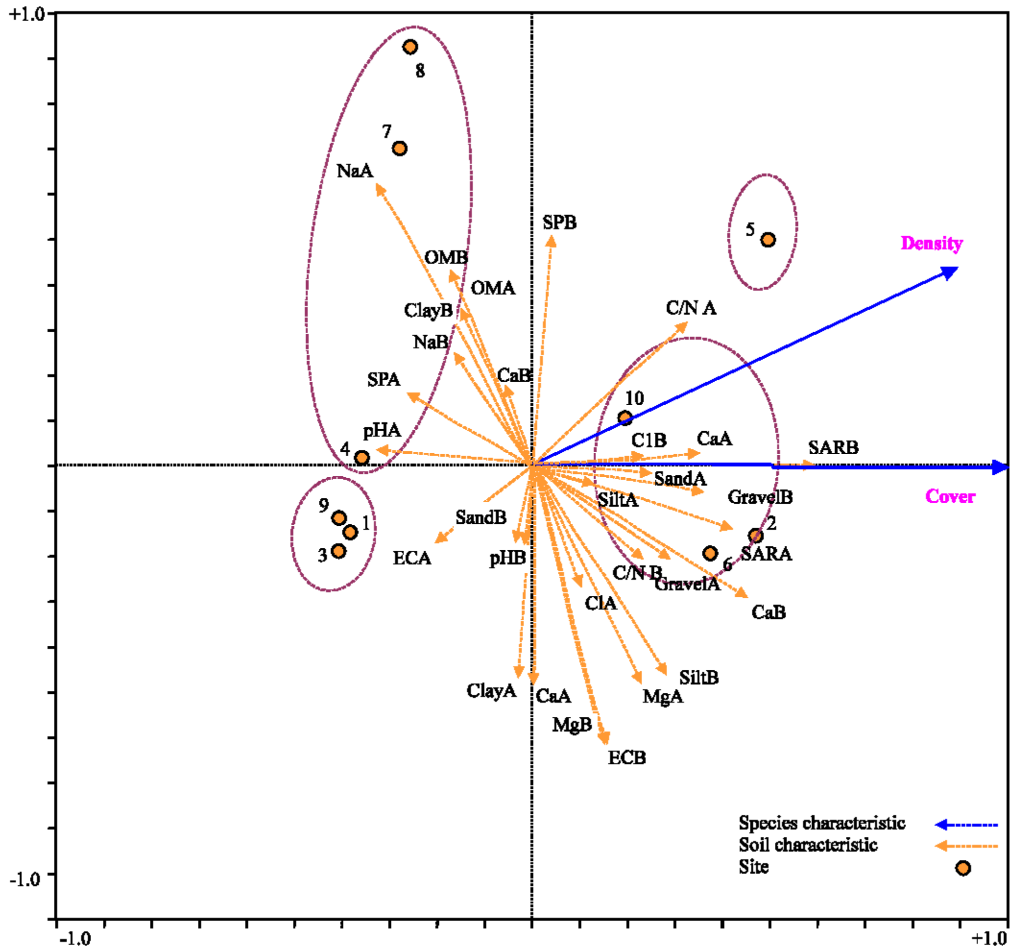

Fig. 3: The relationship between soil characteristic and *Ast. parrawinus* properties obtain by CA method. For species and sites variables abbreviations and soil characteristics units (Appendix A)

growth in these sites (Fig. 3). The correlation between these plant parameters (density and cover percent) are well indicated by the coefficient of correlation values in Table 5. To provide with a better description of soil characteristics relation with plant parameters, the absolute values of coefficients were categorized as follows: 1. No effects (0-0.2), 2. Low effects (0.2-0.4), 3. Moderate effects (0.4-0.6), 4. High effects (0.6-0.8), 5. Very high effects (0.8-1). As it is shown in Table 5, soil characteristics like Ca^{2+} content at soil A layer, sand, Cl^-, Mg^{2+} and Na^+ at B and silt, clay, SP, EC, pH and %OM at A and B layers have no effects on *Astragalus parrawinus* vegetation cover. On the other hand parameters like gavel percentage, Mg content and Na at A layer and Cl^- at B as well as C/N and Ca^{2+} content at both A and B layers of the soil have a moderate effects on vegetation cover of *Astragalus parrawinus*. Soil parameters like sand parentage and soil pH at soil a layer have a moderate effect on the vegetation cover while the same factors at B layer were the most effective ones on percent vegetation cover. The most effective factors on *Astragalus parrawinus* density were C/N ratio and soil pH at B layer. Thus among twenty-eight measured soil parameters, twenty-eight parameters which their correlation coefficient mean with plant parameters were more than 19% were selected and others were eliminated (Table 5). Among the selected soil parameters, C/N ratio, SAR, sand, gravel percentage and Ca^{2+} at A layer and SAR, C/N ratio and Cl^- at B layer had the highest positive correlation while SP, pH and EC parameters at A layer had the lowest correlation with plant parameters.

Table 5: Simple correlation coefficient between soil and plant properties

	Cover	Density	GravelA	GravelB	SandA	SandB	SiltA	SiltB	ClayA	ClayB	SPA	SPB	ECA	ECB	pHA
Cover	1.00														
Density	0.90	1.00													
GravelA	0.29	0.14	1.00												
GravelB	0.41	0.35	0.33	1.00											
SandA	0.31	0.28	0.31	0.76	1.00										
SandB	0.07	0.05	0.49	0.69	0.64	1.00									
SiltA	0.05	-0.02	-0.53	-0.55	-0.34	-0.80	1.00								
SiltB	0.18	-0.09	-0.16	-0.32	-0.20	-0.48	0.79	1.00							
ClayA	-0.03	-0.21	0.37	0.37	0.07	0.48	-0.62	-0.10	1.00						
ClayB	-0.18	-0.03	-0.63	-0.54	-0.57	-0.78	0.60	0.06	-0.66	1.00					
SPA	-0.27	-0.16	-0.67	-0.52	-0.14	-0.40	0.43	0.23	-0.22	0.26	1.00				
SPB	-0.04	0.13	-0.62	-0.46	-0.40	-0.72	0.58	0.24	-0.49	0.62	0.58	1.00			
ECA	-0.18	-0.20	0.17	0.29	0.21	0.35	-0.37	-0.10	0.55	-0.55	0.00	-0.20	1.00		
ECB	0.10	-0.19	0.67	-0.09	-0.15	0.13	-0.08	0.41	0.48	-0.45	-0.30	-0.50	0.23	1.00	
pHA	-0.25	-0.15	-0.30	0.08	0.07	-0.07	-0.09	-0.40	-0.10	0.41	0.07	-0.20	-0.04	-0.30	1.00
pHB	0.05	0.01	-0.17	0.49	0.49	0.29	-0.05	-0.10	0.02	-0.03	-0.10	-0.30	0.27	-0.20	0.60
OMA	-0.14	0.08	-0.28	0.04	0.37	0.22	-0.06	-0.20	-0.25	-0.12	0.53	0.43	0.16	-0.50	-0.25
OMB	-0.15	0.07	-0.30	0.01	0.35	0.19	-0.05	-0.20	-0.25	-0.11	0.55	0.45	0.15	-0.50	-0.25
C/NA	0.38	0.47	0.22	0.78	0.55	0.48	-0.36	-0.40	-0.13	-0.19	-0.60	-0.20	0.18	-0.30	0.06
C/NB	0.28	0.17	0.73	0.82	0.54	0.76	-0.74	-0.40	0.54	-0.66	-0.80	-0.70	0.44	0.34	-0.03
ClA	0.16	0.05	0.05	0.54	0.18	0.36	-0.10	0.08	0.17	-0.28	-0.60	-0.40	0.36	0.08	-0.04
ClB	0.22	0.17	-0.45	-0.16	-0.28	-0.46	0.55	0.48	-0.19	0.18	0.27	0.34	0.09	-0.10	-0.14
CaA	0.28	0.19	-0.12	-0.27	-0.45	-0.74	0.52	0.31	-0.25	0.61	-0.10	0.29	-0.30	0.13	0.29
CaB	-0.08	0.00	-0.62	-0.38	-0.58	-0.64	0.37	0.01	-0.21	0.81	0.33	0.48	-0.35	-0.30	0.54
MgA	0.23	-0.01	0.81	0.26	0.24	0.49	-0.26	0.21	0.34	-0.68	-0.60	-0.70	0.30	0.82	-0.39
MgB	0.17	-0.09	0.73	0.37	0.37	0.68	-0.39	0.14	0.50	-0.79	-0.50	-0.80	0.27	0.76	-0.31
NaA	-0.27	0.06	-0.56	-0.08	-0.05	-0.05	0.02	-0.40	-0.45	0.31	0.30	0.52	0.14	-0.80	0.05
NaB	-0.12	0.03	-0.50	0.20	0.40	0.10	0.24	0.04	-0.45	0.07	0.27	0.31	0.18	-0.60	0.00
SARA	0.44	0.31	0.41	0.45	0.45	0.43	-0.29	0.00	0.28	-0.44	-0.10	-0.30	0.43	0.38	0.05
SARB	0.60	0.48	0.37	0.40	0.21	0.29	-0.38	-0.20	0.40	-0.35	-0.10	-0.20	0.24	0.29	-0.03

	pHB	OMA	OMB	C/NA	C/NB	ClA	ClB	CaA	CaB	MgA	MgB	NaA	NaB	SARA	SARB
pHB	1.00														
OMA	-0.10	1.00													
OMB	-0.10	0.98	1.00												
C/NA	0.40	0.14	0.11	1.00											
C/NB	0.31	-0.18	-0.20	0.64	1.00										
ClA	0.49	-0.27	-0.30	0.60	0.50	1.00									
ClB	0.00	-0.17	-0.20	0.01	-0.40	0.38	1.00								
CaA	0.01	-0.65	-0.60	-0.13	-0.27	-0.10	0.43	1.00							
CaB	0.03	-0.27	-0.30	-0.27	-0.52	-0.30	0.25	0.67	1.00						
MgA	0.00	-0.33	-0.40	0.18	0.63	0.41	-0.10	-0.20	-0.70	1.00					
MgB	0.08	-0.24	-0.30	0.12	0.65	0.38	-0.30	-0.40	-0.70	0.93	1.00				
NaA	0.07	0.66	0.66	0.33	-0.28	0.09	0.18	-0.30	0.08	-0.54	-0.59	1.00			
NaB	0.43	0.68	0.67	0.39	-0.14	0.31	0.16	-0.40	-0.20	-0.29	-0.26	0.72	1.00		
SARA	0.29	0.07	0.05	0.35	0.52	0.12	-0.10	0.00	-0.10	0.45	0.46	-0.30	-0.10	1.00	
SARB	0.02	-0.07	-0.10	0.26	0.44	0.00	0.00	0.13	0.07	0.26	0.26	-0.30	-0.40	0.84	1.00

*, **The same letter(s) are not significantly different at 5 and 1% level, respectively

DISCUSSION

The results showed that in the study area, among different environmental factors (edaphic variables), the distribution of vegetation types was most strongly correlated with some soil characteristics. Abd El-Ghani *et al.* (2003) suggested that there is a relatively high correspondence between vegetation and soil factors. In arid and semi-arid regions, the relation between species distribution and such as texture, saturation moisture, acidity, electrical conductivity, sodium absorption ratio, C/N ratio, organic carbon and soluble ions has been reported by Ungar (1968), Flowers (1985), Kassas and Zahran (1975), Asri (1993), Caballero *et al.* (1994), Maryam *et al.* (1995), Jafari *et al.* (2003a, b) and Moghimi (2005). Abd El-Ghani (2000) also showed strong relationships between vegetation pattern and soil moisture-salinity gradient in the Egyptian inland saltmarshes. Soil texture controls distribution of plant species by affecting moisture availability, ventilation and distribution of plant roots. The role of soil moisture, as a key element in the distribution of the plant species, is described by Zohary and Orshan (1949) in the Dead Sea region of Israel and El-Sheikh and Yousef (1981) in Al-Kharg springs.

Soil pH and calcium content: Soil pH increment at A and B layers is due to accumulation of Na^+ and decrement of Ca^{2+} and Mg^{2+}. As the *Astragalus parrawinus* density increased the consumption of Ca^{2+} and Mg^{2+} in soil B layer increased which this phenomena lead to increment of soil anions like Cl^- and Ca^{2+}. On the other hand the accumulation of plant residues on the top soil increase Na^+ content in that layer after degradation. *Astragalus parrawinus* leaves posses a significant amount of Na^+ which could be leached to the lower layers of the soil due to the local precipitations. This process causes higher SAR values at A and B soil layers which in long term negatively interferes with soil cation exchange capacity at Rhizosphere. The higher osmotic pressure at Rhizosphere decreases the plant roots ability to absorb water. This process is in progress especially at sites No. 2, 5, 6 and 10. As carbonate and bicarbonate of Na^+ and K^+ increases at top soil in long tern period, calcium absorption by plant will decrease and iron and calcium ions activities will be retarded at plant leaves. Potassium carbonate also negatively affects plant respiration and carbohydrate metabolism. So, the accumulation of excessive amounts of bicarbonate salts is toxic to the plants (Malcom and Choukr-Allah, 1995).

Nitrogen and carbon: The higher density of *Ast. parrawinus* on soil surface tend to higher consumption of N at A and B layers of the soil and on the other hand increases the plant residues on the top soil. The plant residues content a large amount of carbon which increases soil carbon content in turn. The massive nitrogen consumption because of high plant density along with carbon and organic matter leaching to soil B layer, lead to a higher C/N ratio at A and B soil layers.

Gravel percentage and soil texture: High gravel and sample sand content in soil texture of A layer of the soil provides with a high infiltrations rate at the top soil. The soluble minerals will be leached easily at such situation and would be available to the plant roots at B layer of the soil. So, such a soil texture (sandy) will cause higher plant and vegetation cover density which is supported by Moghimi (2005) results.

SP, pH and EC: Soil texture of the study area was very light with a very low moisture holding capacity. This characteristic caused that plants develop a lower volume of roots at the upper layers of the soil. The higher plant density of *Ast. par* will increase percent vegetation cover and build up salinity at soil surface which in turn causes high pH value at the top soil. This salinity and alkalinity of the soil will prohibit *Ast. par* community growth in long term period. Jafari *et al*. (2003b) in a study on soil-vegetation relationships in Hoz-e-Soltan of Qom Province indicated that the most effective factors on the separation of different communities were soil salinity and texture. The relation between species distribution and salinity gradient has been reported by Ungar (1968), Flowers (1985), Kassas and Zahran (1975), Asri (1993), Caballero *et al*. (1994) and Maryam *et al*. (1995).

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APPENDIX A

Astragalus parrawinus	*Ast. par*
Eigenvalues	Eign
Gravel (%)	Gravel
Clay (%)	Clay
Sand (%)	Sand
Silt (%)	Silt
Saturation moisture (%)	SP
Sodium absorption ratio	SAR
Carbon-Nitrogen ratio	C/N
Organic matter (%)	OM
pH (acidity)	pH
Electrical conductivity (dS m^{-1})	EC
Sodium ion (Na^+) (meq L^{-1})	Na
Calcium ion (Ca^{2+}) (meq L^{-1})	Ca
Magnesium (Mg^{2+}) (meq L^{-1})	Mg
Chlorine (Cl^-) (meq L^{-1})	Cl

Code A is related to the soil characteristics were measured in the first layer (0-30 cm)
Code B is related to the soil characteristics were measured in the second layer (30-60 cm)

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