INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 4, No. 2, p. 130-140, 2014
http://www.innspub.net

RESEARCH PAPER | OPEN ACCESS

Autecology of *Zataria multiflora* using principal component analysis (PCA) in Fars Province, Iran

Damoun Razmjoue[1*], Hossein Azarnivand[2], Majid Ayatollahi[3], Mohammad Jafari[2], Mahmood Ghafari[4]

[1]*Department of Range Management, Science and Research Branch, Islamic Azad University, Tehran, Iran*

[2]*Faculty of Natural Resources, University of Tehran, Alborz, Iran*

[3]*Department of Pharmacy, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

[4]*Institute of Biochemistry and Biophysics, University of Tehran, Tehran, Iran*

Article published on February 03, 2014

Key words: Autecology, *Z. multifora*, PCA, Fars.

Abstract

Genus Zataria in Iran only has one species, named *Zataria multiflora*. This plant is known as "Broadleaf Thyme" or "Shirazi Thyme" in southern Iran. It is seen in the central part of south and southeastern Iran. To study the autecology of Z. *multifora,* data of vegetation cover including canopy cover percentage, density, frequency, plant height and production as well as physical and chemical properties of soil, climate data and physiography of the region were investigated. To determine the relationship between species and environmental factors PCA (Principle Component Analysis) was used. To determine the similarity between sites, considering various factors and applying Wards method, Euclidean distance index was used and cluster analysis (obtained dendrogram) was interpreted. Results showed that considering all factors (vegetation cover, soil and climate parameters) pH, P, and slope had the highest coefficients in the first component, while rainfall and altitude showed the highest coefficient in the second component. About 63/4% of the variation was accounted for by the first component. According to the site ranking charts, Zarrindasht site showed significant differences with Lar and Neyriz sites. According to the results of cluster analysis, a similarity of 94.4% was obtained for Lar and Neyriz sites.

*Corresponding Author: Damoon Razmjouei ✉ d.razmjoue@gmail.com

Introduction

In our country, rangeland ecosystems comprise much of the renewable natural resources. Proper utilization of these ecosystems requires a good understanding of the characteristics of living components as well as the interaction between the components. Since the outcome of rangeland ecosystem function and behavior is reflected in its vegetation, range and medicinal plants are important components of the ecosystem. Therefore, study of individual behavior, defined as autecology, will result in providing a part of the information required for rangeland management program. Many studies have been done on physical factors affecting the growth of range and medicinal species, the interaction between these species and biotic factors as well as natural phenomena related to the autecology of these species. Zhou *et al.* (2007) numerically analyzed the correlation between desert plant communities and soil factors in southern edge of the Gorban desert using PCA method.

Lopez *et al.* (2004) stated that the ultimate goal of applying multivariate analysis was to examine the effect of environmental factors on species and plant communities statistically. Song *et al.* (2006) analyzed the plant communities of wolong protected grasslands in Mountain quantitatively. Moner *et al.,* (2006) studied the vegetation of desert ecosystems of west Egypt using CCA method. We - Q *et al.* (2008) analyzed the relationship between soil properties and halophyte species in the coastal areas of northern China using multivariate analysis (PCA and CCA). Shao (2005) classified the vegetation of Kuan–Tanatural Park in Taiwan based upon soil chemical and physical properties through factor analysis. Baruch (2005) investigated seasonal Savana of Venezuela using cluster analysis and Canonical Correspondence Analysis (CCA).

Zataria multiflora, belonging to the family Laminaceae is distributed only in Iran, Afghanistan and Pakistan (Ghahraman, 1988). In Iran, it is found in the provinces of Sistan and Baluchestan, Hormozgan, Fars, Isfahan and Yazd (Jam-Zad, 1994).

The aim of this study was to study the autecology *Z. multiflora* using PCA in Fars Province, Iran.

Material and methods

Study sites

1. Pardis Mountain site: It is 50 km far from the Lar city, located between the longitudes 53° 33' 17"-53° 22' 56" and latitudes 27° 29' 19"-27° 25' 32". The average temperature is between 25-30 °C and the average rainfall is180-210 mm per year.

2. Mazaijan site: This site is 56 km far from the Zarin Dasht city, located between the longitudes 54° 25' 8"–54° 53' 29" and latitudes 28° 9' 49"-29° 57' 59". The average temperature is between 30-35 °C and the average rainfall is140-160 mm per year.

3. Jazin site: This site is 56 km far from the Neyriz city, located between the longitudes 53° 45' 58"–53° 39' 48" and latitudes 29° 49' 22"–29° 45' 17". The average temperature is between 20-25 °C and the average rainfall is 250-350 mm per year.

In the beginning, with field investigations and library studies the main habitats of this species were identified in three sites and physiognomic units were separated using aerial photographs and topographic maps. In each physiognomic unit, key area was selected and at each site, 4 transects of 100 m length were established by random systematic method. Along each transect, 5 plots of 2×2 square meters were selected. The size of the sampling unit in each vegetation type was determined by minimal area method, and the number of plots was calculated by statistical method. After establishing transects and plots, vegetation data including canopy cover percentage, density, frequency, height, and production were measured. To study soil properties, at each site 3 profiles were taken at two depths of 0-10 and 10-50 cm. Physical and chemical properties of the soil were measured. Climatic and physiographic data were also carefully calculated. To determine the relationship between species and environmental factors, indirect gradient analysis PCA (Principle Component Analysis) was used. According to various factors and using Wards method, the similarity between the sites was determined by Euclidean distance index and cluster analysis (obtained dendrogram) was interpreted.

Results

Canopy cover

Due to the low number of samples, vegetation cover variables in sites and applying Principal Component Analysis method, considering the first two components was enough. According to the results, canopy cover percentage and production had the largest coefficients in the first component. In the second component, density and frequency were more important. Table 1 shows the changes of variables. As can be seen, variables are in different quarters.

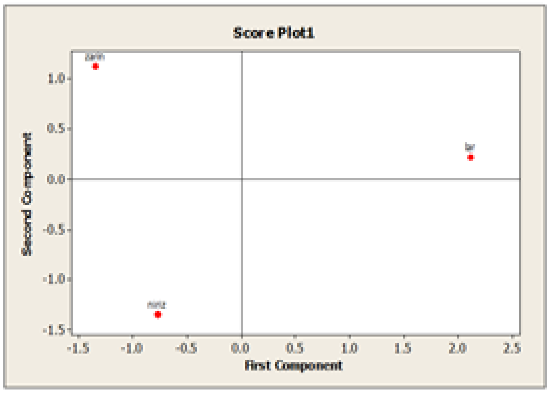

Fig. 1. Site ranking chart for vegetative cover variables.

Table 1. PCA coefficients for vegetation cover variables.

Variable	PC1	PC2	PC3	PC4	PC5
Canopy cover percentage	-0.529	0.157	0.628	0.215	-0.504
Density	-0.360	-0.595	-0.029	-0.703	-0.144
Frequency	-0.392	-0.550	-0.012	0.570	0.468
Plant Height	-0.423	0.497	0.164	-0.345	0.655
Production	-0.508	0.268	-0.760	0.122	-0.278

According to the classification of site ranking charts, Lar site differed from two other sites and there was difference between Neyriz and Zarindasht in terms of vegetative factors (Fig 1,2). In order to determine the similarity among sites, the dendrogram was drawn with regard to the vegetative cover variables using Wards method. According to the diagram, there was more than 50% similarity between Zarindasht and Neyriz, while, Lar differed with these two sites in terms of vegetative cover variables (Fig 3).

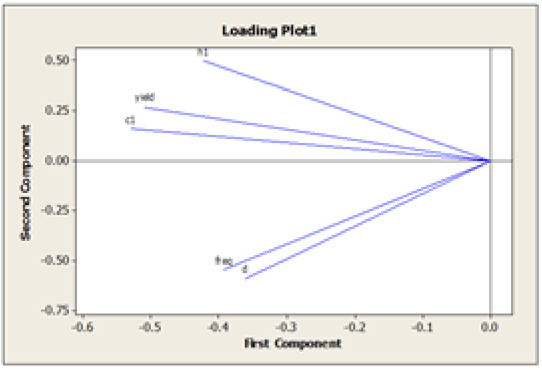

Fig. 2. Vegetative cover variables.

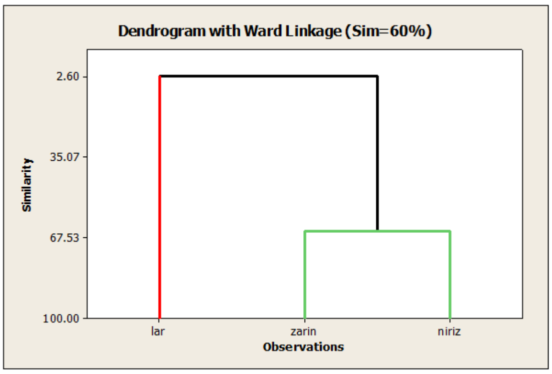

Fig. 3. Similarity dendrogram of vegetative cover variables.

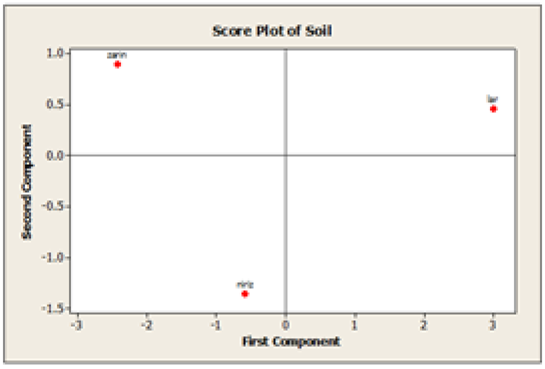

Fig. 4. Site ranking chart for soil parameters.

Table 2. Coefficients of the Principal Components of soil parameters.

Variables	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Salinity	-0.323	0.385	-0.034	-0.292	0.153	0.510	0.217	0.543
pH	0.328	0.358	0.120	-0.696	-0.004	-0.224	-0.459	-0.006
Organic Carbon	-0.363	0.003	-0.129	-0.288	-0.800	-0.100	0.171	-0.205
Nitrogen	-0.363	0.001	0.409	-0.157	0.214	0.425	-0.095	-0.651
Phosphorus	-0.360	-0.114	0.139	0.281	-0.209	0.080	-0.782	0.312
Potassium	-0.363	0.042	0.451	-0.047	0.002	-0.456	0.264	0.273
Clay	-0.121	-0.789	0.225	-0.490	0.186	0.046	-0.030	0.158
Silt	-0.341	0.291	-0.725	0.037	0.173	-0.105	-0.147	-0.180
Sand	0.363	-0.040	-0.026	0.026	-0.427	0.521	0.026	0.098

Soil parameters

With regard to the soil parameters and Principal Component Analysis, the largest coefficients in the first component was obtained for organic carbon, nitrogen and the percentage of sand while clay percentage had the largest coefficients in the second component (Table 2).

According to the results of site ranking in terms of soil parameters, Lar differed from the two other regions (Fig 5). In order to determine the similarity among sites, the dendrogram was drawn using Wards method. According to the diagram, there was about 71.4% similarity between Zarindasht and Neyriz (Fig 6).

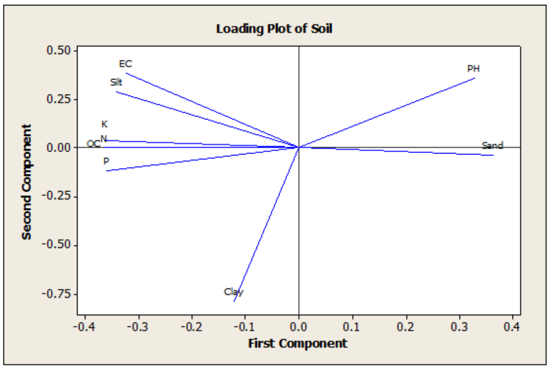

Fig. 5. Soil parameters.

Climate

According to the Principal Component Analysis for climate variables, temperature and moisture in frost days had the largest coefficients in the first component. In the second component, the largest coefficient was obtained for rainfall (Table 3). By matching the two following graphs, it was found that

Neyriz differed from the other two sites (Fig 7,8). According to the diagram, there was 78.2% similarity between Zarindasht and Lar in terms of climate variables (Fig. 9).

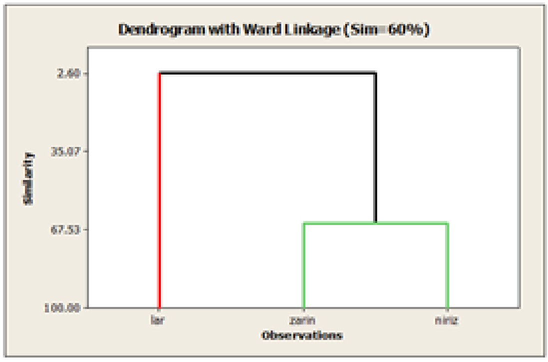

Fig. 6. Similarity dendrogram of soil parameters.

Soil and vegetative cover variables

Principal Component Analysis showed that canopy cover percentage, OC, (organic carbon) and N had the largest coefficients in the first component, while clay percentage had the largest coefficient in the second component (Table 4). The biplot graph also showed that Lar and Zarindasht were close to each other in terms of soil and vegetation cover variables, while Neyriz was quite different with the other two sites (Fig 10, 11). According to the results of cluster analysis, a similarity of 64.8 % was obtained for Lar and Zarindasht sites, but the similarity decreased to 52.6 % when Neyriz was entered to this group (Fig. 12).

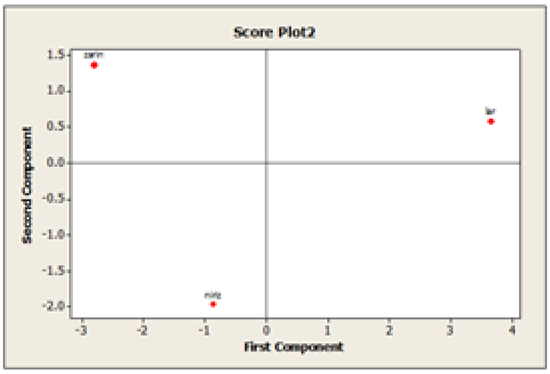

Fig. 7. Site ranking chart for climate parameters.

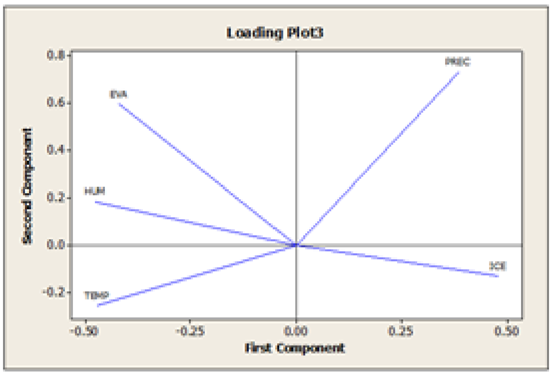

Fig. 8. Climate parameters.

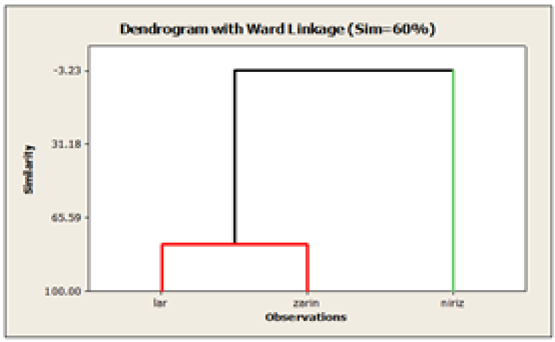

Fig. 9. Similarity dendrogram of climate parameters.

Table 3. Coefficients of the principal components of climate parameters.

Variable	PC1	PC2	PC3	PC4	PC5
Temperature	-0.471	-0.254	0.433	0.427	0.587
Rainfall	0.384	0.729	0.346	0.448	0.042
Moisture	-0.476	0.185	-0.567	0.573	-0.299
Evaporation	-0.419	0.595	-0.188	-0.504	0.426
Number of frost days	0.479	-0.129	-0.580	0.189	0.619

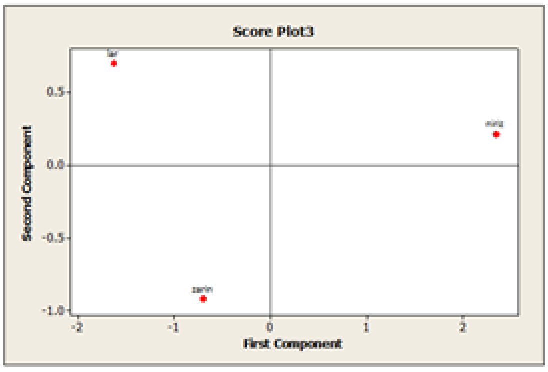

Fig. 10. Site ranking chart for soil and vegetation cover variables.

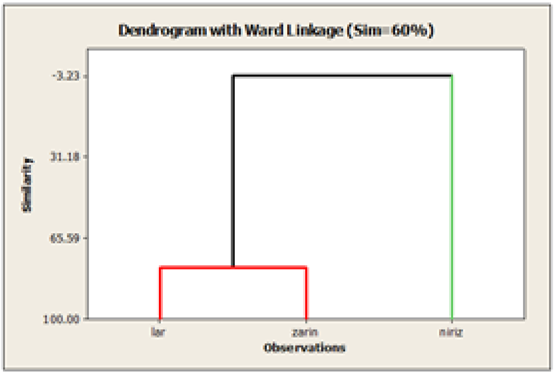

Fig. 12. Similarity dendrogram of soil and vegetation cover variables.

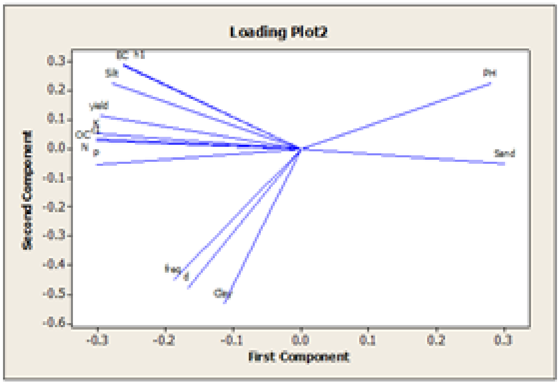

Fig. 11. Soil and vegetation cover variables.

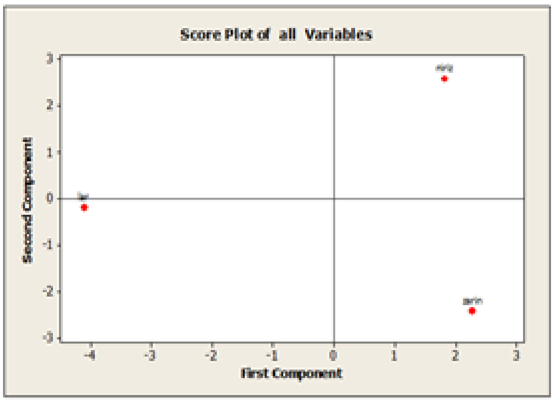

Fig. 13. Site ranking chart for soil, vegetation cover, and climate variables.

Table 4. The main coefficient of soil and vegetation cover variables.

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Cover	-0.302	0.031	0.131	0.158	-0.127	-0.094	0.264	-0.035
Density	-0.167	-0.477	0.025	-0.141	-0.030	-0.019	-0.037	0.172
Frequency	-0.187	-0.450	-0.052	0.456	0.406	0.216	0.053	-0.087
Plant Height	-0.261	0.289	-0.209	0.258	-0.201	-0.247	-0.463	-0.277
Production	-0.296	0.114	-0.084	-0.301	0.308	-0.197	-0.511	-0.065
Salinity	-0.262	0.285	-0.055	-0.322	0.167	0.421	0.369	-0.587
pH	0.278	0.223	-0.106	-0.390	-0.016	0.189	0.005	0.382
Organic Carbon	-0.302	0.027	0.028	-0.165	0.321	0.369	-0.255	0.349
Nitrogen	-0.302	0.025	-0.240	-0.165	-0.209	-0.381	0.379	0.171
Phosphors	-0.301	-0.054	0.054	-0.124	0.073	-0.183	0.117	0.064
Potassium	-0.301	0.053	-0.123	-0.037	0.247	-0.228	0.240	0.287
Clay	-0.113	-0.532	0.098	-0.459	-0.394	0.042	-0.166	-0.264
Silt	-0.278	0.222	0.814	0.090	-0.202	0.097	-0.047	0.158
Sand	0.301	-0.052	0.407	-0.209	0.494	-0.503	0.065	-0.242

Soil, vegetation cover and climate variables

In this step, climate variables were entered into the model and classification was performed.

According to the results, P, K, sand percentage and canopy cover percentage had the largest coefficients in the first component, while in the second component rainfall had the largest coefficient (Table 5). Graphs indicate the similarity between Neyriz and Zarrindasht and the difference of Lar with them (fig 13, 14). According to the results of cluster analysis, a similarity of 41.4 % was obtained for Neyriz and Zarindasht sites (Fig. 15).

Physiographic factors

According to the results, the aspect had the largest coefficient in the first component, while in the second component the largest coefficient was obtained for slope (Table 6). The bipolt graph also showed that Neyriz was differed from the two other sites in terms of physiography (Fig 16, 17). The results of cluster analysis showed a similarity of 95% for Lar and Zarindasht sites, while the similarity decreased significantly when Neyriz was entered to this group (Fig. 18).

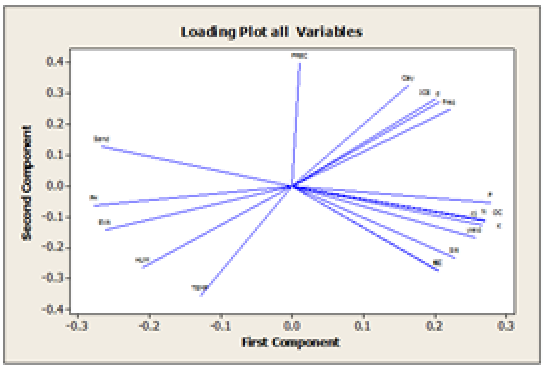

Fig. 14. Soil, vegetation cover, and climate variables.

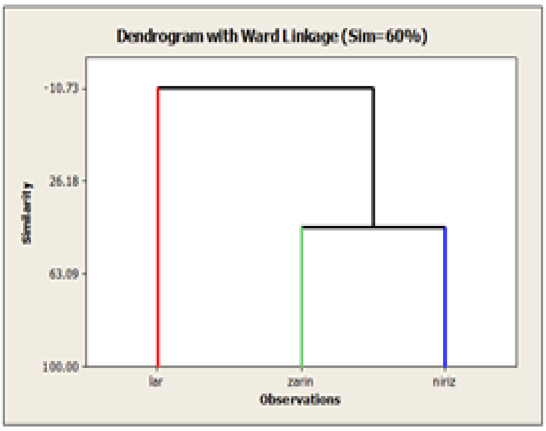

Fig. 15. Similarity dendrogram of soil, vegetation cover, and climate variables.

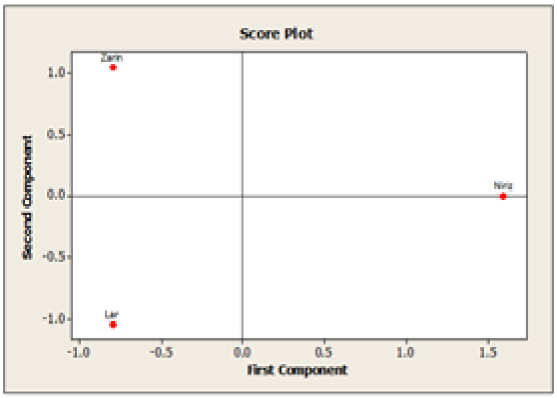

Fig. 16. Site ranking chart for physiographic factors.

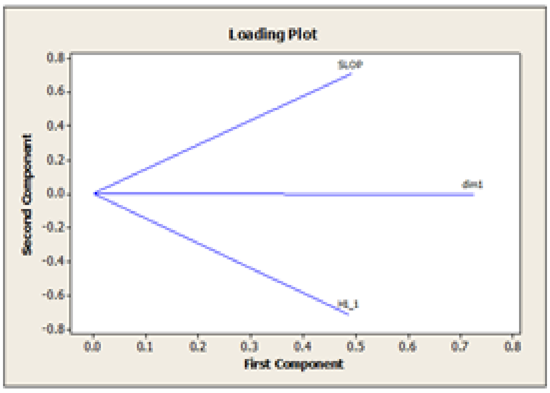

Fig. 17. Physiographic factors.

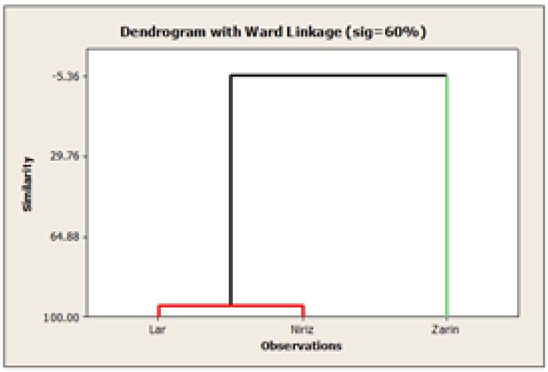

Fig. 18. Similarity dendrogram of physiographic factors.

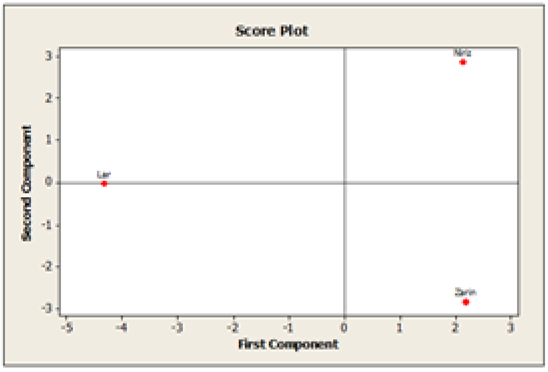

Fig. 19. Site ranking chart for all variables.

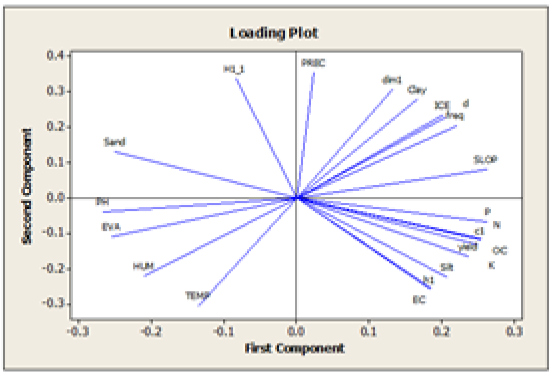

Fig. 20. All variables.

All variables

According to the obtained results, pH, P and slope had the largest coefficients in the first component, while in the second component, rainfall and altitude had the largest coefficient (table 7).With regard to the first component, 63.4% of the variance was justified. The two following graphs indicated a significant difference between Zarindasht and the two other sites (Fig. 19, 20). According to the results of cluster analysis, a similarity of 94.4 % was obtained for Lar and Zarindasht sites (Fig. 21).

Table 5. The main coefficients of soil, vegetation cover and climate variables.

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Cover	0.269	-0.113	0.208	0.001	-0.243	-0.095	-0.120	-0.544
Density	0.205	0.271	-0.043	0.055	0.642	-0.015	0.060	-0.054
Frequency	0.220	0.247	0.010	0.044	-0.490	0.125	0.047	0.141
Plant Height	0.203	-0.274	0.006	0.339	-0.056	-0.198	0.002	0.494
Production	0.255	-0.167	-0.152	-0.160	0.076	0.062	0.433	0.282
Salinity	0.205	-0.272	0.051	-0.363	0.118	0.471	0.040	-0.075
pH	-0.277	-0.066	-0.260	-0.262	-0.055	0.074	-0.117	0.046
organic Carbon	0.270	-0.110	0.062	-0.071	-0.220	0.224	-0.060	0.121
Nitrogen	0.270	-0.109	0.157	-0.189	-0.031	-0.434	0.161	0.004
Phosphorus	0.278	-0.055	0.003	-0.064	0.246	-0.115	0.222	-0.316
Potassium	0.266	-0.127	0.038	-0.259	-0.161	-0.206	0.111	-0.009
Clay	0.162	0.325	-0.125	0.168	- 0.289	0.133	0.065	-0.191
Silt	0.227	-0.235	-0.051	0.236	0.109	0.549	-0.117	0.058
Sand	-0.266	0.126	-0.002	-0.274	-0.109	0.037	0.418	0.151
Temperature	-0.128	-0.354	-0.111	0.285	-0.045	-0.113	0.316	-0.009
Rainfall	0.010	0.397	0.119	-0.025	-0.032	0.222	0.474	-0.004
Moisture	-0.209	-0.265	-0.064	-0.427	-0.072	0.028	-0.072	-0.087
Evaporation	-0.262	-0.143	0.837	0.122	0.041	0.141	0.142	0.017
Number of frost days	0.200	0.279	0.287	-0.322	0.099	-0.084	-0.377	0.407

Table 6. The main coefficients of physiographic factors.

Variable	PC1	PC2	PC3
Slope	0.490	0.704	0.513
Aspect	0.724	-0.001	-0.690
Height	0.486	-0.710	0.510

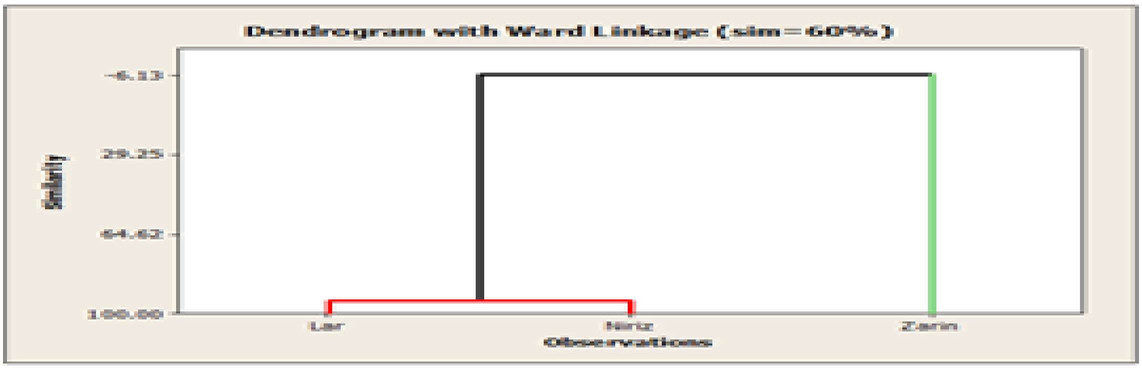

Fig. 21. Similarity dendrogram of all variables.

Table 7. The main coefficients of all variables.

Variables	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Salinity	0.185	-0.255	0.169	-0.057	-0.075	0.112	0.348	-0.289
pH	-0.266	-0.039	-0.004	-0.091	-0.062	0.185	-0.171	-0.160
Organic Carbon	0.253	-0.116	0.036	0.096	-0.154	0.008	0.079	-0.157
Nitrogen	0.253	-0.115	-0.017	-0.371	0.193	-0.121	-0.084	0.390
Phosphorus	0.263	-0.068	-0.122	-0.277	-0.141	-0.156	-0.145	0.008
Potassium	0.249	-0.131	-0.076	-0.353	-0.213	-0.056	-0.077	-0.023
Clay	0.167	0.276	-0.155	-0.045	0.065	-0.051	-0.176	-0.226
Silt	0.207	-0.223	0.010	0.514	-0.030	-0.001	0.372	0.011
Sand	-0.249	0.130	0.189	-0.448	-0.358	0.031	0.343	0.063
Cover	0.252	-0.119	-0.022	-0.003	-0.050	-0.408	-0.071	0.001
Density	0.206	0.226	-0.069	-0.100	0.226	-0.047	0.145	-0.330
Frequency	0.219	0.203	-0.014	0.168	-0.214	-0.123	-0.065	-0.056
Plant Height	0.183	-0.257	0.008	0.096	0.281	0.174	-0.081	0.462
Production	0.237	-0.165	-0.070	-0.170	-0.291	0.523	0.050	0.064
Slope	0.261	0.080	0.111	0.190	-0.337	0.303	-0.220	0.147
Aspect	0.132	0.307	0.048	0.136	-0.351	-0.304	0.079	0.232
Height	-0.084	0.335	-0.184	0.018	-0.037	-0.041	0.433	0.459
Temperature	-0.135	-0.304	0.051	0.078	-0.345	-0.385	-0.061	-0.081
Rainfall	0.025	0.351	-0.041	0.149	-0.162	0.190	-0.384	0.009
Moisture	-0.209	-0.220	-0.856	0.068	-0.202	0.028	0.015	-0.002
Evaporation	-0.255	-0.109	0.258	0.087	-0.206	0.089	-0.086	0.083
Number of frost days	0.201	0.233	-0.168	-0.048	0.040	0.205	0.287	-0.171

Discussion and conclusion

As stated by Jafari *et al.,* (2001) in a study on vegetation relationships of Yazd province and urbanxzyk(1993), in the current research it was found that Principal Component Analysis was perfectly efficient in habitat analysis and investigation of different variables including vegetation cover, soil, climate and physiography. Moner *et al.,* (2006) investigated desert ecosystems of west Egypt using Principal Component Analysis and classified 5 groups in association with soil properties including soil chemical properties (EC, pH, ```). In this study, soil properties were also classified using Principal Component Analysis and the results of some of the factors were significant. The results of PCA showed that the importance of each variable was different in the components. The factors, affecting the distribution of plant communities as well as other factors directly or indirectly, can be divided into two groups as follows: Soil physical and chemical properties including soil texture (sand, silt and clay) and K, OC, pH, EC, ..., and Physiographic factors of the region (altitude, aspect, and slope). According to the obtained results of PCA for soil properties, OC, N, and sand percentage had the largest coefficients in the first component while in the second component the largest coefficient was recorded for clay percentage. Our results are consisted with the findings of Sperry *et al.,* (2002), stating that soil texture was indirectly associated with moisture and soil fertility, and soil physical and chemical properties had important role on vegetation variability. At a specific regional climate, soil texture and chemical properties of soil contribute to the presence or absence of plant species as well as plant's life. (Mesdaghi, 2000). The effect of soil physical and chemical properties on distribution of plant species have been reported in many studies (Moner *et al.,* 2006; El-Sheikh *et al.,* 1981). Baruch (2005) showed that high percentage of sand and altitude affected the separation of Savana in Venezuela. Other researchers (Azarnivand *et al., 2002,* Hosseinitavasol *et al., 2002,* Brotherson *et al., 1986*) also confirmed the role of edaphic parameters on vegetation distribution. In this study, in order to determine the similarity between sites, Wards method was used and a similarity of 71.4% was obtained for Zarindasht and Neyriz, in terms of soil parameters. This indicated the presence of *Zataria multiflora* in these two sites. The results of this study are in agreement with those of Korrouri *et al.,* (2000), stating that edaphic parameters affected the distribution of plant species. In this study, soil, cover and climate variables were entered into the model and results showed that P, K, canopy cover percentage and sand percentage had the largest coefficients in the first component while in the second component rainfall had the largest coefficient in the second component. Our results indicated the difference between Neyriz and Zarrindasht with Lar in terms of cover, climate, and soil variables. This result is consistent with Mohtashamnia *et al.,* (2007) who stated that soil texture and climate variables were the most important environmental factors affecting the establishment and distribution of ecological groups.

Reference

Azarnivand H, Jafari M, Moghaddam M, Khalili A, Zare Chahooki M. 2002. Effect of soil properties and elevation changes on the distribution of two species of sagebrush (Artemisia) (Case study: rangeland areas that Word, and Semnan Branch) Iranian Journal of Natural Resources **56(2-1),** 100-93.

Jafari M, Chahooki M, Azarnivand h, Baghestani n, Zahedi A. 2001. Vegetation relations with mountains behind Yazd physical and chemical properties of soil using multivariate analysis. Iranian Journal of natural resources **55(3),** 432-440.

Jam-Zad, M. 1994. thyme, Research Institute Forest and Ranglands publicationsm, Tehran **1,** 7-5.

HosseinTavassoli M, Jafari M. 2002. Relationship of soil properties in the area with some grassland species Taleghan. Journal of Gorgan

University of Agricultural Sciences and Natural Resources. Tenth year. Number One.

Ghahraman, A. 1988. Flora Iran, Tehran University Publications **5**.

Mohtashamnia S, Zahedi h. 2007. Steppe Vegetation ordination in relation to soil and topography factors. Journal of Range Management, first year, second edition, summer, 142-158.

Mesdaghi, M. 2000. Vegetation Description and Analysis (translated). Jihad Press University of Mashhad, 278-296.

Baruch Zdravko. 2005. Vegetation environment relationships and classification of savannas in Venezuela, Flora **200,** 49-64.

Brotherson J, D. Rasmussen Rd Bluk. 1986. Comparative habiti and community relationship of Atriplex confretifolia and Sarcobatus vermiculatus in Central Utah Great Basin Naturalist **46,** 348-357.

El – Sheikh AM, M. Youssef. 1981. HalopHyte and xeropHyte vegetation near al Kharj springs. Journal of College of Science, University of Riyadh **12**, 5-21.

KorrouriS, and M Khoshnevis. 2000. Ecological and environmental studies of Iranian Juniperus sites, Research Institute of Deserts and Rangelands press, 208.

Lopez pujol, J Bosch, M Simon, J Blanche. 2004. Allozyme diversity in the tetraploid endmic Thymus loscosii (Lamiaxeae).

Moner M, A, EL-Ghani. 2006. Soil vegetation relationship in a costal desert plain of southern Sinai, Egypt, Journal Arid Environments **55,** 607-628.

Shao Eei, &W.L, chang. 2005. Interpretation and discrimination of marshy wetlands by soil factor in the kuan – tunatural park, Taiwan, Environmental Monitoring and Assesment **107,** 181-202.

Song A, S Liu, Z Shi, L Dong. 2006. Quantitative classification and ordination meadow in Wolong Nature Reserve. Yang Tong Sheng Tai XueBao **17(7),** 117-8.

Sperry J, SHacke U.G. 2002. Desert Shrub water relations with respect to soil Characteristic and plant functional type. Functional Eccology **16,** 367-378.

Urbanxzyk S. 1993. Classification and ordination alpine plant communities, sheep Mountain Lemhi County, Idaho, M.S. Thesis. University of Idaho, Moscow, ID. 54.

Wei Q,& *et.al.*, 2008. Relationship between soil characteris and halopHyte vegetation in coastal region of north china. Pak J.Bot **40(3),** 1081-1090.

Zhou Z. W Xiaoxue, L Tong. 2007. The numerical fiction of desert Vegtation and soil interpretation in Qitai County, Xingiang.