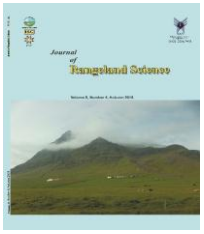
Contents available at ISC and SID

Journal homepage: www.rangeland.ir



Research and Full Length Article:

Ecological Survey of the Presence and Absence of *Ferula ovina* (Boiss.) Boiss. and *Ferula persica* Willd. in North-Western Rangelands of Iran (Case Study: Zanjan Province)

Farhad Aghajanlou[A], Ardavan Ghorbani[B]*, Mohammad Ali Zare Chahouki[C], Raoof Mostafazadeh[D], Kazem Hashemi Majd[E]

[A]Ph.D. Student of Rangeland Science, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran

[B]Associate Professor, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardabili Ardabil, Iran, *(Corresponding Author), Email: a_ghorbani@uma.ac.ir

[C]Professor, Faculty of Natural Resources, University of Tehran, Karaj, Iran

[D]Assistant Professor, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran

[E]Associate Professor, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran

Received on: 18/04/2017
Accepted on: 17/02/2018

Abstract. This study was conducted to investigate the effect of ecological factors on distribution, presence and absence of species *Ferula ovina* and *F. persica* in the semi-arid rangelands of Zanjan province, Iran in 2015. The locations of ten 4m^2 plots with 15m spacing on three 150 m long transects were systematically randomized and determined in each key area within each habitat. The soil surface features including total canopy cover, canopy cover of target species, bare soil and stone and gravel on the soil surface were estimated. Three mixed soil samples from the locations at the beginning, middle, and end of each transect from depth of 0-30 cm were collected to determine soil properties. Physiographic and climate factors of each selected site were determined. Independent sample t-test and one-way analysis of variance were conducted to compare the related parameters and the discriminant analysis was also performed to determine the importance of environmental variables on the presence and absence of the target species. The results showed that in *F. persica* habitat, the percentage of total neutralizing value and silt was less than that in the absence area of the species. In contrast, in *F. ovina* habitat, the amount of these variables was significantly higher than that in the absence area of the specie. The results of discriminant analysis showed that temperature parameters, altitude, sand and gravel percent on the soil surface, electrical conductivity, total neutralizing value and rainfall in the first canonical function had the highest value and they were the first factors affecting species distribution and location differentiation. However, presence and absence of species in the target habitats are often dependent on some variables such as pH, soil silt percent, aspect, precipitation and minimum temperature..

Key words: Discriminant analysis, Distribution, Functions, *F. ovina*, *F. persica*

Introduction

Arid and semi-arid rangeland ecosystems are strongly affected by physical and environmental condition. Therefore, an understanding of the relationships among these factors has an important role in planning and management, which can be achieved by studying the relationships between the plant species and the factors affecting their establishment. First, it means that environmental variables undergo changes; secondly, there is a complex interaction between plant and environment variables (Jongman *et al*., 1987). The relationship between vegetation and environmental factors is one of the major issues affecting the formation of the structure of plant communities and their distribution in each area (Moghaddam, 1998). Therefore, the relationship between ecological factors such as topography, climate, soil, vegetation and organisms must be recognized. The presence and distribution of plant species in rangeland ecosystems are not random, but the variations of climate, soil, topography, anthropological and other attributes play major roles in their distribution (Ghorbani *et al.*, 2015; Akbarlou and Nodehi, 2016). Determination of the variables that control the presence and distribution of rangeland species is one of the main objectives in the rangeland ecosystem studies and assessments. However, interactions between plant species and both soil properties and other environmental variables have been well established for some plant species while understanding of how a variety of plant species in native rangelands responds to soil properties and other environmental variables is poorly developed (Ghorbani *et al.*, 2015; Zare Chahouki and Piri Sahragard, 2016).

Xian-Li *et al.* (2008) had studied the relationships between vegetation, soil and topography in a dry warm river valley in south west of China. Their results confirmed that plant diversity was mainly correlated with soil water content, and soil water content was mainly determined by soil texture, especially clay content. The results of Yibing (2008) using Principal Component Analysis (PCA) and Correspondence Analysis (CA) in China showed that soil physical and chemical properties such as nutrients, moisture, salinity, and pH were effective in the homogeneity of habitat. In the study of relationships between environmental variables and species diversity in Loess Plateau of China, Zhang and Dong (2010) reported that elevation, soil type, slope and aspect were important factors in the Loessi zone's recovery in China, and had determining roles in species distribution. Moreover, a correlation between some chemicals and properties of soil moisture with vegetation and different species has been proved in various studies (Sheikh *et al.*, 2014; Dyakov, 2014; Gonzales *et al.*, 2014). However, in addition to the physical and chemical factors of the soil, physiographic and climatic factors are also effective in plant distribution (Gemedo *et al.*, 2014; Ghorbani *et al.*, 2015).

Giant fennel (*Ferula L.*) is a plant of the Apiaceae family. The growing areas of this family are mainly in Mediterranean regions such as Turkey, Iran and Turkmenistan (Ghahreman, 1993). The genus *Ferula* contains 170 to 185 species widespread from Central Asia to the West across the Mediterranean to North Africa (Pimenov and Leonov, 1993; Kurzyna *et al.*, 2008). However, in Asia, Giant fennel genus has a broader scope rather than the other genera of this family; it is considered as the third genus of this family throughout the world (Pimenov and Leonov, 2004). In Iran, 32 species of Giant fennel have been reported (Mozaffarian, 2007). *F. ovina* is one of the dominant species in the mountains of Alborz. Although in the case of being green and in the presence of some palatable species, it is less

considered by livestock, it has a main role in feeding livestock at the end of summer and beginning of fall. It even plays a more important role as harvested forage in winter-feeding of livestock in different rural areas of Iran (Azhir and Shahmoradi, 2007). *F. persica* has been reported as an endangered plant in some parts of rangelands of the country such as Tehran, Mazandaran and Qazvin provinces. Therefore, studying the behavior of rangeland species and their relationship to other ecosystem components will provide information that can be used for appropriate rangeland management programs (Moghaddam, 1998). Hence, due to the lack of information regarding the distribution of this species, the present study was conducted with the objective to examine the environmental factors affecting their distribution, especially in the rangelands of Zanjan province to determine the most effective ecological factors in their distribution so that some managerial strategies to be considered for conservation, restoration and improvement of such vegetative areas.

Materials and Methods

The study area

The study areas were selected in Zanjan province in the northwest of Iran. The habitats of *F. ovina* and *F. persica* were selected by the literature review (Ghahreman, 1993; Mozaffarian, 2007; Aghajanlou *et al.*, 2015), fieldwork, previous studies and available information in the Natural Resources headquarters of Zanjan. Three habitats of *F. ovina* including Soltanieh, Zakr-Khanchay and Shilander were selected. The only habitat for *F. persica* was Zanjanrood (Vallarood).

The geographical location of selected habitats has been shown in Fig. 1. The characteristics of each selected site are presented in Table 1.

Table 1. Characteristics of studied habitat

Species	Habitat	Longitude	Latitude	Slope (%)	Mean Annual Temperature (C°)	Annual Precipitation (mm)
F. ovina	Soltanieh	48° 49′ 35″E	36° 18′ 20″N	62	7.2	403
	Zaker-Khanchy	48° 44′ 41″ E	36° 41′ 30″N	47	8.3	347
	Shilander	48° 37′ 54″E	36° 50′ 01″N	53	6.4	327
F. persica	Zanjanrood (Vallarood)	48° 21′ 17″E	36° 43′ 03″N	59	11.3	242

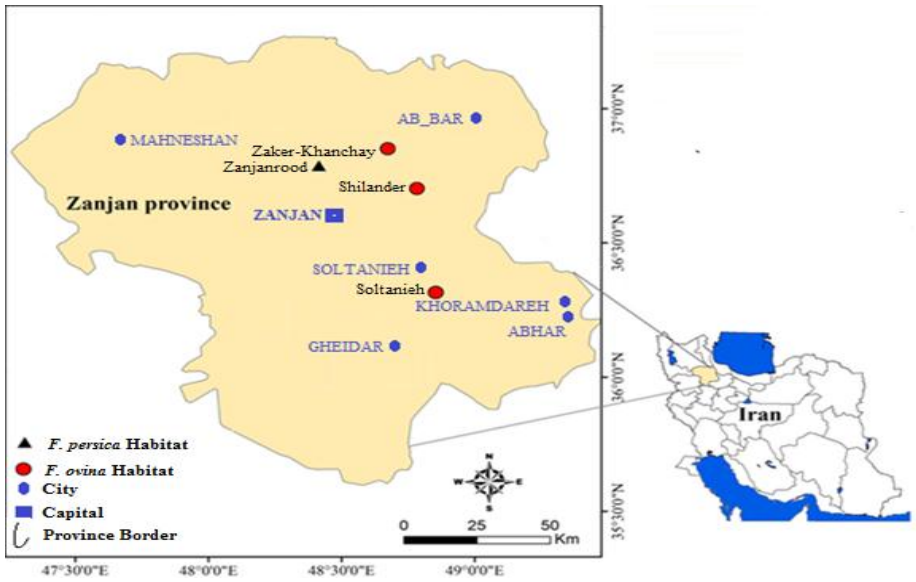


Fig. 1. Map of location of study area and habitat

Sampling method

In each habitat, initially one site with target species (*F. ovina* or *F. persica*) distribution was selected as the presence of the selected species was abundant. Near to each of the selected sites, another site which did not have target species was selected in the same habitat. Therefore, a total of six sites for *F. ovina* (present and absent) and two sites for *F. persica* (present and absent) were selected. Sampling occurred from 20 May to 15 Jun 2015.

In sites with the presence of species, according to the distribution of the selected species and in adjacent sites (absence of species), three points were randomly selected in the key area. In each point, a 150 m transect was established, and systematic random sampling was carried out within 10 plots of 4 m^2 area with a 15 m spacing (overall, 30 plots in sites with the presence of species, and 30 plots in sites with absence of species). These transects were established parallel to each other and perpendicular to the slope. Plot size was calculated using the minimal area method and the number of plots was obtained by graphical methods (Cain, 1938; Moghaddam, 2001). Total Canopy Cover (TCC), Canopy Cover of the Target Species (CCTS), Percentage of Stone and Gravel (PSG) on the soil surface and bare soil were recorded in each site.

Soil samples were collected from a 0-30cm depth in the first, middle and end of each transect in all of sites (Northup *et al*., 1999). The soil properties such as Electrical Conductivity (EC), soil acidity (pH), soil Organic Carbon (OC), Total Neutralizing Value (TNV as the amount of calcium and magnesium carbonates in the lime), soil potassium (K), soil phosphorus (P), soil texture and saturation humidity (SP) (Burt, 2004; Jafarian *et al*., 2008) were determined in the soil lab of agricultural and natural resources research center of Zanjan province, Iran.

The climatic factors including annual precipitation and Mean annual Temperature (MET), annual mean of the Maximum Temperatures (MAT) and annual mean of the Minimum Temperatures (MIT) were extracted using a derived gradient formula for each, which were derived from meteorological data (from synoptic and climatological stations) and calculated for each site (a 10 year period, 2006 to 2015). A Digital Elevation Model (DEM) map was derived using 1: 25000 topographic maps of the national cartographic centre of Iran with 10 m horizontal and vertical accuracy. Elevation, slope and geographical aspect maps were derived from the DEM for the selected habitats and sites.

Data analysis

The normality of the data was assessed using the Kolmogorov–Smirnov test. The one-way ANOVA statistical test was used to analyze the significant difference between the effects of environmental variables on the presence or absence of *F. ovina* and *F. persica* (Zare Chahouki, 2010). The t-test was used to evaluate the differences among the variables studied in both presence and absence sites of target species. Stepwise Discriminant Analysis (DA) was used to determine the significance of the variables studied in species distribution and to verify the grouping of sampling locations (Zare Chahouki, 2010). Data were analyzed using SPSS16 software.

Results

Results of means comparison of the measured properties were compared for presence and absence of habitats of each species using t-test. The one-way ANOVA was used to conduct he comparisons between all of sites. Results showed significant differences between all of traits except SP, EC, K, Clay and PSG (Table 2).

The results of means comparisons of studied variables between presence and

absence sites of target species are presented in Table 2. As it is clear, For *F. ovina*, there were significant differences between habitats (presence and absence of the species) for Total Neutralizing Value (TNV) (P<0.01), silt, stone and gravel (PSG) (P<0.05). Higher values of TNV, silt and PSG were obtained in *F. ovina* presence site (Table 2).

For *F. persica*, there were significant differences between habitats (presence and absence of the species) for Total Neutralizing Value (TNV), aspect (P<0.01) and silt (P<0.05). Lower values of TNV, aspect and silt were obtained in *F. persica* presence site (Table 2).

Table 2. Comparison of measured properties in the presence and absence of species habitats

Variables	*F. ovina*			*F. persica*			F test
	Absence	Presence	T Test	Absence	Presence	T test	Between all sits
SP (%)	42.00±7.30	43.30±13.10	0.85^{ns}	33.70±0.5	35.00±2.6	0.27^{ns}	1.19^{ns}
EC (%)	0.41±0.12	0.44±0.14	0.37^{ns}	0.42±0.01	0.43±0.06	0.54^{ns}	0.13^{ns}
pH	7.15±0.16	7.35±0.40	-0.29^{ns}	7.84±0.04	7.83±0.07	1.40^{ns}	7.57**
TNV (%)	1.50 ±1.62	3.80 ±1.70	-4.70**	6.30±0.08	2.57±0.80	3.00**	8.38**
OC (%)	2.10±0.72	2.50±1.50	-1.55^{ns}	0.57±0.08	0.40±0.09	0.730^{ns}	4.72*
K (ppm)	295.3±79.2	334.0±15.8	-0.09^{ns}	172.7±16.5	170.3±35.2	0.66^{ns}	2.67^{ns}
P (ppm)	8.50±6.90	11.30±2.99	1.40^{ns}	1.73±0.11	2.20±0.00	1.10^{ns}	4.72*
Sand (%)	53.30±5.80	47.30±10.20	1.36^{ns}	60.00±0.6	68.70±7.60	-1.50^{ns}	5.73**
Silt (%)	31.3±5.05	39.8±8.80	-3.80*	27.7±0.2	12.0±0.50	2.50*	13.20**
Clay (%)	15.30±3.08	12.90±5.30	2.60^{ns}	12.30±0.50	19.30±3.51	-1.19^{ns}	2.19^{ns}
Slope (%)	47.4±5.50	54.1±8.20	2.70 ^{ns}	46.70±0.40	59.30±7.50	2.04^{ns}	3.44*
Aspect ((°)	95±47.40	235±83.50	1.00^{ns}	105.0±26	90.0±0.00	4.40**	10.25**
Altitude (m)	2450±50.10	2428±44.00	2.20^{ns}	1555±0.50	1572±3.50	-0.98^{ns}	643.2**
PSG (%)	35.4 ±12.70	42.0 ±15.20	3.20*	20.80±2.60	38.50±9.10	1.00^{ns}	2.09^{ns}
Precipitation (mm)	361.5±31.2	360.0±34.2	2.10^{ns}	241.30±0.6	242.30±0.6	-0.05^{ns}	24.90**
MET (C°)	7.30±1.03	7.40±1.05	-2.10^{ns}	11.30±0.06	11.30±0.06	0.34^{ns}	26.70**
MIT (C°)	-1.40±0.34	-1.20±0.32	-2.10^{ns}	4.90±0.06	4.80±0.00	0.93^{ns}	646.9**
MAT (C°)	15.80±0.22	15.90±0.18	-2.10^{ns}	19.40±0.00	19.30±0.0	1.10^{ns}	574.8**
TCC (%)	39.50±2.70	40.70±2.20	0.32^{ns}	28.03±0.00	28.80±0.0	0.31^{ns}	3.53*

ns, * and **= non significant and significant at 0.05 and 0.01 probabaility levels

The results of the Discriminant Analysis (DA) showed that the DA was able to identify three canonical functions, of which the first, second and third functions have 95.5, 3.1 and 0.3% of the variance, respectively. Eigenvalues and canonical correlation were more in the first function than the second one (Table 3).

The Wilks' lambda values had increased from the first function to the three audit one, and chi-square value was significant in the first and second functions (P<0.01) and third one (P<0.05). Thus, the averages of groups was different (Table 4); consequently, the first function had higher discrimination power in separating the groups.

Table 3. Eigenvalues and percentage of variance explained by the first three discriminant analysis

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	229.94	95.50	95.50	0.99
2	9.77	3.10	99.70	0.95
3	0.98	0.30	100.00	0.70

Table 4. The values of Wilks' lambda in discriminant analysis

Test of Function (s)	Wilks' Lambda	Chi square	df	Sig.
1 through 3	0.00	157.82	18	0.00
2 through 3	0.05	55.09	10	0.00
3	0.50	12.32	4	0.02

The result of discriminant coefficients of the variables (Table 5) showed the linear correlation among environmental variables and discrimination function.

The MIT (annual mean of the Minimum Temperature), altitude, MAT(annual mean of the Maximum Temperature), PSG (Percentage of Stone and Gravel), EC (Electrical Conductivity), TNV (Total of Neutralizing Value) and amount of annual precipitation were primarily the most influential factors in the first function; the percentage of silt, MET (Mean annual Temperature) and sand percent at the second function; and finally, percentage of slope, geographical aspect, SP (Saturation humidity), OC (Organic Carbon percentage), quantity of potassium and phosphorus, acidity (pH) and clay percent at the third function were as affecting factors in identifying the sites and distribution of species.

Table 5. Discriminant coefficient of factors in canonic functions

Variables	Functions		
	1	2	3
MIT (°C)	0.57*	-0.13	-0.13
Altitude (m)	-0.54*	0.12	0.14
MAT (°C)	0.51*	-0.15	-0.13
PSG (%)	-0.43*	0.02	0.26
EC (%)	-0.37*	0.33	-0.10
TNV (%)	0.26*	0.08	0.15
Precipitation(mm)	-0.11*	0.03	0.04
Silt (%)	-0.06	0.29*	-0.25
MET (°C)	0.01	-0.28*	-0.24
Sand (%)	0.04	-0.22*	0.19
Slope (%)	0.01	-0.05	0.69*
Aspect (°)	-0.03	0.32	0.48*
SP (%)	-0.07	0.05	-0.47*
OC (%)	-0.09	0.04	-0.44*
K (ppm)	-0.07	0.04	-0.29*
P (ppm)	-0.07	0.13	0.24*
pH	0.06	0.08	0.14*
Clay(%)	0.02	-0.03	0.03*

* Significant correlation between each variable and discriminant function

According to Table 6, the properties including pH, silt percent, slope percent, geographical aspect, annual precipitation and MIT (the annual mean of the Minimum Temperatures) had been determined as significant factors in detecting the presence or absence of the target species (*P*) (Equation 1). Therefore, the discrimination equation for the first function will be:

$$P = 3.27\ \mathrm{pH} + 0.05\ \mathrm{silt} + 0.03\ \mathrm{slope} + 0.00\ \mathrm{aspect} - 0.05\ \mathrm{precipitation} + 4.73\ \mathrm{MIT} - 10.79 \quad \text{(Eq.1)}$$

Table 6. Canonical discriminant function coefficients

Variables	Function		
	1	2	3
pH	3.27	4.83	0.28
Silt (%)	0.05	0.22	-0.07
Slope (%)	0.03	-0.12	0.17
Aspect (°)	0.00	0.03	0.00
Precipitation (mm)	-0.05	0.01	-0.02
MIT (C°)	4.73	0.51	-0.69
Constant	-10.79	-42.92	-1.10

The results related to the classification of the studied habitats using discriminant analysis have been shown in Table 7. As the Table shows, 100% of the main data in the prediction model are properly classified indicating that the accuracy of the classification of the model is excellent.

Table 7. The results of classification using discriminant analysis

Species	Sits	*Ferula persica*		*Ferula ovina*		Total
		Presence	Absence	Presence	Absence	
Ferula persica	Presence	100.00 a	0.00	0.00	0.00	100.00
	Absence	0.00	100.00	0.00	0.00	100.00
Ferula ovina	Presence	0.00	0.00	100.00	0.00	100.00
	Absence	0.00	0.00	0.00	100.00	100.00

a.100% of original grouped cases correctly classified

Discussion

The significant difference between some of the studied variables in the presence and absence locations of the species are indicative of various ecological requirements of species. The results of different studies also showed that presence and distribution of plants in rangeland ecosystems is not by chance or casually. However, it is under the influence of climatic characteristics, topography and physical and chemical properties of soil (Barnes *et al.,* 1982; Zare Chahouki and Zare Chahouki, 2010). The results obtained from the means comparison of studied variables in locations showed that the amount of TNV in places with the presence of *F. ovina* was significantly higher than the absence locations of the target species. So, it seems that the *F. persica* has been distributed in an area where the quantity of TNV was much lower than its adjacent area that is the species absence area. According to tolerance law, not only lack of a factor limits the growth and establishment of plant in the environment, but also too many factors or elements would limit the distribution of plants; tolerance of species against environmental factors is different (Moghaddam, 1998). It seems that *F. ovina* species prefers relatively calcareous environments, but *F. persica* faces with growth limitations in relatively calcareous environments. The studies conducted on *F. ovina* species confirmed that this species has a considerable canopy cover percent in the geological formations of calcareous and has been one of the dominant species of habitat in many areas (Azhir and Shahmoradi, 2007). Another factor having a significant difference in habitats of both species as compared with the areas of absence was silt content of soil. Soil silt in habitat of *F. ovina* species was higher than that in absence area while in *F. persica* species habitat, the amount of silt was diverse. On the other hand, soil texture in *F. ovina* habitat was sandy–loamy and in *F. persica* habitat, it was loamy. In other words, *F. ovina* distributes in soils with lighter texture rather than *F. persica*. As a result, the silt percent and soil texture in the studied habitats can be considered as one of the factors affecting distribution of species and segregation of areas. In other studies, soil texture has been mentioned as an important factor in segregating plant groups (Taghipour *et al.,* 2008; Rezaipoorbaghedar *et al.,* 2011).

It seems that both species prefer sloppy landscape for their distribution because in habitats of both species, the percentage of slope was higher than the site of the absence of the species and in the habitat of *F. persica*, it had a significant difference. Probably, one of the factors affecting this issue is ignorance of the country's natural resources such as rangelands where the people destroy their habitats and change them to agricultural lands with low yields or no yields, especially the habitats of *F. persica* that are located in downstream lands and surrounded by agricultural areas and gardens. It must be noted that judging about this issue requires another study. Despite lack of significant difference of phosphorus in the area with the presence of species rather than the adjacent area with the absence of species,

its amount in presence of both species was higher as compared with the adjacent areas with lack of the species. After nitrogen, phosphorus is the most important nutrient in plant nutrition that plays an important role in reproductive growth (Leyles, 1975). Reduction of the element lower than a level has been as a limiting factor in distribution of the species. Different researches have described Phosphorus and Potassium as factors affecting distribution of forage species (Tarmi *et al*., 2009; Khatibi *et al.*, 2012). Although *F. ovina* species was one of the dominant species in the vegetation of the area in their southern habitats, it was observed sporadically in other aspects. The factor of geographical aspect is responsible for the quantity of available water to plants, soil temperature and the amount of light received by the plant. On the other hand, difference in intensity of light in different aspects of a slope creates local climate changes (Gonzales *et al.,* 2014). Distribution of the *F. ovina* species especially in the southern aspects of the studied areas as a dominant species is considered as an indication of the effect of slope aspect as one of the main factors affecting distribution of the species. Investigations conducted regarding the descriptive autecology study of *F. ovina* in Iran are in agreement with our findings. Azhir and Shahmoradi (2007) concluded that the distribution and presence or absence of *F. ovina* species depend on the geographical aspect and percentage of slope.

According to eigenvalues results and canonical correlation coefficient of the first function as well as values of Wilks Lambda, it is indicated that the estimated function is proper for separating groups and has a good segregation power. The higher the eigenvalue and the nearer the canonical correlation coefficient to one, the stronger the obtained results, and the more accurate the classification will be (Zare Chahouki, 2010). The results obtained from the accuracy of classification confirmed this claim.

Accordingly, it was determined that variables of the minimum temperature, altitude, maximum temperature, percentage of stone and gravel on the soil surface, electrical conductivity, total neutralizing value and rainfall in the first canonical function, and percentage of soil silt, mean temperature, and the percentage of sand in the second canonical function and such factors as slope percent, geographical aspect, soil saturation percent, organic carbon percent, quantity of phosphorus, potassium, acidity of the soil, and soil clay percent in the third canonical function have had the highest contribution, respectively. In addition, these factors have been effective in distribution of species. The obtained results are in line with the findings of other researchers in this regard (Davies *et al.,* 2006; Asadian *et al.,* 2017).

On the other hand, pH, quantity of soil silt, slope percent, geographical aspect, sum of annual rainfall, and the minimum temperature in both presence and absence of species have been some of the most important factors. These conclusions were in agreement with the results of Nodehi *et al*. (2014). According to the results, it is recommended that consideration of these details would ensure the effectiveness of the rehabilitation plans and modification of *F. ovina* and *F. persica* habitats.

References

Akbarlou, M. & Nodehi, N., 2016. Relationship between Some Environmental Factors with Distribution of Medicinal Plants in Ghorkhud Protected Region in Northern Khorasan Province (Iran). *Jour. Rangeland Science,* 6 (1): 63-72. (In Persian).

Aghajanlou, F., Fayaz, M., Mussavi, A. & Abdinejad, P., 2015. Ecological Regions of Iran: Vegetation Types of Zanjan Province. Technical publication, Research Institute of Forest and Rangelands, 126p. (In Persian).

Asadian, G., Javadi ,S. A., Jafary, M., Arzani, H. & Akbarzadeh, M., 2017. Relationship

between environmental factors and plant communities in enclousure rangelands. *Jour. Rangeland Science*, 7(1): 20-34. (In Persian).

Azhir, F. & Shahmoradi, A. A., 2007. Autecological study of *Ferula ovina* in rangelands of Tehran province. *Jour. Range and Desert Research*, 3(21):359-367. (In Persian).

Barnes, B.V., Pregitzer, K. S. & Spies, T. A., 1982. Ecological forest site classification. *Jour. Forestry*, 80: 493-498.

Burt, R., 2004. Soil Survey Laboratory methods. Soil Survey Investigations Rep. 42, vs. 4.0. USDA, Natural Resources Con- serv. Serv. Washington, DC.

Cain, S. A., 1938. The species- area curve. Amerrican Midland Naturalist, 21: 81-146.

Davies, K.V., Bates, J. D. & Miller, R. F., 2006. Vegetation characteristics across part of the Wyoming big sagebrush alliance. *Rangeland Ecology and Management*, 59: 567-575.

Dyakov, N. R., 2014. Gradient analysis of vegetation on the South slope of Vitosh Mountain (South west Bulgaria). *Applied Ecology and Environmental Research*, 12(4): 1003-1025.

Gemedo, D., Brigitte, L. M. & Johannes, I., 2014. Relationships between vegetation composition and environmental variables in the Borana rangelands (Southern Oromia). Ethiopia Sinet, Ethiopia. *Jour. Science*, 37(1): 1- 12.

Ghahreman, A.,1993. Plant systematics (Kormophytes of Iran). Vol 2. Center of Academic publishing, 842p, Tehran, Iran. (In Persian).

Ghorbani, A., Abbassi Khalaki, M., Omidi, A. & Zare hesari, B., 2015. Compare some ecological factors affecting the distribution of plants species *A. austriaca* and *A. fragrans* wild. Jacq. in southeastern rangelands of Sabalan. *Jour. Rangeland*, 9(2): 129-141 (In Persian).

Gonzales-Alcaraz, M.N., Jimenez-Carceles, F.J., Alvarez, y. & Alvarez-Rogel, J., 2014. Gradient of soil salinity and moisture and plant distribution in a Mediterranean Semi-Arid Saline watershed: A model of soil plant relationships for contributing to the management. *Jour. Catena*, 115: 150-158.

Jafarian, Z., Arzani, H., Jafari, M., Zahedi, Gh. & Azarnivand, H., 2008. Analyzing the relationship between distribution or plant communities and climatic and physiographic factors using classification and ordination methods in Rineh Rangelands. *Jour. Rangeland*, 6: 125-141. (In Persian).

Jongman, RHG., Ter Break ,CJF. & Van Tongeren, OFR., 1987. Data analysis in community and landscape ecology. Center Fire Agricultural Publishing and Documentation. wageningen. 299 p.

Khatibi, R., Ghasemi Arian, Y., Jahantab, E, and Haji hashemi, M. R., 2012. Investigation on relationships between soil properties and vegetative. *Jour. Range and Desert Research*, 19 (1): 72-81. (In Persian).

Kurzyna-Mlynik, R., Oskolaski, A.A., Downie, SR., Kopacz, R., Dzka, AW, and Spalik, K., 2008. Phylogenetic position of the genus *Ferula* (Apiaceae) and its placement in tribe Scandiceae as inferred from nr DNA ITS sequence variation. *Jour. Plant Systematics and Evolution*, 274: 47-66.

Leyles, L., 1975. Possible effects of wind Erosion on soil productivity. *Jour. Soil and Water Conservation*, 30: 279-283.

Moghaddam, M R., 1998. Range and Range management. University of Tehran press, Tehran, Iran, 470p. (In Persian).

Moghaddam, M R., 2001. Quantitative plant ecology. University of Tehran press, Tehran, Iran, 285p. (In Persion).

Mozaffarian, V., 2007. Flora of Iran (Umbelliferae). Vol 54. Research Institute of Forest and Rangelands press, Tehran, Iran. 600pp. (In Persian).

Nodehi, N., Akbarlou, M., Sepehry, A., Vahid, H., 2014. Effect of topographical factors on distribution of Plants communities in semi-steppe grasslands (case study: ghorkhud Region in Northern Khorasan Province, Iran). *Jour. Rangeland Science*, 4 (4): 298-305. (In Persian).

Northup, B. K., Brown, J. R., Holt, J. A., 1999. Grazing impact on the spatial distribution of soil microbial biomass around tussock grasses in a tropical grassland. *Jour. Applied Soil Ecology*, 13:259-270.

Pimenov, M. & Leonov, M., 1993. The genera of Umbelliferae. Royal Botanic Gardens, Kew. 164p. UK.

Pimenov, M. & Leonov, M., 2004. The Asian Umbelliferae biodiversity database (ASIUM) with particular reference to South-West Asian taxa. *Turkish Jour. Botany*, 28: 139-145.

Rezaipoorbaghedar, A., Hakimi, M. H., Sadeghinia, M., Azimzadeh, H.R., 2011. Effect of some soil properties on distribution of *Eurotia ceratoides* and *Stipa barbata* in Baghedar, Bafgh rangelands. *Jour. Rangeland Science*, 4(1): 417-424. (In Persian).

Sheikh, S.A., Rabia. M., Rabia.S., Mohammad,

N.A. & Tahir, A., 2014. Environmental diversification and spatial variations in riparian vegetation. *Pakistan Jour. Botany*, 46(4): 1203-1210.

Taghipour, A., Mesdaghi, M., Heshmati, Gh.A. & Rastgar, Sh., 2008. The effect of on distribution of range species at Hazar Jarib area of Behshahr. *Jour. Agriculture Science and Natural Resource*, 15(4): 195-205. (In Persian).

Tarmi, S., Helenius, J. & Hyvonen, T., 2009. Importance of edaphic, Spatial and management factors for plant communities of field boundaries. *Jour. Agriculture, Ecosystem and Environment*, 131: 201-206.

Xian-Li, Xu., Ke-Ming, Ma., Bo-Jie, Fu., Cheng-Jun, Song. & Wen, Liu. 2008. Relationships between vegetation and soil and topography in a dry warm river valley. SW China. *Jour. Catena*, 75: 138–145.

Yibing, Q., 2008. Impact of habitat heterogeneity on plant community pattern in Gurbantunggut Desert. *Jour. Geographical Science*, 14(4): 447-45.

Zare Chahouki, M. A., 2010. Data analysis in natural resources research using SPSS software. University of Tehran press, 310pp. (In Persian).

Zare Chahouki, M. A. & Zare Chahouki, A., 2010. Predicting the distribution of plant species using logistic regression. *Jour. Desert*, 15: 151-158. (In Persian).

Zare-Chahouki, M. A, & Piri-Sahragard, H., 2016. Maxent modelling for distribution of plant species habitats of rangelands (Iran). *Polish Jour. Ecology*, 64(4): 453-467. (In Persian).

Zhang, J. T. & Dong, Y., 2010. Factors affecting species diversity of plant communities and the restoration process in the loess area of China. Ecological Engineering Special Issue: Vegetation and Slope Stability, 36: 345-350.

بررسی اکولوژیکی حضور و عدم حضور گونه *Ferula ovina* (*Boiss.*) *Boiss.* و *Ferula persica Wild* در مراتع شمال غرب ایران (منطقه مورد مطالعه: استان زنجان)

فرهاد آقاجانلو[الف]، اردوان قربانی[ب*]، محمدعلی زارع چاهوکی[ج]، رئوف مصطفی‌زاده[د] و کاظم هاشمی مجد[و]
[الف]دانشجوی دکترای علوم مرتع، گروه مرتع و آبخیزداری، دانشکده کشاورزی و منابع طبیعی، دانشگاه محقق اردبیلی
[ب]دانشیار گروه مرتع و آبخیزداری، دانشکده کشاورزی و منابع طبیعی دانشگاه محقق اردبیلی، [*](نگارنده مسئول)، پست الکترونیک: a_ghorbani@uma.ac.ir
[ج]استاد گروه احیاء مناطق خشک و کوهستانی، دانشکده منابع طبیعی دانشگاه تهران
[د]استادیار گروه مرتع و آبخیزداری، دانشکده کشاورزی و منابع طبیعی دانشگاه محقق اردبیلی
[و]دانشیار گروه علوم مهندسی خاک، دانشکده کشاورزی و منابع طبیعی دانشگاه محقق اردبیلی

تاریخ دریافت: ۱۳۹۶/۰۱/۲۹
تاریخ پذیرش: ۱۳۹۶/۱۱/۲۸

چکیده. این مطالعه به منظور بررسی تأثیر عوامل بوم‌شناختی بر پراکنش و حضور و عدم حضور گونه‌های *Ferula ovina* (Boiss.) Boiss. و *Ferula persica* Wild. در رویشگاه‌های مختلف در مراتع استان زنجان در سال ۱۳۹۴ انجام گرفت. در هر یک از مکان‌ها، تعداد سه ترانسکت ۱۵۰ متری در منطقه معرف به شکل تصادفی مستقر و در هر ترانسکت تعداد ۱۰ پلات با فواصل ۱۵ متر از هم به‌صورت تصادفی سیستماتیک استقرار یافتند. متغیرهای پوشش سطح خاک شامل درصد سنگ و سنگریزه، خاک لخت، پوشش تاجی کل و گونه‌های مورد هدف در مکان‌های‌حضور و عدم حضور گونه ثبت شد. در هر ترانسکت نمونه‌برداری از خاک از پلات‌های اول، وسط و آخر در قالب یک نمونه به‌صورت مخلوط جهت تعیین خصوصیات خاک انجام گرفت. عوامل فیزیوگرافی و ویژگی‌های اقلیمی هریک از مناطق مشخص شد. از تحلیل واریانس و آزمون توکی جهت بررسی میزان تفاوت بین عوامل مورد بررسی در سایت‌ها و از روش آنالیز تشخیص جهت تعیین مهم‌ترین عوامل مؤثر بر حضور و عدم حضور گونه‌های هدف در سایت‌های مورد مطالعه استفاده شد. نتایج تجزیه داده‌ها نشان داد که در رویشگاه *F. persica* میزان مواد خنثی‌شونده و درصد سیلت، نسبت به منطقه عدم حضور گونه کمتر و برعکس در رویشگاه *F. ovina* مقدار این متغیرها نسبت به منطقه عدم حضور گونه‌های مورد مطالعه بیشتر بود. نتایج آنالیز تشخیص نشان داد که پارامترهای دما، ارتفاع از سطح دریا، درصد سنگ و سنگریزه در سطح خاک، هدایت الکتریکی، میزان مواد خنثی‌شونده و میزان بارندگی در تابع کانونی اول بیشترین مقدار را داشته و در انتشار گونه‌ها و تفکیک مکان‌ها از موثرترین عوامل در درجه اول هستند. اما حضور و عدم حضور گونه‌ها در رویشگاه‌های مورد مطالعه وابسته به متغیرهای چون اسیدیته، میزان سیلت خاک، جهت جغرافیائی، بارندگی و دمای حداقل بوده است.

کلمات کلیدی: آنالیز تشخیص، انتشار، تابع، *F. ovina*، *F. persica*