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The Survey of Plant Species Diversity and Richness Between Ecological Species Groups (Zagros Ecosystem, Ilam)

[1]M. Heydari and [2]Ali Mahdavi
[1]Ilam Genral Natural Resources Office, Iran
[2]Department of Forestry and Rangeland, Faculty of Agriculture, Ilam University, Iran

Abstract: The aim of this study was to investigate the biodiversity and richness of vegetation between ecological species group. In this research, vegetation (tree, shrub, bush and herbaceous species), Persian Oak (*Quercus brantii*) natural regeneration, some physical and chemical properties of soil and physiographic factors were taken in 50 sample plots. The plots area was 20×20 m. The sample plots were located using transect's method. The coverage percent of trees and shrubs in each plot were measured regarding to large and small canopy diameter. For herbaceous layer, Withaker, hasted plot sampling was used and 64 m^2 were defined as minimal area. Overall, 4 trees, 3 shrubs, 1 bush and 78 herbaceous species, which belong to 73 genera and 32 families, were recognized. Multivariate analysis methods were used to classify and determine the relationship between species composition and environmental factors and also to recognize ecological species group. The results indicated that five ecological species groups were recognized in the study area and the parameters such as: elevation, organic matter, N, P, K, bulk density, SP, pH, clay and C/N were important factors. The results indicated that biodiversity and richness were maximum in the third group. This site was more humid than the others and organic materials such as, N, P and K are higher than the other sites. In the fifth group that bulk density was high and organic matters were low and its soil was compacted, biodiversity and richness were lower than the other groups.

Key words: Ecological species group, plant diversity and richness, Ghalarang protected area, Ilam

INTRODUCTION

Plants as one of the land resources of the ecosystem have an importance role on the living of creatures, nature, preservation and ecosystem balance. Developing technology and industry and population increase and some other factors have pressed the natural resources. The results of these changes cause a big problem to be existed for natural resources in Iran. Ten percent of herbal and arboreal species are subjected to extinction in the world through different grades. In recent several years, in the environmental assemblies of the universe, two subjects of biological variety and climate changes have been expressed as the main problems of the human being's specifications of living communities and are a function of existed species numbers and size of populations defining those species in one determined geographical district (Krebs, 1998). The main principle in preserving an ecosystem in to recognize elements and it's forming species and also to distinguish needs and social-individual ecological specifications. It is obvious that the distribution and development of herbal species is not accidentally in the nature, so that this covering has been created by different factors and has a balance with these factors in every greenhouse naturally. In reality, the coverage of plants is a complete mirror for representing greenhouse features; therefore, it is a very useful guidance for polling opinion about the ecological conditions of the region (Daubenmire, 1976). Reasonable and ideal exploitation from natural resources is not possible without having a whole and scientific recognition. Therefore, establishing a balance between production and exploitation can be possible by ecological study of resources and environment. One of the methods for categorizing greenhouse are applying the one type criterion, this method has some faults of which a limited part of coverage of plants of the region will be considered also the existence of non-existence of some species in one region is caused by conditions which have low relation with greenhouse conditions and are affected by the past history and conditions of the greenhouse. Among these conditions, forest fire, grazing, pests, wind blowing, destroying, sudden happenings and etc. can be pointed out. However, so many methods are existed for

Corresponding Author: Mehdi Heydari, Ilam Genral Natural Resources Office, Iran

categorizing forest lands, but not all of them have the necessary usage for expressing the importance of the relations among on ecosystem elements. Because, some of them use only one factor for example soil or vegetation (Sebastia, 2004). To solve this problem and to survey site quality, the multivariate methods are expressed that are indicating multi gradients are one of these methods to identify the ecological species groups. The forest ground species that are indicating site conditions such as, moisture, nutrients, pH of soil and climate conditions are creating different species groups that are called ecological species groups (Barnes *et al*., 1998). The Zagros forest is located on Zagros mountains in different aspects and different elevations with its specific micro-climate is included different species types. With respect to this point that many of species in Zagros forest are scare and are belong to critically endangered species therefore the study of this valuable ecosystem and the diversity of species would be for better conservation and rehabilitation of this ecosystem would be necessary.

MATERIALS AND METHODS

The study area: The study area was located in Galaran's protected area in the Northwest of Ilam Province in Iran (Fig. 1). The average annual rainfall and temperature are 590.37 mm and 17.2°C, respectively. Dry season in the area begins from early May and continues to early October (Heydari, 2006).

Sampling method: At the first, the study area was bounded on a map (1:50000 scale) then a sample plots grid was designed. The data were collected using 50 sample plots with 20×20 m^2 dimensions that were designed in Transect's method.

In each sample plot, trees and shrubs species types, number and percentage of each tree and shrub species with measuring small and big diameter of crown cover were recorded. For gathering herbaceous cover information, Withaker snail plot sampling method was used and a minimal area 64 m^2 was determined. The collection of herbaceous information was done in two months (May and June).

In each sample plot, scientific name (genus and species type), percentage of cover, elevation with an altimeter, slope with Sunto gradiometer and geographical aspects were measured by exact record of Azimuth from up to bottom of the slope. Geographical aspect is used for multivariate analysis methods with formula:

$$\cos (45-A)+1$$

where, A is Azimuth foothill (Fu *et al*., 2004).

To record soil data, in the center of each sample plot, 3 samples of soil in depth of 1-15 cm were taken and they were mixed together until a compounded sample was made (Lososova *et al*., 2004). The characteristics of soil which were studied in this research including; bulk density by the method of lump, determining the texture of soil by the method of hydrometer, acidity of the soil with pH meter system, saltiness of soil by use of electric guidance system, absorbable P by use of flame photometer are found. Lime by the method of titrimeter total N by the method of Kjeldahl, organic carbon by the method of Walkey-Black and the basis of percentage and the ratio of C to N was calculated. Absorbable P by the method of sodium bicarbonate in pH 8.2 with the method of Olson were measured (Zarinkafsh, 1987).

The survey biological diversity between ecological species groups: In order to study the biological diversity in the study area Shannon-Wiener index and Margalef richness are used. The following formulas were used.

Shannon-Winer index (Shannon and Weaver, 1949):

$$H_{max} = -\Sigma n_i \ln P_i$$

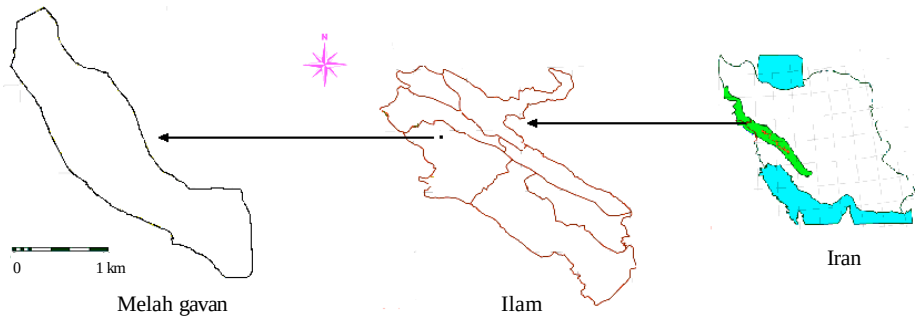

Fig. 1: Geographical location of the study area in Iran and Ilam Province

Where:

n_i = The No. of individuals in each species; the abundance of each species

P_i = The relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individuals in the community

H_{max} = The maximum No. of Shannon-Wiener index

Margalef richness index (Margalef, 1958):

$$R = S-1/\ln(n)$$

Where:

n = The No. of individuals

S = The No. of taxa

For studying the diversity between the groups we use the one way Analysis of Variance (ANOVA) and for studying the comparison between the averages Dunken analysis was used.

Studying the ecological species groups: In order to analysis the data, first data should be a standard. After that from the Principal Components Analyzing (PCA) and the data related to the environmental factors (soil and topography) it is used to classify the sample plot and the site. Moreover, Common Correspondence Analysis (CCA) is used in order to study the relation between the environmental factors and vegetation and to determine the ecological species groups of the area. It is used the PC-ORD software for classifying vegetation and determining ecological species groups in the area.

RESULTS

Four tree species, 3 shrub species, 1 bush species and 79 herbaceous species belong to 73 genera and 32 families could be recognized in this study.

Asteracea family and euphorbia genus allocated the most species in this study. The results show that *Bromus tectorum* L., *Galium verum* L., *Arvensis ranuculus* L., *Allysum* sp. and *Ixiolirion tatarium* (pall) form, 44, 46, 40 and 38% the presence of the most species in the area, respectively. Among tree species, *Quercus brantii* has the most presence in the area. The results of vegetative forms in accordance with Raunkiær method show that Trophits (54%) allocate the most percent of vital forms of the area (Barnes *et al*., 1998).

To determine the most importance factors among environmental factors of study case, the method of principal component analysis is used. For this purpose, first and second axes of PCA are used because of having more percentage from special amount (3187 and 5137, respectively) and the percent of variance (18.16 and 25.3, respectively). Distance between sample plot in the first and second axes show their similarity and dissimilarity. Sample plots which are nearer to each other in relate to environmental factors (physiographic and soil) are more similar to each other and the sample plots which are farer to each other have less similarity.

The axis one has positive correlation with the saltiness of soil (r = 0.242), the percent of saturated moisture (r = 0.348), K (r = 0.325), P (r = 0.333) and total N (r = 0.371) and organic matter (r = 0.382) and has the negative correlation with acidity of the soil (r = 0.282) and the percentage of clay (r = 0.278). The axis 2 has the positive correlation only with the altitude (r = 0.254). CCA analysis shows that the factors such as saltiness of soil, organic matters, percentage of saturated moisture, total N, P, K, C/N, sand and geographical direction, acidity of soil, clay and bulk density have a significant relationship ($p<0.05$) with distribution of vegetation species. In this CCA analysis, the axes one, two were used because these axes had the highest amount. This method is a kind of direct analysis that is used to examine the relation between the distribution of species and environmental factors. The analysis of environmental variability show that factors such as saltiness of the soil (0.238), organic matter (0.724), the percentage of saturated moisture (0.512), total N (0.616), P (0.727), K (0.527), C/N (0.516) sand (0.302) and geographical directions (0.228) have positive correlations with axis one and the factors such as acidity of soil (0.543), clay (0.470) and bulk density (0.588) have negative correlation with. Acidity of the soil (0.444) and clay (0.202) has positive correlation with axis 2. And saltiness of the soil (0.357), organic matter (0.304) and the percent of saturated moisture (0.497), total N (0.353), P (0.376), K (0.537) silt (0.376) bulk density (0.447) elevation (0.470) have negative correlation with this axis. Organic matter, the percent of saturated moisture, total N, P, K, C/N and bulk density have more correlation with axis one while the role of the other factors in this axis is less. In correlation with above factors we can divide vegetation species into five sites (Fig. 2). At the bottom of the left side of the axis two species:

Heteranthelium piliferum (Banks and Soland.) Hochst., *Stipa capensis* Thunb, *Turgenia latifolia* (L.) Hoffm., *Fibigia macrocarpa*, *Lathyrus sativus* L., *Ziziphora tenuir* L., *Medicago rigidula* (L.). All form a group that show a positive correlation with pH and clay and show a negative correlation with percent of saturated moisture, percent of organic matter, K, total N, P, C/N, elevation, silt, bulk density. This group is lack of tree species index.

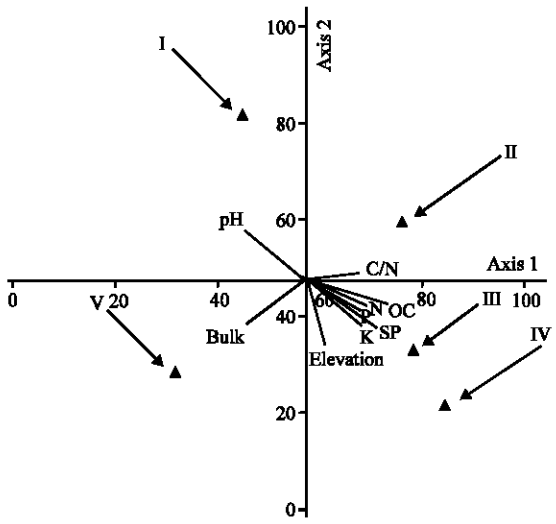

Fig. 2: The result of CCA classification for sample plots

The most important factors in separation are pH and clay.

In the right side of the axis species such as: *Quercus brantii* Linddl, *Frankenia pulverulenta* L., *Prangos acaulis* (DC) Bornm. *Bromus tectorum* L., *Anthemis altissima* L., *Hordeum bulbosum* L., *Centaurea intirica*, *Euphorbia macroclada*, *Trigonella latialata* (Bornm.), *Cousinia pichleriana* Bornm. *Galium verum* L., *Papaver agremone* and *Hordeum glaucum* Steud Ex Rech. F.

They form a group. This group shows positive correlation with the axes 1 and 2. Dominant tree species in this group is *Quercus brantii* and most species of this group are herbaceous species. This group with percent of saturated moisture, percent of organic matter, K, total N, P, C/N, geographical direction show positive correlation. This site is located in low elevation and it does not have any correlation with elevation.

The most important factor in separation of this group is C/N as well as bulk density I slow in this group. At the bottom of right side of axis1 (group 3) species such as: *Acer monspessulanum* L., *Tragopogon vedenskyi* M. Pop. Expavlov, *Geranium lucidum* L., *Stipa barbata* Desf., *Medicago radiate* L., *Silene commelinifolia*, *Colchicum robustum* (Bge.) Stefanov., *Geranium tuberosum* L., *Cerasus microcarpa* (C.A. Mey.) Boiss. subsp. *microcarpa*., *Fritillaria* sp. and *Glycyrrhiza glabra* L. Var. glabra.

Form a group. This group has positive correlation with group 1 and has negative correlation with group 2 and its index tree species is *Acer monspessulanum.*

This group with the percent of saturated moisture, percent of organic matter, K, total N, P, bulk density, elevation and geographical direction show a significant correlation. This group is in high elevation. At the bottom of right side of axis 2 form another group that have negative correlation with this axis and have a positive correlation with axis 1, however its correlation with axis 1 is less than group 3. The species of this group consist of: *Amygdalus haussknechtii* (C.K. Schneider) Bornm., *Trigonella monantha* C.A. Mey. subsp. *monantha*., *Fumaria vaillantii* Loisel., *Poa annua* L. and *Marrabium vulgare* L. and its index tree species is *Amygdalus haussknechtii.* This group also like the earlier group with the percent of saturated moisture, percent of organic matter, K, total N, P, elevation, geographical direction, bulk density, silt show a positive correlation. However, its correlation is less with the percent of saturated moisture, percent of organic matter, K, total N, P and it is more with elevation and bulk density.

Table 1: The results of ANOVA between groups in terms of diversity and richness

Source of variation	Significance or not significance	F-value	df	p (0.05)
Shanon-Wiener index	*	2.6	5	0.03
Margalef's richness index	*	2.6	5	0.02

*Significance (0.05)

Species: *Daphne mucronata* Royle, *Linum album* Ky. Ex Boiss, *Phlomis persica* Bioss., *Eryngium billardieri* F. Delaroche, *Euphorbia aleppica* L. and *Euphorbia denticulate* Lam.

With the index species *Daphne mucronata* in the left side and at the bottom of the axis form a group that has negative correlation with axis 1 and this group with bulk density, acidity of soil and clay shows a significant correlation. High bulk density is the most factors in separation of this group while C/N in this group is low.

Results of studying biological diversity between ecological groups: First of all, based on Kolmogorov-Smirnon examination it should be approved that the data are normal. For analyzing the diversity between the groups, one-way Analysis of Variance (ANOVA) was used. The results of ANOVA show that there is a significant difference between the groups in terms of biological diversity of Shanon-Wiener and Margalef's richness index (Table 1).

The results of Duncan's analysis show that there is a significant difference between groups in terms of Shannon-Wiener diversity.

Group 3 shows the most and group 5 shows the least Shanon-Wiener diversity. The comparison of average between groups based on Margalef's richness index

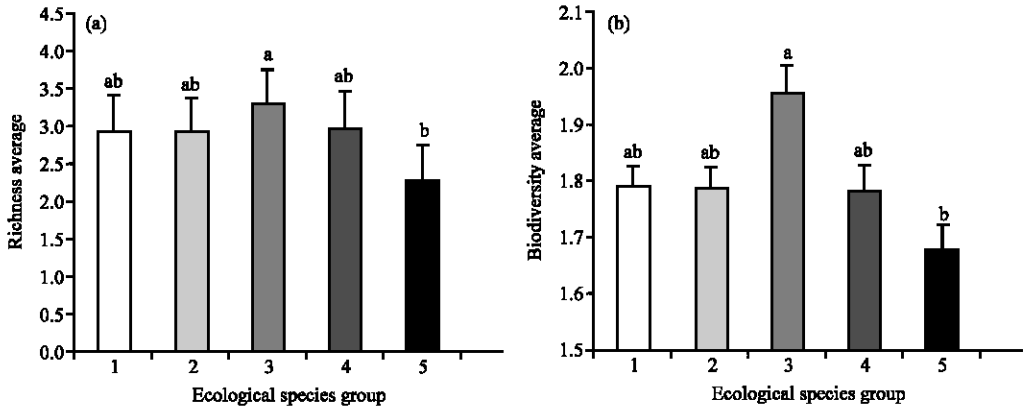

Fig. 3: The results of Duncan's analysis for plant (a) richness and (b) diversity in different groups

shows that group 3 has the most and group 5 has the least amount of richness. But between groups 1, 2 and 4 there is no significant difference (Fig. 3a, b).

DISCUSSION

In the study area 5 units of ecosystem are determined by the use of physiographic and edaphic factors. Between the physiographic and edaphic factors in this research, elevation, the percentage of saturated moisture, P, N, K, C/N, bulk density, the percentage of clay and acidity of soil as the most important factors in separating and classifying the site are put forward. Both the method of PCA and CCA show that the elevation influences the distribution of vegetation and forming the species of ecologic groups. Elevation influences the temperature and the distribution of vegetation.

Jazerehei and Ebrahimirastaghi (2003) believe that altitude is a limiting factor in Zagros forests. The effect of elevation and physiographic in changing the species of ecological groups, in ecosystems of oak, in different researches is confirmed (Baruch, 2005). Chen (1997) in South of Taiwan show that the organic carbon, N, available K exchangeable iron and sodium, at high elevation in comparison to the low elevation are in a large quantity while the acidity of soil, accessible P, calcium, exchangeable Mg are in large quantity at low elevation significantly. Probably the main reason of the organic matter's increasing at the high elevation is the quality of the humus and the slow speed of decomposition in the summit. This research determines that middle elevation in comparison with low elevations is more fertile and the quantity of important elements of soil nutrients is more than the other elevations. The role of elevation on distribution and change of vegetation is more than the other factors of topography (direction and slope). Moradi (1994) remarks that the factor of elevation is more effective that the other factors of topography (direction and slope). The results show that the slope does not influence on combination and distribution of vegetation, the reason is probably the even slope in the study area (Mirzaii, 2006). The geographic direction in this study in accordance with CCA results influences on distribution and diversity of species. Geographic direction can influence on humidity, fertility, depth of soil, distribution and the growth of vegetation because they can influence the amount of humidity changeable amount of sun shine, change of temperature and the blow of territorial winds. This effect is considerable especially in the areas that there is a little amount of rainfall and humidity (Salifu *et al*., 2006). C/N is one of the important factors in distribution and separation of groups in the study. Christine and McCarthy (2005) stated that C/N correlates with distribution of herbaceous species. The sites which have high C/N and organic matters, they show low bulk density.

Mirzaii (2006) could also reach the same results in his study in Arghavan valley of Ilam. The ecological species of group 5 is against the ecological species of group 2 and its soil has less amount of organic matter, more compact and more bulk density. In this study, it is determined that in the sites that the amount of organic matter is more; pH is less and the soil is more acidic.

The humidity of the soil is one of the other important factors in separation of the species groups of vegetation in this study. In a study in mixed forests of Boreal in the groups of pines in Albert International Park in Canada, the humidity of soil is one of the most important factors in distribution of alkaline species. In this regard, Sebastia (2004) in a study in order to examine the role of topography and soil in separating the communities by multivariate methods confirms this subject and he stated that the humid communities are more acidic and have more nutrient elements than dry communities. Archambullt *et al*. (1989) determine the ecological species groups of Oak ecosystems in the South Eastern Michigan.

These groups are determined on the basis of presence and absence and the amount coverage of species along the gradient of humidity and fertility of soil. pH is an important factor in distribution and disposition of plant communities (Brosfske *et al*., 2001; Gough, 2001). In this study also this factor is considered as one of the effective factors in separation of ecological species groups. P, K, N are presented as of the important factors of distribution and separation of plant communities in different studies (Rikhari *et al*., 1991). The results of study confirm this subject. On the basis of results of the study, the amount of P in humid sites is more than dry sites. Fu *et al.* (2004) in a research which is titled as the relationship between the characteristics of soil, topography and diversity of plants in a mixed deciduous forest near Binjing in China state that organic matter was an important index for fertility of soil and among all the factors of soil, organic matter and total N have the most effect on the characteristics and distribution of plants. The results of the present study also confirm the important effect of organic matter on distribution of species and separation of ecological species groups.

Group 1: On the basis of the results of CCA, it is formed at the bottom of the left side of axis, group 1. The most important factor in separating that is pH and clay. The soil of this site has tendency to being alkali and the amount of N and other nutrient elements are low. This group doesn't have any tree species index and *Stipa capensis* Thumb. and *Medicago rigidula* are dominant herbaceous species (the most percent in this group). Ellenberg (1992) confirmed the presence of these two genera in half alkaline to alkaline soils which have the lack of N.

Group 2: The dominant species of this group is *Quercus brantii*. This species formed a group with other species such as *Bromus tectorum* (Tabatabaei and Ghasriani, 1992) confirmed these combinations.

This site in comparison to site 3 has less moisture and nutrients. Jazerehei and Ebrahimirastaghi (2003) in their research stated that the site of this species is dry areas and the sites that have less nutrients. *Bromus tectorum* L. grows in dry soils that are dryer that moist most of the time. Especially the soils which have the small amount on N more that the average amount of N. The other index species of this group is *Galium verum* L. Ellenberg (1992) states that this species has moist site with acidic soil.

Group 3: This group forms in high elevations. This is a moist site with high nutrient elements. It has higher amount of organic matter because of the quality of humus and low speed of decomposition in high elevations. Chun *et al.* (2004) and Fu *et al.* (2004) stated that the organic matter is an important index for explaining the fertility o soil.

On the basis of this, we can say this site (site 3) which its organic matter is high in comparison with other sites, is more fertile. Index species of this group is *Acer monspessulanu.* Sabeti (2002) indicated that presence of this species was in high elevations. Jazerehei and Ebrahimirastaghi (2003) believed that the site of this species is in timberline areas. *Cerasus microcarpa* is also in this site. Sabeti (2002) believe that the site of this species is semiarid and semihumid elevations of Zagros that confirms with the results of this research. Also Tabatabaii and Javanshir (1966) confirmed the presence of these two species together in Zagros forests.

Group 4: The index species of this group is *Amygdalus haussknechtii.* This group of species forms in high elevations. Irannejad (1994) also stated that the site of this species is high elevations and cold regions by examining the plant communities of almond species. Jazerehei and Ebrahimirastaghi (2003) confirmed the presence of this species in high elevations. Lonicera nummularifolia (the highest percent of presence) with Amygdalus haussknechtii are present in this group. Sabeti (2002) sated that its site is in high elevations of zagros. Tabatabaii and Javanshir (1966) confirm the accompanying of these two species in Zagros forests.

Group 5: The index species of this group is *Daphne mucronata* and *Euphorbia* species was presented with this group as well. In this site, bulk density is high and organic matter is low. A lot of screes are seen at the surface of soil on this site. The surface soil is compacted. Heydari (2006) confirmed the presence of Daphne in compacted soil with high bulk density.

Results show that group 3 has the most diversity and richness among the organized groups. This group forms in high elevations of the area and its soil is moist and the amount of its nutrient elements is high as well. Chen (1997) in the south of Taiwan show that organic C, N, accessible K, iron and exchangeable sodium has the most amounts in high elevations in comparison to the low elevations while acidity of soil, accessible P. Ca and exchangeable Mg were significantly more in low elevations. The reason of increasing the organic matter in high elevations is probably the quality of humus and low speed of decomposition in the summit. So, the suitable condition of site in this group can be a reason for increasing the diversity and richness. In contrast, the group 5 has the least diversity and richness, high bulk

density, its sampling plots were destroyed mostly and its soil is compacted. Therefore, decreasing of diversity and richness in this group maybe is because of improper conditions of site (soil). It is suggested to do such studies in the other sites in order to recognize the proper conditions of site and dominant species of each site in the case of ecological groups and to reach a proper sample to improve and to protect the natural resources.

REFERENCES

Archambullt, L., B.V. Barnes and J.A. Witter, 1989. Ecological species groups of Oak ecosystem of Southeastern Michigan. For. Sci., 35: 1058-1074.

Barnes, B.V., D.R. Zak and S.H. Spurr, 1998. Forest Ecology. 4th Edn., John Wiley and Sons Inc., New York, ISBN: 9780471308225, pp: 774.

Baruch, Z., 2005. Vegetation-environment relationships and classification of the seasonal savannas in Venezuela. FLORA JENA, 1: 49-64.

Brosfske, K.D., J. Chen and T.R. Crow, 2001. Understory vegetation and site factors: Implications for a managed Wisconsin landscape. For. Ecol. Manage., 146: 75-87.

Chen, Z.S., 1997. Relations of soil properties to topography and vegetation in a subtropical rain forest in southern Taiwan. Vegetatio, 132: 229-241.

Christine, J.S. and B.C. McCarthy, 2005. Relationship of understory diversity to soil nitrogen, topographic variation and stand age in an Eastern Oak forest USA. For. Ecol. Manage., 217: 229-243.

Chun, C.T., Z.S. Chen and H. Chang-Fu, 2004. Relationships between soil properties and slope position in a lowland rain forest of Southern Taiwan. Geoderma, 123: 131-142.

Daubenmire, R.F., 1976. The use of vegetation in assessing the productivity of forest lands. Bot. Rev., 42: 115-143.

Ellenberg, H., 1992. Zeigerwerte von Pflanzen in Mitteleuropa. 2nd Edn., Verlag Erich Goltze KG, Goettingen, ISBN: 3884525182, pp: 258.

Fu, B.J., S.L. Liu, K.M. Ma and Y.G. Zhu, 2004. Relationships between soil characteristics, topography and plant diversity in a heterogeneous deciduous broad-leaved forest near Beijing, China. Plant and Soil, 261: 47-54.

Gough, L., 2001. Vascular plant species richness in Alaskan arctic tundra: The importance of soil pH. J. Ecol., 88: 54-66.

Heydari, M., 2006. Investigation ecological species groups in relation to environmental factors in Ghalarang protected area, Ilam. M.Sc. Thesis, Guilan University.

Irannejad Parizi, M.H., 1994. Ecological investigation of Amygdalus species community in Kerman province. M.Sc. Thesis, University of Tarbiat Modares.

Jazerehei, M.H. and M. Ebrahimirastaghi, 2003. Zagros Silviculture. 1st Edn., University of Tehran Press, Tehran, Iran, pp: 560 (In Persian).

Krebs, J.C., 1998. Ecological Methodology. 2nd Edn., Benjamin Cummings, ISBN: 10: 0321021738, pp: 624.

Lososova, Z.M. Chytri, S. Cimalová, Z. Kropác, Z. Otipková Pyšek and L. Tichi, 2004. Weed vegetation of arable land in Central Europe: Gradients of diversity and species composition. J. Veg. Sci., 15: 415-422.

Margalef, R., 1958. Information theory in ecology. Gen. Syst., 3: 36-71.

Mirzaii, J., 2006. Investigation of relations between topology, vegetation and soil in north of Ilam province. M.Sc. Thesis, University of Tarbiat Modares, Iran.

Moradi, H.R., 1994. Investigation of relations between geomorphology, vegetation and soil in Vaz watershed. M.Sc. Thesis, University of Tarbiat Modares, Iran.

Rikhari, H.C., R.S. Singh and S.K. Tripathi, 1991. Pattern of species distribution, community characters and regeneration in major forest communities along an elevation gradient in central Himalaya. Int. J. Ecol. Environ. Sci., 17: 174-176.

Sabeti, H., 2002. Forests, Trees and Shurbs of Iran. 3rd Edn., Iran University of Science and Technology Press, Yazd, pp: 808.

Salifu, K.F., A.N. Michael, F.J. Douglass and S.D. Anthony, 2006. Chemical indices of growing media for nursery production of *Quercous rubra* seedlings. Hortic. Sci., 41: 1342-1346.

Sebastia, M.T., 2004. Role of topography and soils in grassland structuring at the landscape and community scales. Basic. Applied Ecol., 5: 331-346.

Shannon, C.E. and W. Weaver, 1949. The Mathematical Theory of Communication. 1st Edn. University of Illinois Press, Urbana, USA.

Tabatabaei, M. and F. Ghasriani, 1992. Natural Resources of Kurdistan. 1st Edn., Jehad-e-Daneshgahi Cultural Press, Tehran, pp: 570.

Tabatabaii, M. and K. Javanshir, 1966. Western Forest of Iran. 1st Edn., Kermanshah and Kurdistan Forests, Tehran, Iran, pp: 235.

Zarinkafsh, M., 1987. Applied Soilogy. 1st Edn., University of Tehran Press, Tehran, Iran, pp: 245.