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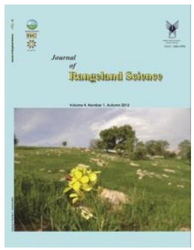


**Full Length Article:**

# Investigating the Effects of Soil Factors on Biodiversity in Plant Communities of Karvan Rangeland (Case Study: Isfahan Province, Iran)

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**Abstract.** Understanding the plant species diversity could be used as an important indicator applied for the natural areas management. The aim of this study was to investigate the relationships between soil characterizes with distribution and diversity of plant in vegetation types in Karvan district (located in west of Isfahan province). For this purpose, three vegetation types were selected as follows: *Scariola orientalis-Astragalus gossypinus (Sc.or-As.go), Hordeum fragile-Astragalus gossypinus (Ho.fr-As.go)* and *Cousinia bachtiarica-Astragalus gossypinus (Cu.ba-As.go).* Then, four transects random sampling - systematic bias to the general and lateral slope of the region in each vegetation type were placed and the name and other characterize of the plants were recorded by 90 of randomly quadrate one $m^2$, also the soil samples of the start and end of each transect from two different depths (0-20 and 20-75 cm) of soil were taken. Soil samples were analyzed and the physicochemical factors were measured. Diversity indices such as Menhinick, Margalef and Fisher alpha were analyzed by VMSP software and soil data were analyzed by PC-ORD software. The results of numerical indices showed a different diversity index in vegetation types and there were significant correlation between some soil properties and diversity index. It was concluded that the *Sc.or-As.go* type had the highest diversity in comparison with the other vegetation types (*Ho.fr-As.go* and *Cu.ba-As.go*). Finally soil properties such as organic matter, clay and soil depth had positive and the amount of lime and gypsum had negative correlation with species diversity.

**Key words**: Soil factors, Diversity indices, Vegetation types, Karvan rangeland

## Introduction

Rangelands are natural ecosystems containing great genetic resources and plant species diversity having profound effects on stability of the rangelands. Biotic and Abiotic environmental factor are inextricably linked to each other, mutually influence on both (Komaee *et al.*, 2012).

Many factors such as soil characteristics, climate and physiography could be making various plant communities in different areas. Intensity of environmental resources such as light, soil moisture and nutrients in the region along with the plants ecological requirements causes the plant species habitats (Gray and Spies, 1997) so diversity is depending on the variety of environmental factors such as rainfall, soil and altitude (Rahmani, 2009).

Even both the altitudinal location on the hill and the aspect determine a regular distribution pattern of the plant communities, which is closely related to soil and erosion features and patterns and floristic composition of plant communities than in other close lithologies (Guardia and Ninot, 1992), on the other hand, the environmental factors affecting on the plant diversity, although ecosystems are broadly arranged in a latitudinal pattern (White, 1983).

Biodiversity refers to all species of plants, animals and micro-organisms existing and interacting within an ecosystem (Vandermeer and Perfecto, 1995). Every place has different plant in sort and number: for example, a vast part of the Sahara, the Tenere, is habitat to only 20 plant species in an area of about 200000 $Km^2$.

Overlaid on these latitudinal patterns are pockets of rich biodiversity with small distribution ranges, particularly in tropical montane areas (Rahbek, 1995).

Diversity (biodiversity) underpins ecosystem functioning and the provision of ecosystem services and essential for human well-being. Plants provides for food security, human health, the provision of clean air and water; it contributes to local livelihoods, and economic development, and is essential for the achievement of the millennium development goals, including poverty reduction. In addition it is a central component of many belief systems worldviews and identities.

Therefore biodiversity means more than counting species. Nature insight takes a look at global patterns of diversity, investigates what it tells us about ecological and evolutionary processes, and provides a blueprint for international action to conserve biodiversity and ecosystem degradation. The strategic plan serves as a flexible framework for the establishment of national and regional targets and it promotes the coherent and effective implementation of the many objectives of the convention on biological diversity (UNEP, 2010).

It is argued that because biodiversity mediated renewal processes and ecological services are largely biological, their persistence depends upon the maintenance of biological integrity and diversity in ecosystems (Altieri, 1999).

Commonly used method for assessing non-target-based mathematically computed Indices, are the Simpson and Shannon-Weiner indices (Sanders, 1981; Sun, 1992).

Soil factors play a major role in ecological processes and are closely associated with the growth and distribution of plants. So far different researches have done such studies (Abbasi and Afsharzadeh, 2008) that relative to diversity of plant community in different pastures. Shannon and Weiner index (Shannon, 1948), Simpson index (Simpson, 1949) or the inverse of Simpson index (Sun, 1992), they are based entirely on the number and relative abundance of all the taxa being evaluated (species, genus or family).

Although the use of these indices has a scientific basis, their use as an evaluation tool in the plant selection process is limited to the number and evenness of the taxonomic unit being evaluated Richards (1983), so in order to understand the effect and relation of soil characteristics on vegetation types and diversity of plants this study was conducted in Karvan regland communities in west of Isfahan province, Iran.

## Materials and Methods

### Study area

The study area is located in 70 km west of Isfahan in Iran with annual rainfall of 250 mm and average annual temperature of 14 °C. The region stretches from the east to west with a greater height in southern parts of the region with 2900 m above sea level (altitudinal range is from 2050 m to 2250 in study part) and the aspect of the region is north to west and south to west. The region has topography with mild slope about 12% that covered with shrub form and perennial grasses, (Fig. 1).

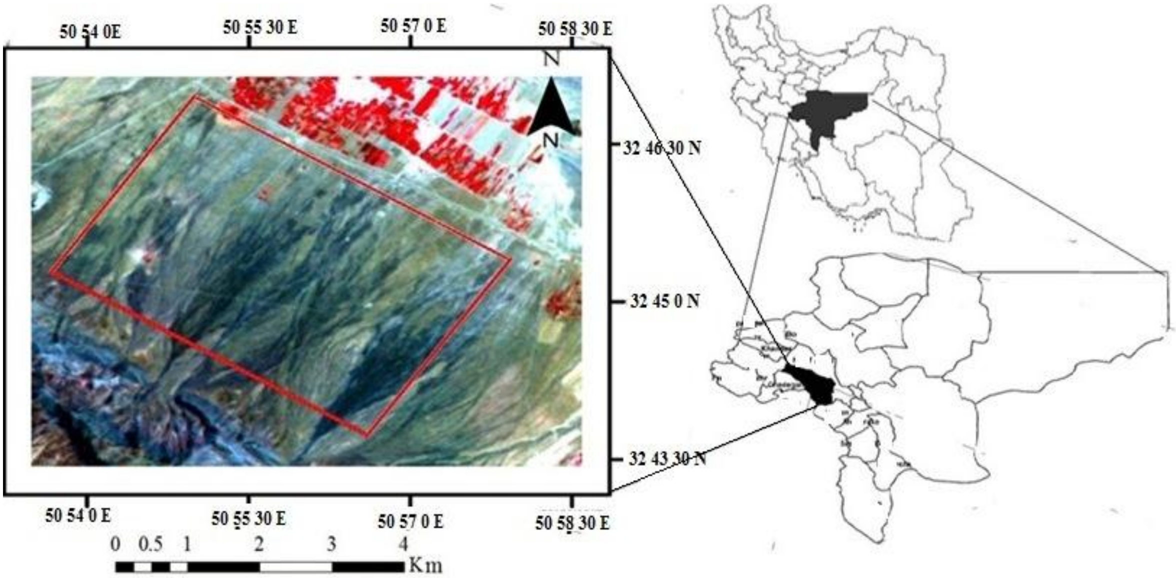


**Fig. 1.** Geographic location of study area (rangeland of Karvan district in Isfahan province, Iran)

### Data collection and analysis

To investigate the relationship between vegetation and soil factors, after a preliminary visit, tree vegetation types determine with physiognomic- floristic system. Three major vegetation types including: *Scariola orientalis-Astragalus gossypinus*, *Hordeum fragile-Astragalus gossypinus* and *Cousinia bachtiarica-Astragalus gossypinus* were detected in this area and the factors affecting the distribution of these vegetation types were studied. First of all, a floristic list was prepared for each vegetation type. Then, suitable plot size was determined in each vegetation type according to canopy cover percentage, density and frequency of the species were recorded in $1m^2$ plots (because of the similarity of vegetative forms and according to twice the largest plant canopy (Moghaddam, 2008) [*Scariola orientalis* in *Sc. or- As. go* type; *Hordeum fragile* in *Ho.fr-As.go* type and *Astragalus gossypinus* in *Cu.ba-As. go* type], the same plot size in all of three vegetation types were selected).

To achieve the purpose, four transects (200 m in length) in each vegetation type with 100 meters distance from each other were placed oblique to the general and lateral slope of the region. Therefore, in this study in order to investigate the species diversity of herbaceous plants, 90 1 $m^2$ quadrate [according to the primary plotting, measuring the canopy, and using the formula-$N=[s^2*t^2]/k^2$- at 10 percent error (Moghaddam, 2008)] were sampled during the transects from low altitude to high altitude in different aspects (West and East). Within each plot, the full floristic composition of herbaceous plants, canopy cover percentage, density and frequency of the species were recorded. All sampling locations had similar characteristics, in terms of sampling method and physiographic characteristics of the area.

There are different methods to take the soil sample. For example, in cultivation plants without deep roots, the soil samples depth is done from 30 to 60 cm from the surface, or in area that has relatively deeper roots is taken from 60, 90 to 120 cm and in deeper soil that cover by tree vegetation, the soil sampling is done more than 120 cm of soil profile (Yazdanshenas *et al.*, 2012). However in this study, the soil sampling were taken from the start and end of each transect in two different depths (0-20 and 20-75 cm according to soil depth, bed rock and length of plant roots). Finally, 24 profiles (8 profiles in each vegetation type) and 48 soil samples were taken from different depths. Soil samples according to their respective code were dried in the shade, after drying, soil samples were pass through with a 2 mm sieve and the gravel percentage were calculated.

The results of correlation between the value of diversity indices and soil properties on each vegetation type, presented in (Table 2). Then, physical and chemical soil properties such as: pH, EC, $CaSO_4$, $CaCO_3$, OM, N, P, K, Clay, Sand, Silt and SP (Saturation Percentage) were measured.

In order to determinate the Biodiversity Indicators (BI), the data obtained from plant properties' by using the MVSP[1] software and data from the soil characteristics in three types of vegetation were analyzed by using PC-ORD software (DCA method). Also, in order to determinate the diversity, we use variety of indicators such as: Shannon index, Simpson index, Menhinick, Margalef and Fisher alpha for better comparison. Also to investigate the relationships between Diversity indices and environmental factors, soil characteristics, the SPSS software were used.

## Results

The results of diversity indices in each the vegetation types are shown in (Table 1). Based on the results each vegetation type shows the different results. The *Sc. or- As. go* type not only has the most of the variation between species, but also there is intraspecific variety in mentioned type.

**Table 1.** Diversity Indexes in different vegetation types

| | Vegetation Types | | |
|---|---|---|---|
| Diversity Indexes | *Scariola orientalis-Astragalus gossypinus* | *Hordeum fragile-Astragalus gossypinus* | *Cousinia bachtiarica-Astragalus gossypinus* |
| Shannon index | 1.41 | 1.51 | 1.42 |
| Simpson index | 0.44 | 0.62 | 0.65 |
| Menhinick | 3.47 | 2.77 | 2.44 |
| Margalef | 5.03 | 4.54 | 3.82 |
| Fisher alpha | 25.98 | 11.93 | 9.23 |

[1] - Malti Variate Statistical Package

The results of correlation between the value of diversity indices and soil properties on each vegetation type, presented in Table 2. All computing were performed by two methods in order to more accurately, Spearman's rho and Kendall's tau_b. These two methods are usually used to calculate the diversity of indicators and because the way that they are calculated is a little different from each other, the accuracy will be increases and determines the significant of the relationships automatically.

**Table 2.** The correlation coefficient between soil factor and diversity indexes

| Soil Factors[1] | Shannon Index | | Simpson Index | | Menhinick | | Margalef | | Fisher Alpha | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kendall's tau_b | Spearman's rho | Kendall's tau_b | Spearman's rho | Kendall's tau_b | Spearman's rho | Kendall's tau_b | Spearman's rho | Kendall's tau_b | Spearman's rho |
| Gypsum ($CaSo_4$) | 0.98$^{**}$ | 0.99$^{**}$ | -0.35$^{ns}$ | -0.58$^{ns}$ | 0.33$^{ns}$ | 0.55$^{ns}$ | 0.33$^{ns}$ | 0.55$^{ns}$ | 0.99$^{**}$ | 0.63$^{ns}$ |
| Lime ($CaCO_4$) | 0.99$^{**}$ | 0.97$^{**}$ | -0.33$^{ns}$ | -0.55$^{ns}$ | 0.33$^{ns}$ | 0.55$^{ns}$ | 0.33$^{ns}$ | 0.55$^{ns}$ | 0.94$^{**}$ | 0.94$^{**}$ |
| Organic Matter (OM) | 0.33$^{ns}$ | 0.54$^{ns}$ | 0.99$^{**}$ | 0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.66$^{ns}$ |
| Nitrogen (N) | 0.00$^{ns}$ | 0.00$^{ns}$ | -0.61$^{ns}$ | -0.56$^{ns}$ | 0.66$^{ns}$ | 0.56$^{ns}$ | 0.86*$^{s}$ | 0.86$^{*}$ | -0.29$^{ns}$ | -0.33$^{ns}$ |
| Phosphorus (P) | 0.36$^{ns}$ | 0.52$^{ns}$ | -0.88$^{**}$ | -0.96$^{**}$ | 0.99$^{**}$ | 0.99$^{**}$ | 0.00$^{**}$ | 0.99$^{**}$ | 0.99$^{**}$ | 0.99$^{**}$ |
| Potassium (K) | -0.33$^{ns}$ | -0.55$^{ns}$ | -0.33$^{ns}$ | -0.55$^{ns}$ | 0.33$^{ns}$ | 0.55$^{ns}$ | 0.33$^{ns}$ | 0.55$^{ns}$ | 0.33$^{ns}$ | 0.74$^{*}$ |
| Clay (CL) | -0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | 0.99$^{**}$ | 0.99$^{**}$ | 0.99$^{**}$ | 0.99$^{**}$ | -0.33$^{ns}$ | 0.03$^{ns}$ |
| Acidity (pH) | 0.33$^{ns}$ | 0.55$^{ns}$ | 0.33$^{ns}$ | 0.54$^{ns}$ | -0.33$^{ns}$ | -0.54$^{ns}$ | -0.33$^{ns}$ | -0.54$^{ns}$ | 0.99$^{**}$ | 0.95$^{**}$ |
| Silt | 0.34$^{ns}$ | 0.52$^{ns}$ | 0.32$^{ns}$ | 0.55$^{ns}$ | -0.32$^{ns}$ | -0.55$^{ns}$ | -0.32$^{ns}$ | -0.55$^{ns}$ | -0.33$^{ns}$ | -0.48$^{ns}$ |
| Gravel | -0.33$^{ns}$ | -0.55$^{ns}$ | -0.33$^{ns}$ | -0.54$^{ns}$ | 0.33$^{ns}$ | 0.55$^{ns}$ | 0.33$^{ns}$ | 0.55$^{ns}$ | 0.33$^{ns}$ | 0.24$^{ns}$ |
| Electrical Conductivity(EC) | -0.81$^{**}$ | -0.88$^{**}$ | 0.816$^{**}$ | 0.866$^{**}$ | -0.81$^{**}$ | -0.866$^{**}$ | -0.81$^{**}$ | -0.86$^{**}$ | -0.82$^{ns}$ | -0.63$^{ns}$ |
| Saturation Percent (SP) | -0.33$^{ns}$ | -0.56$^{ns}$ | 0.98$^{**}$ | 0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.68$^{ns}$ |
| Depth | -0.34$^{ns}$ | -0.54$^{ns}$ | 0.99$^{**}$ | 0.98$^{**}$ | -0.99$^{**}$ | -0.98$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.99$^{**}$ | -0.72$^{*}$ |

**:Correlation is significant at the 0.01 level, ns: showed no significant relationships,1:Each factor was chosen out of the whole soil profile

The soil characteristics in three types of vegetation were analyzed by DCA method. Detrended Correspondence Analysis (DCA) performs the analysis by a method that evaluate the factors at more detailed and will prevent the concentration factors on a specific area on the axes, also this method is used by several people widely (Zare Chahuky, 2009). (Table 3), shows the cumulative gradient length of soil factors on each axes of the DCA graph. Each soli factors has specific gradient on each axes of DCA graph, these gradients represent the amount of effectiveness of factors on separate the plant communities. (Fig. 2), shows the most important and effective factors on breakdown of plant types in the region. Some factors such as OM, $CaCO_3$ and $CaSO_4$ were separated obviously.

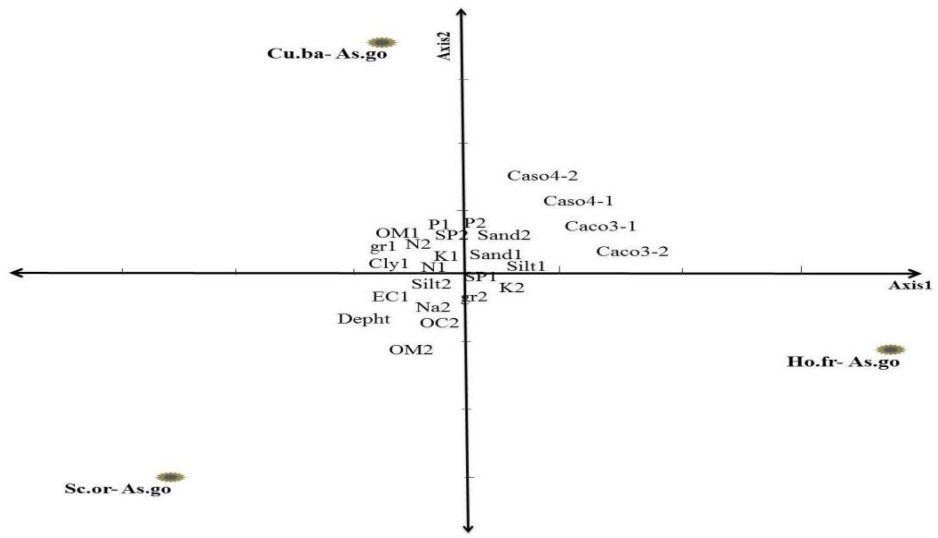


**Fig. 2.** Ordination of vegetation types in Detrended Correspondence Analysis (DCA) according to soil habitats factors

**Table 3.** The gradient length of factors soil on the each axes of the DCA graph

| Soil Characteristics | $AX_1$ | $AX_2$ | $AX_3$ |
|---|---|---|---|
| Gr (2) | 18.00 | 25.00 | 25.00 |
| pH(2) | 11.00 | 25.00 | 24.00 |
| Clay (2) | 5.00 | 22.00 | 22.00 |
| Silt (2) | 16.00 | 21.00 | 21.00 |
| Sand (2) | 13.00 | 29.00 | 29.00 |
| EC(2) | 9.00 | 23.00 | 22.00 |
| OM(2) | 4.00 | 0.00 | 0.00 |
| SP(2) | 9.00 | 19.00 | 19.00 |
| P(2) | 15.00 | 30.00 | 30.00 |
| K(2) | 8.00 | 31.00 | 31.00 |
| $CaCO_{3(2)}$ | 32.00 | 24.00 | 23.00 |
| $CaSO_{4(2)}$ | 26.00 | 49.00 | 48.00 |
| Gr (1) | 11.00 | 26.00 | 26.00 |
| pH(1) | 11.00 | 24.00 | 24.00 |
| Clay(1) | 7.00 | 25.00 | 25.00 |
| Silt(1) | 21.00 | 21.00 | 20.00 |
| Sand(1) | 5.00 | 27.00 | 27.00 |
| OM(1) | 2.00 | 27.00 | 27.00 |
| SP(1) | 7.00 | 21.00 | 21.00 |
| N(1) | 10.00 | 27.00 | 27.00 |
| P(1) | 1.00 | 31.00 | 30.00 |
| K(1) | 3.00 | 28.00 | 28.00 |
| $CaCO_{3(1)}$ | 33.00 | 32.00 | 31.00 |
| $CaSO_{4(1)}$ | 33.00 | 34.00 | 33.00 |
| Soil depth | 8.00 | 21.00 | 21.00 |

## Discussion and Conclusion

Plants are universally recognized as a vital part of the world's biodiversity and an essential resource for the earth. Many thousands of wild plants have great economic and cultural importance, providing food, medicine, fuel, clothing, shelter and other services for humans around the world. Many plant species are threatened by habitat transformation, over-exploitation, invasive alien species; pollution and climate change, and are now in danger of extinction, and to halt the destruction of plant diversity that is essential to meet the present and future needs of humankind (GSPC, 2009). However, understanding the relationship between plant diversity and environmental factors such as soil will help us to maintain the plants and diversity.

Comparison of results indicate that there are higher species diversity in the first vegetation type (*Sc.or-As.go*) than in the other types (*Ho.fr-As.go* and *Cu.ba-As.go*) that can explain the wellbeing of the soil properties of this site see (Table 1). Among all of the soil factors, amount of N, pH and silt percentage had no correlation with diversity indices. Diversity usually decreases when fertilization is applied to a plant community (Ditommaso and Aarssen, 1989; Gough *et al.*, 2000), which appears to be a result of increased competitive exclusion with added soil resources (Abrams, 1995; Rajaniemi, 2002). Statistical test was significant (p<0.01) for diversity indices (Shannon index, Simpson index, Menhinick, Margalef and Fisher Alfa) comparing by some of soil factors such as: OM%, SP, $CaCO_3$%, $CaSO_4$%, Sand%, Clay% and depth of soil profile. Amounts of organic matter, clay, gravel, electrical conductivity and soil depth was higher in *Sc.or-As.go* type and these factors have shown the most associated and correlation with variety of indicators. In the other hand, amounts of lime and gypsum are more in *Ho.fr-As.go* and *Cu.ba-As.go* types and these factors have shown the lowest correlation with the index of plant diversity. Also the results of the statistical analysis of the soil data showed that there were significant differences in the soil characteristics habitat among the vegetation types in this area. Chemical properties such as soil Organic Matter (OM), Electrical Conductivity (EC), gypsum and lime are the main and effective factors on the vegetation type separation and depth of soil profile, percentage of clay and silt of soil physical properties are effective factors. In recent studies such as Sadeghinia *et al.* (2010), the amount of limestone has been one of the important factors on the separating plants habitats.

There is a specific explanation for this difference about diversity that, the soil condition was very rich showed in the *Sc.or-As.go* type that other researcher such as Brand (1991) has been to point this out. Rahimi *et al*. (2012) investigated the relationship between soil properties and distribution of plant species. The results showed that the amount of gypsum, organic matter and organic carbon were the most important soil properties effective on separation of vegetation types. Komaee *et al.* (2012); Torang *et al*. (2008); Fahimi-Pur *et al.* (2010) and Ahmadi *et al.* (2010) introduced organic matter and depth as the most important soil factors effective in separation of vegetation types in the study area. According to (Table 2), the degree of intraspecific diversity with soil characteristics such as phosphorus, lime and acidity have a great relationship. But based on (Fig. 2 and Table 3), increasing the amount of lime is related to *Ho. fr- As. go* and *Cu. ba- As. go* types, but the amount of Phosphorus and acidity in the *Sc. or- As. go* type is more than other two types. In most cases, amount of gypsum had no significant relationship with the coefficients of diversity. Amount of gypsum in *Ho.fr-As.go* and *Cu.ba-As.go* types is more than *Sc.or-As.go* type. General comparison of diversity indices shown in (Table 1), so that the *Sc.or-As.go* type has been greater amounts in almost all indicators. The conservation of threatened wild plants growing on production lands and the prevention of impaction plant diversity in surrounding ecosystems also affecting change in policy, legislation and institutional frameworks (required by this target) is a long-term process, but to be successful in conserving plant diversity, this target must be driven by relevant agencies (UNEP, 2010). Ultimate results of this study showed that *Sc.or-As.go* vegetation type has a higher rank of Plant diversity compared to *Ho.fr-As.go* and *Cu.ba-As.go* vegetation types and this vegetation type (*Sc.or-As.go*) in terms of restoration and conservation should be given priority.

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# مطالعه اثر ویژگی‌های خاک بر روی تنوع گیاهی مراتع کرون (مطالعه موردی: استان اصفهان، ایران)

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**چکیده.** شناخت تنوع گیاهان می‌تواند به عنوان شاخص مهمی برای مدیریت عرصه‌های طبیعی مورد استفاده قرار گیرد. بدین منظور این مطالعه برای بررسی ارتباط بین خصوصیات خاک رویشگاه و تنوع گیاهان در مراتع کرون واقع در غرب استان اصفهان انجام شد. بدین ترتیب سه تیپ گیاهی شامل ***Scariolia orientalis-Astragalus gossypinus*** ***(Sc.or-As.go)***، ***Hordeum fragile-Astragalus gossypinus (Ho.fr-As.go)*** و ***Cousinia bachtiarica-Astragalus gossypinus (Cu.ba-As.go)*** شناسایی و انتخاب شدند. سپس چهار ترانسکت ۲۰۰ متری با فاصله ۱۰۰ متر از همدیگر و اریب با شیب عمومی و جانبی منطقه در هر تیپ گیاهی قرار داده شدند. به منظور بررسی خصوصیات پوشش گیاهی، تعداد ۹۰ پلات یک متر مربعی به صورت سیستماتیک تصادفی در منطقه قرار داده شد و لیست تمام گیاهان و خصوصیات آنها یاداشت گردید. همچنین نمونه‌برداری خاک از ابتدا و انتهای هر ترانسکت و از دو عمق مختلف (۲۰-۰ و ۷۵-۲۰ سانتی‌متر) انجام شد و خصوصیات فیزیکی و شیمیایی هر نمونه اندازه‌گیری شد. اطلاعات مربوط به پوشش با استفاده از نرم افزار MVSP مورد تجزیه قرار گرفتند و شاخص تنوع (مانند: منهینگ، مارگالف و تنوع درون گونه‌ای آلفا) برای هر تیپ گیاهی محاسبه شد. سپس رابطه همبستگی بین شاخص تنوع و مقادیر مربوط به خصوصیات خاک در بین ۳ تیپ گیاهی بررسی شد. از طرفی تفاوت مربوط به خصوصیات خاک منطقه با نرم افزار PC-ORD مورد آنالیز قرار داده شد. نتیجه بررسی نشان داد که شاخص تنوع بین سه تیپ گیاهی متفاوت میباشد به طوری که تیپ گیاهی ***Sc.or-As.go*** نسبت به تیپ گیاهی ***Ho.fr-As.go*** و ***Cu.ba-As.go*** بالاترین تنوع گیاهی را دارد. بررسی همبستگی عوامل نشان داد که فاکتورهایی مانند ماده آلی، میزان رس و عمق خاک رابطه مستقیم و خصوصیاتی مانند میزان گچ و ازدیاد آهک رابطه منفی با تنوع گیاهی دارند.

**کلمات کلیدی:** خصوصیات خاک، شاخص تنوع، تیپ‌های گیاهی، مراتع کرون