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# Effects of Ecological Factors on the *Distribution* of *Artemisia* melanolepis and *Artemisia aucheri* in Southeast of Sabalan, Iran

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**ABSTRACT**

**Aim** This study aimed to assess the relationship between environmental variables (physiographic and soil) and distribution of *Artemisia melanolepis* and *A. aucheri* to find the most effective factors on the distribution of these species southeast faced slopes of Sabalan Mt., in the northwest of Iran.

**Materials & Methods** 4 sites with the distribution of the genus *Artemisia* (site with the presence of *Artemisia* species) and four sites with the absence of 2 *Artemisia* species were selected. In each site, five transects with a length of 100m (50 one square meter plots) with random- systematically method was established, and the density of *Artemisia* species and land cover parameters (including percent of litter, stone and gravel, total canopy cover, and bare soil) were recorded in each plot. Seventy-two soil samples were collected from 0-15cm depth. Sampling was conducted from May to July 2015 in the pick growing stage. One-way ANOVA and Canonical Discriminate Analyses (CDA) were used for data analyses.

**Findings** The ANOVA and mean comparison results showed that all selected environmental variables except total canopy cover and bare soil had significant differences ($p<0.01$). The results of CDA showed that two functions justified 76.6 and 23.4 percent, respectively, and 100% of the data variance. Finally, 97.3% of the grouped cases were classified correctly. The elevation, potassium, slope, aspect, stone, and gravel were primarily the most effective factors in the first function in the discrimination of the *Artemisia* species. Some parameters such as sand, silt, electrical conductivity, total neutralizing value, water-dispersible clay, organic matter, pH, total canopy cover, litter, and bare soil were second effective factors in the discrimination of sites and distribution of *Artemisia* species.

**Conclusion** Although physiography and soil variables affected the establishment of Artemisia species and showed significant differences between the three discriminated groups; however, the degree of importance of physiographic parameters is more significant than soil factors.

**Keywords** Rangeland; Species Distribution Modelling; Species-Environment Relationship; Ardabil Province

**CITATION LINKS**

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## Introduction

The rangeland ecosystem plays an important role in maintaining a sustainable environment [1]. Rangeland degradation resulted in decreased productivity and economic potential, environmental deterioration, and the decline of biodiversity and complexity [2]. The increase in degradation leads to the weakening or loss of the restoration function, such as resilience and self-regulation of the ecosystem [1-3]. Rangeland degradation occurs because its ecosystems are highly vulnerable to over-exploitation and inappropriate land use [4, 5]. One of the consequences of rangeland degradation is the loss of plant species diversity [4, 5]. Plant species diversity is one of the most important factors for the sustainability of ecosystems [4, 6]. Plant species' presence and distribution in rangeland ecosystems are not random, but such factors as climate, soil, topography, anthropological, and interactions between species play major roles in their development [7-9].

Understanding the relationship between vegetation and environmental factors is one of the major issues affecting the formation of plant communities' structure and their distribution in each area [10]. Determining the factors that control plant species' presence and distribution is one of the main objectives in the rangelands ecosystems studies [8, 9, 11]. In the study [12] by conducting the Principal Component Analysis (PCA) and Canonical Correlation Analysis (CCA) in China indicated that physical and chemical features of the soil, including humidity, salinity, and acidity, were effective inhomogeneity of the plant communities in the regional scale. Another study [13] using discriminant analysis showed that temperature parameters, altitude, sand, stone, and gravel percent on the soil surface, electrical conductivity, total neutralizing, and rainfall in the first canonical function had the highest value, and they were the first factors affecting species distribution. However, the presence and absence of *Ferula ovina* and *F. persica* in the rangelands of Zanjan province were often dependent on some variables such as pH, soil silt percent, aspect, precipitation, and minimum temperature. Another study [7] using discriminant analysis reported that the distribution of *Festuca ovina* in south-eastern rangelands of the Sabalan was more compatible with higher altitudes and lower temperatures and does not tolerate soil salinity. It is more compatible with high pH, organic matter, phosphorus, and potassium. In the study [14] reported that ecological factors which affect the distribution of *Artemisia fragrans* and *A. austriaca* in south-eastern Sabalan were more effected by litter, elevation, rainfall, temperature, organic matter, bare soil, stone and gravels, available potassium, sand, and silt, slope, and aspect.

Sabalan Mountain is important from the socio-economic-ecological perspectives and existence of high palatable species, genetic resources, nomadic life, ecotourism, mineral water, and spa, geothermal energy [5, 14-16]. *Artemisia* species in south-eastern rangelands of Sabalan are dominant, which *A. aucheri* distributed in mid and *A. melanolepis* in high altitude [9, 14, 17, 18]. *A. melanolepis,* as the native threatened species, is important from the Sabalan rangeland biodiversity perspective, and *A. aucheri* has productivity potential. Both soil conservation, medicinal, and aromatic potential [14, 17, 18]; thus, regarding limited information, understanding the relationship between environmental factors and species distribution is necessary [6]. Therefore, the main objective is to understand both selected species' ecological requirements for proper management practices. Thus, this study was conducted to identify the effects of topographic, climatic, and edaphic characteristics on the distribution of *Artemisia melanolepis* and *A. aucheri* in the Sabalan south eastern rangelands.

## Materials and Methods

**Study Area:** Mount Sabalan (4,811m in elevation), as the third-highest Mt. in Iran, is located in northwest Iran, which is one of the main rangeland ecosystems in Iran [5, 16]. This study's main selected habitats (Table 1) are in the southeast faced slopes of Mt. Sabalan in Ardabil province (Figure 1).

Eight habitats were selected with the genus *Artemisia* distribution. *A. melanolepis* and *A. aucheri* are distributed in two habitats, and two habitats close to each Artemisia habitats were selected as the absence habitats of A. melanolepis *A. aucheri*. The selected habitats have moderate summer and cold winter, and four to five months of the year covered with snow and the climate of habitats are cold semiarid [7, 15, 16]. The soil varies dramatically, but generally, in terms of depth and fertility, it is fair to good rangeland soil with sandy-loamy texture [7, 14, 18]. Current land use of the selected habitats is rangeland, which is used as the summer rangeland of Shahavan nomads' livestock, and almost in 4 to 5 months (May to September) of the year are grazed by main sheep (95%) and goat and others (5%) [15, 20].

**Table1)** Location and characteristics of the selected habitats [4, 7, 14, 15, 19]

| Environmental characteristics | | | Selected habitats |
|---|---|---|---|
| **Geographical status** | Latitude (N°) | | 38°01'04'' to 38°12'43'' |
| | Longitude (E°) | | 47°51'43'' to 47°56'11'' |
| | Altitude (m) | | 1800-3200 |
| | Slope (%) | | Different |
| **Meteorological*** | Annual precipitation (mm) | | 494 to 681 |
| | Annual mean temperature (°C) | | 1.90 to 8.11 |
| **Vegetation status** | Vegetation type | *A. melanolepis* | *Asteragalus cordachrum; Alopecurus texilis; Festuca ovina* |
| | | *A. aucheri* | *Festuca ovina; Onobrychis coronuta; Astragalus* sp. |
| | Plant species | | *Agropyron tauri; Allium monophyllum; Alyssum bracteatum; Anthemis atropatana; Apium nodiflorum; Arenaria dianthoides; Astragalus aegobromus; A. cordatus; A. peristerus; Ballota nigra; Campanula stevenii; Centaurea fhizantha; Eragrostis curvula; Galium verum; Helychrisum psychrophilum; Henrardia persica; Inula helenium; Lamium album; Leontodon asperrimus; Linaria dalmatica; L. grandiflora; Minuartia brevis; Nonnea persica; Oxytropis persica; Papaver rhoeas; Pedicularis sibthorpii; Poa compressa; Polygonum avicular; Potentilla bifurcal; Ranunculus sabalanicus; Scorzonera grossheimilipsch; Sedum annuum; Stachys iberica; S. lavandulifolia; Tanacetum polycephalum; Thesium ramosum; Thymus kotschyanus; Tragopon gongylorrhizus; Trifolium montanum; T. pratense* and *Veronica orientalis* |

*According to meteorological stations in the surrounding region (with a 10-year period/2006 to 2015).

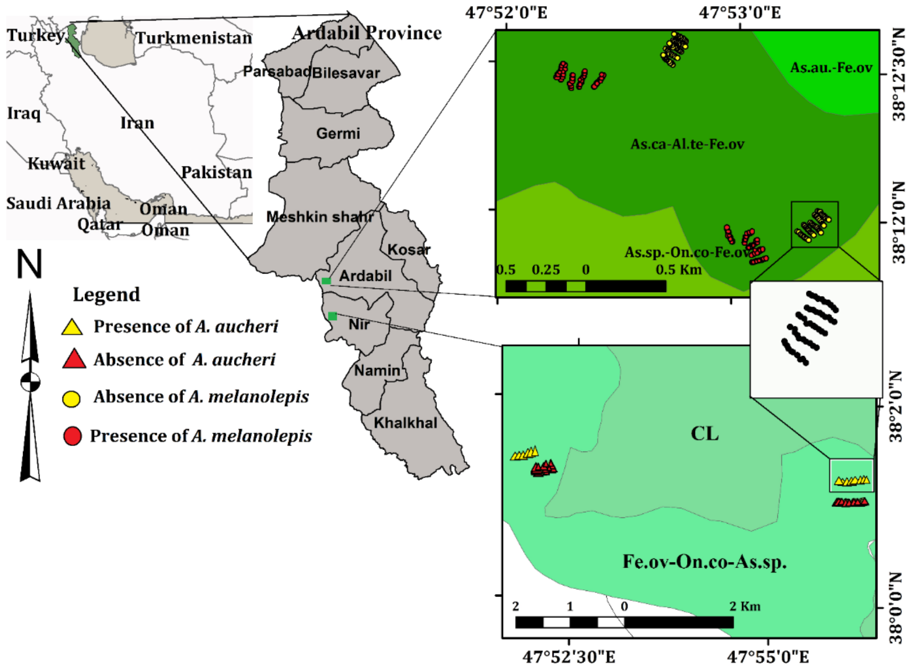


**Figure 1)** Vegetation types, location of the habitats, and samples for presence and absence of the selected species in Ardabil Province and Iran

**Sampling Methods and Laboratory Measurements:** Initially, to recognize the distribution of the genus *Artemisia*, a comprehensive study was conducted by a literature review [4, 14, 15, 19, 21, 22]. Finally, three groups of sampling sites: the first group with the presence of *A. melanolepis,* the second group with the presence of *A. aucheri,* and the third group with the absence of them were selected. In each site, five transects with a length of 100 meters were established (40 transects). The first transect was established randomly on the present sites, and others were established by 50 meters from each other on the selected habitats. One of the sampling problems using a random method may not cover samples equally all of the regions, random-systematically method reduces this problem [23]. The plot's size should be appropriate to double the average area of the most common species [24-26]. Considering the time factor in sampling, some researchers [27] consider square plots to be the most appropriate plots. Thus, based on previous studies [4, 5, 14, 15, 22] and the distribution of plant communities, the size of the sampling plot for vegetation and land surface properties was selected one square meter. Statistically, sampling an area by a large number of small plots is better than using large plots [28].

Then, ten plots were established along each transects with 10-meter intervals (400 plots). The distance between the plots and the transects was considered based on the vegetation characteristics, topographic status, research purpose, and area of the selected sites [29]. The density of *Artemisia* species and the percentage of total vegetation cover, litter, stone and gravel, and bare soil were recorded in each plot. In transects, one, three, and five of each selected site, three soil samples from 0-15cm depth at the starting, middle and ending points of each transect were taken from each site (nine samples from each site, total 72 soil samples). Each sampling point's position was recorded using a handheld Garmin Oregon 550 Global Positioning System (Garmin, 2011). Soil samples air-dried at room temperature and passed through a two mm sieve. Soil texture and water-dispersible clay were determined by the hydrometer method [30]; organic matter by the Walkley and Black's method [31]; particulate organic matter by physical separation [32]; available potassium by flame photometry method; total neutralizing value by neutralizing with acid and titration with profit method [33]; pH and electrical conductivity in a saturation state extracted by pH meter and electrical conductivity meter [34] (Table 2).

Digital topographic maps of the study area at the scale of 1:25000 from the National Cartographic Centre of Iran were used for creating a digital elevation model (DEM, pixel size 30×30m). Using DEM, elevate on, slope, and aspect classes were extracted in $ArcGIS_{10.1}$ software for each sampling plot. Precipitation and temperature vale for each plot were extracted from derived relevant gradient equations [4, 14, 15] using DEM. Aspect data change to quantitative value using Equation 1 [35].

$$A' = \cos(45 - A) + 1 \tag{1}$$

A′: converted value of aspect and A: the azimuth value of aspect.

**Table 2)** List of variables in the dataset

| Variable | Code | Unit | Mean±SD |
|---|---|---|---|
| **Density of *A. melanolepis*** | DsAm | $n/m^{-2}$ | 20.11±24.68 |
| **Density of *A. aucheri*** | DsAa | $n/m^2$ | 1.80±2.00 |
| **Elevation** | Elev | m | 2563.90±498.81 |
| **Slope** | Slope | % | 20.29± 8.78 |
| **Aspect** | Aspect | - | 0.96± 0.61 |
| **Precipitation** | Pre | mm | 569.14± 95.17 |
| **Mean temperature** | Tem | °C | 9.89± 2.55 |
| **Litter** | Lit | % | 2.02± 1.67 |
| **Bare Soil** | BS | % | 20.00± 13.84 |
| **Stone & Gravel** | SG | % | 15.08± 13.88 |
| **Total Canopy Cover** | TCC | % | 63.03± 16.28 |
| **Clay** | Clay | % | 16.51± 6.22 |
| **Sand** | Sand | % | 62.36± 9.40 |
| **Silt** | Silt | % | 21.00± 5.08 |
| **Organic Matter** | OM | % | 2.65± 0.65 |
| **Particulate Organic Matter** | POM | % | 2.44± 0.68 |
| **Water Dispersible Clay** | WDC | % | 34.74± 12.85 |
| **Total Neutralizing Value** | TNV | % | 0.69± 0.36 |
| **Potassium ion ($K^+$)** | K | meq/l | 819.09± 268.95 |
| **pH (acidity)** | pH | - | 7.11± 0.47 |
| **Electrical Conductivity** | EC | ds/m | 212.41± 51.30 |

**Statistical Analysis:** The normality of data and homogeneity of variances were examined using Kolmogorov-Smirnov and the Levene test. A large portion of the data was not normal, which was normalized using logarithmic, and square root transforms. Correlations of environmental variables were analyzed using Pearson correlation coefficients and principal component analysis (PCA) to investigate the most susceptible variances, multicollinearity, and the importance of components explaining the most of variances in the dataset [36]. The pair variables which correlated 0.8 were removed. One-way ANOVA was used to analyse the significance of differences among habitats of *A. melanolepis* and *A. aucheri* and sites with absences of selected species (3 groups sites) in terms of selected environmental factors. Each measured variable's importance in the distribution of selected species was analyzed using canonical discriminant analysis (CDA).

ArcGIS (version 10.4) and Spatial Analyst Tool (ESRI, 2017) were used to extract the base maps and SPSS24 and PC-Ordination5 softwares for data analysis.

## Findings

Results of collinearity showed a high correlation between elevation and climatic factors (pre and tem) (r=0.98), and particulate organic matter with organic matter (r=0.93). Thus, climatic factors and POM were removed from the dataset. Moreover, there was a high correlation between the percentage of clay, sand, and silt (r=0.82), so clay was removed from the dataset. The results of the analysis of variance between the presence and absence of *A. aucheri* and *A. melanolepis* in the habitats showed a significant difference for all the selected variables ($p<0.01$) except for total canopy cover and bare soil. According to the results of the mean comparison (Table 3), some parameters such as elevation, water-dispersible clay, sand, bare soil, stone, and gravel in the habitats of *A. melanolepis* were more than in comparison with the habitats of *A. aucheri*, and at the absence sites of *Artemisia*. On the other hand, means of electrical conductivity, total neutralizing value, and silt in the habitats of *A. aucheri* showed a greater amount in comparison with the habitats of *A. melanolepis* and absence sites.

Results of canonical discriminant analysis of habitats based on environmental variables showed that this analysis was able to identify two canonical functions, which the first function has 76.6% of the variance, the second function 23.4%, and totally 100% of the variance. Moreover, the canonical correlation coefficient showed that functions 1 and 2 could discriminate well in the groups (Table 4). Wilks' Lambda ranges from zero to 1. The lower Wilks Lambda, the larger the between-group dispersion. A small (close to zero) value of Wilks' Lambda means that the groups are well separated. Table 3 indicates that Wilks' Lambda values had increased from the first function (with Wilks' Lambda 0.05) to the second audit function (with Wilks' Lambda 0.35), and the chi-square value is significant in both functions ($p<0.01$). Thus, the average of groups was different.

Given that the first function has a low Wilks' Lambda value compared to the second function (Table 4), thus, the first function has higher discrimination power in separating the groups. In each of these two functions, the selected attributes had different coefficients. Thus, variables influencing the grouping of habitats and the distribution of *A. aucheri* and *A. melanolepis* seem groups can be determined due to these coefficients (Table 5). Achieved results represent the suitability of the estimated function in identifying of the group because the eigenvalue was high (5.92 for the first function and 1.81 for the second), and the value of the canonical correlation coefficient was closer to one (0.93 for the first function and 0.81 for the second). Thus the obtained function was strong, and classification accuracy was acceptable.

Linear correlation among environmental variables and discrimination function shows that the elevation, available potassium, slope, aspect, stone, and gravel were primarily the most influential factor in the first function in the spreading of the *Artemisia* species (Table 4). Some parameters such as sand, electrical conductivity, total neutralizing value, silt, water-dispersible clay, organic matter, pH, total canopy cover, and bare soil were second places as the affecting factors in identifying the sites and distribution of *Artemisia* species. Elevation and slope were having the highest standardized coefficient, as well as bare soil and total canopy cover having the lowest standardized coefficient had the maximum and minimum impacts on the first detection function, respectively. Available potassium and bare soil have the greatest effect on function 2.

(2)

$Y_1$=1.757total neutralizing value+1.194organic matter-0.449pH-0.389aspect 0.112slope+ 0.139silt+0.103sand+0.034water dispersible clay-0.005stone and geavel+0.005elevation-0.003total canopy cover-0.004electrical conductivity-0.001available potassium+0.007bare soil

Results of classification for selected habitats using CDA are shown in Table 6 and Diagram 1. The percentages presented in this Table show the matching level of observed and predicted cases. Accordingly, if the data of the *A. aucheri* were placed in discrimination function (Group 1), the function would recognize correctly in 97% of cases, the membership of the species in the Group 1. If the data of the *A. melanolepis* were in discrimination function (Group 2), the function would detect correctly in 100% of cases the membership of the species in the Group 2. If the sites' data without the two species were in discrimination function (Group 3), the function would detect correctly in 96% of cases the membership of them in Group 3; and overall, 97.3% of main grouped cases have classified correctly. These results indicate that selected environment variables affect the distribution of the selected species; thus, variables are correctly selected.

**Table 3)** Comparison of attributes at the presence and absence sites of *A. melanolepis* and *A. aucheri*

| Parameters | *A. aucheri* | | *A. melanolepis* | | Absence of two species | | F value |
|---|---|---|---|---|---|---|---|
| | Mean | Std. Error | Mean | Std. Error | Mean | Std. Error | |
| **Elev** (m) | 2134.00[a] | 285.40 | 3103.00[b] | 39.51 | 2508.00[c] | 464.70 | 186.40** |
| **Slope** (%) | 24.85[a] | 5.65 | 14.02[b] | 5.36 | 21.15[c] | 9.67 | 49.635** |
| **Aspect** | 1.35[a] | 0.58 | 0.64[b] | 0.46 | 0.94[c] | 0.60 | 39.37** |
| **EC** (ds/m) | 259.98[a] | 57.01 | 198.83[b] | 38.88 | 195.41[b] | 37.27 | 69.79** |
| **pH** | 7.06[a] | 0.68 | 6.84[b] | 0.35 | 7.27[c] | 0.31 | 33.17** |
| **OM** (%) | 3.10[a] | 0.69 | 2.37[b] | 0.47 | 2.57[c] | 0.60 | 37.75** |
| **TNV** (%) | 0.91[a] | 0.34 | 0.73[b] | 0. 34 | 0.56[c] | 0.34 | 36.19** |
| **K** (meq/l) | 885.01[a] | 171.20 | 518.14[b] | 176.83 | 936.61[b] | 219.02 | 8.43** |
| **WDC** (%) | 24.35[a] | 8.77 | 40.87[b] | 1.57 | 36.88[c] | 9.60 | 60.94** |
| **Silt** (%) | 24.23[a] | 4.30 | 20.43[b] | 3.69 | 19.68[b] | 5.35 | 31.83** |
| **Sand** (%) | 52.02[a] | 7.70 | 67.53[b] | 5.19 | 64.96[c] | 7.77 | 121.31** |
| **TCC** (%) | 67.61[a] | 10.75 | 64.52[a] | 18.51 | 59.99[b] | 16.80 | 8.14** |
| **Lit** (%) | 2.39[a] | 1.96 | 2.03[ab] | 1.60 | 1.83[c] | 1.52 | 37.47** |
| **SG** (%) | 13.26[a] | 5.92 | 23.87[b] | 16.51 | 11.44[c] | 13.34 | 46.31** |
| **BS** (%) | 16.76[a] | 8.02 | 22.08[a] | 16.81 | 20.35[a] | 14.41 | 0.92[ns] |

**: Significant at p<0.01; *: Significant at P<0.05 and *ns*: no significant; Same letters in a row is showing no significant difference.

**Table 4)** Eigenvalues, Wilks' Lambda, and the percentage of variance explained by the two first functions in discriminant analysis

| Parameters | Function | |
|---|---|---|
| | 1 | 2 |
| **Eigenvalue** | 5.92[a] | 1.81[a] |
| **Variance** (%) | 76.60 | 23.40 |
| **Cumulative** (%) | 76.60 | 100.00 |
| **Canonical correlation** | 0.93 | 0.81 |
| **Test of function**(s) | 1 through 2 | 2 |
| **Wilks' lambda** | 0.05 | 0.35 |
| **Chi-square** | 1155.41 | 401.81 |
| **df** | 32 | 15 |
| **Sig.** | 0.000 | 0.000 |

a: First, two canonical discriminant functions were used in the analysis.

**Table 5)** Standardized canonical discriminant function coefficients and structure matrix in the selected sites

| Parameters | Standardized canonical discriminant function coefficients | | Structure matrix | |
|---|---|---|---|---|
| | Function | | Function | |
| | 1 | 2 | 1 | 2 |
| **Elev** (m) | 1.656 | 0.078 | 0.395* | 0.087 |
| **K** (meq/l) | -0.276 | 0.584 | -0.328* | 0.290 |
| **Slop** (%) | -0.866 | -0.063 | -0.205* | -0.022 |
| **Aspect** | 0.220 | -0.270 | -0.170* | -0.123 |
| **SG** (%) | -0.065 | 0.234 | 0.084* | -0.049 |
| **Sand** (%) | 0.739 | 0.433 | 0.261 | 0.417* |
| **EC** (ds/m) | -0.166 | -0.546 | -0.153 | -0.384* |
| **TNV** (%) | 0.593 | -0.341 | -0.031 | -0.313* |
| **Silt** (%) | 0.658 | -0.258 | -0.081 | -0.260* |
| **BS** (%) | 0.085 | 0.665 | -0.080 | 0.256* |
| **WDC** (%) | 0.391 | 0.156 | 0.184 | 0.243* |
| **pH** | -0.198 | 0.437 | -0.113 | 0.225* |
| **P** | -0.028 | -0.291 | 0.024 | -0.215* |
| **OM** (%) | 0.712 | 0.402 | -0.156 | -0.190* |
| **CCT** (%) | 0.055 | 0.373 | -0.005 | -0.150* |
| **Lit** (%) | 0.102 | 0.008 | -0.017 | -0.098* |

**Table 6)** The results of classification using canonical discriminant analysis

| Site | Classification results[a] | | | Total |
|---|---|---|---|---|
| | Predicted group membership | | | |
| | Absence of two species | *A. aucheri* | *A. melanolepis* | |
| **Absence of two species** | 96.0 | 2.5 | 1.5 | 100.0 |
| ***A. aucheri*** | 3.0 | 97.0 | 0.0 | 100.0 |
| ***A. melanolepis*** | 0.0 | 0.0 | 100.0 | 100.0 |

a: 97.3 % of original grouped cases correctly classified

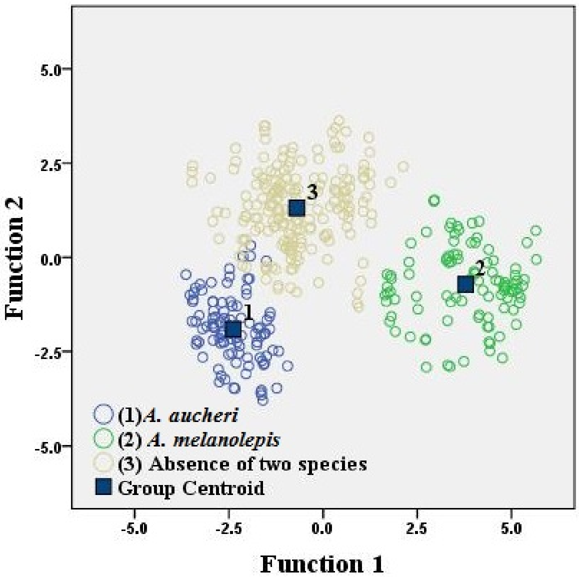


**Diagram 1)** Canonical discriminant functions in the presence and absence conditions of species

## Discussion

The study of the effective factors on the distribution of vegetation types can specify the relationships between vegetation and environmental factors; thereby, the optimized management of natural resources can be applied systematically to the corresponding planning [37], due to this fact that vegetation cover of each region is the resultant of its environmental gradients. Therefore, it can be concluded that a combination of environmental factors such as climate, soil, and topography affect the establishment of selected species. Comparing the selected ecological factors in the habitats of selected species and the location or absence of these species show that most of the variables except total canopy cover and bare soil had significant differences. According to the field data, *A. melanolepis* was found in sites with higher elevations, and *A. aucheri* had greater density in the lower elevations. Thus, it seems that these species' ecological requirements appear to be different and environmental characteristics of these species' distribution ranges will have different effects. The results of CDA introduce elevation, slope, and aspect as factors affecting the distribution of these two species. In many studies, the effects of topographic factors in species distribution were well documented [5, 8, 14]. Some studies [38, 39] reported that topographic variability plays a critical role in determining plant species distribution at the local scale.

On the other hand, other studies such as [40] reported that topographic factors were sometimes acting through soil microclimate or nutrient availability. Therefore, these environmental factors are important in detecting plant species distribution variations with spatial scale and providing insight into the environmental requirements of the species needed for successful ecological restoration and the establishment of plantations [41]. Because one key factor influencing the success of habitat restoration projects is introducing appropriate and adaptable species. Our study provides important informative support for planning ecological restoration in our study area.

Our findings show that percent of silt and sand have significant differences in habitats of *A. aucheri*, *A. melanolepis,* and habitats without these species, and both of these species prefer soils with sandy-loam texture. Soil texture can affect the erosion process, temperature, porosity, and other soil properties. Therefore, this parameter has an important role in species growth [42]. Various investigators [8, 43] in their studies showed that vegetation has a high relationship with those environmental factors that somehow play a role in the control of available water. Some studies [8, 13, 14, 17] proved that the soil texture (clay, silt, and sand) is one of the most important factors effective on species distribution.

In this study, organic matter was effective in the selected species distribution. Probably, this issue happened due to a large amount of litter in these habitats. *A. aucheri* and *A. melanolepis* prefer soil with 3.1% and 2.3% organic matter, respectively. Soil organic matter (SOM), a key component of soil-plant ecosystems, is closely associated with soil features and processes [44]. Soil organic matter within the rangeland system provides more nutrients for plant growth, which results in positive feedback as more plant biomass is likely to produce more soil organic matter [45]. Also, organic materials affect some of the physical, chemical, and biological properties of soil. Some of these properties, including soil structure, water holding capacity and available moisture, fertility, hydraulic conductivity, and improved mean weight diameters of aggregates, are also effective in species distribution [14, 45-47]. Some studies [14, 48, 49] showed that organic matter was one of the soil characteristics affecting the distribution of species.

The water-dispersible clay (WDC) of soil in the habitats of *A. melanolepis* was more than the habitats of *A. aucheri.* WDC shows soil resistance to erosion that a high level of this feature represents soil's erodibility [50]. Thus, the erodibility of soil in *A. melanolepis* habitats are more than the habitats of *A. aucheri*.

According to the results, electrical conductivity, pH, and total neutralizing value of soil were other effective factors in distributing *A. melanolepis* and *A. aucheri*. The effect of soil salinity and acidity on species distribution was well documented [7, 17, 47, 49] because of the low solubility of calcium carbonate, no adverse effect on species' growth. Calcium carbonate improves soil's physical properties, increasing soil surface resistance to erosion, and increasing water permeability [51]. Thus, regarding the higher amount of tatal neutrializing value in habitats of *A. aucheri* compared to other studied rangelands; infiltration and resistance to erosion in A. aucheri habitats are more than *A. melanolepis* habitats.

## Conclusion

Among the selected environmental variables, elevation, slope, aspect, and available potassium had a significant role in separating the habitats of selected species. According to the results of this study, *Artemisia melanolepis* is recommended in high altitude (above 3000m) with approximately 14 percent slope, lower available potassium (518ppm) and soil with sandy-loam texture and *Artemisia aucheri* in middle altitude (2100m) with approximately 25 percent slope, average available potassium (885ppm) and soil with sandy-loam texture for environmental reclamation programs in rangelands. Thus, details of this study can be useful in the optimal management of the rangelands.

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**Ethical Permissions:** The authors ensure that they have written entirely original works, and if the authors have used the work or words of others, they have been appropriately cited or quoted.

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