Classification and Determination of Indicator Environmental Properties in Western Iran Rangelands

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ABSTRACT

How soil characteristics affecting plant species density was investigated through the one-way ANOVA method in typical rangelands of Iran in Zagros Mountains region. All of present species were identified, studied, tagged and named. Four plant types were identified based on two-way indicator species analysis (TWINSPAN). Survey was done at two depths of soil (0-30 and ≥ 30 cm). In each plot canopy related factors were measured and to determine chemical and physical properties of soil, at primary and end points of each transect profiles were dug. For each profile eight factors at two depths were measured inclusive: soil texture, Organic matter, total nitrogen percent, absorbable phosphorus, absorbable potassium, Lime, pH and EC. Means of squares comparison showed that organic matter, phosphorus, potassium, EC, sand and lime were more effective on species density at two depths in such rangeland ecosystems.

Key words: Iran; plant density; rangeland; soil characteristics; Zagros.

INTRODUCTION

Rangeland could be defined as the land on which indigenous vegetation (climax or natural potential) is predominantly grass, grass-like plants, forbs, or shrubs that are grazed or have the potential to be grazed, and which is managed as a natural ecosystem for grazing livestock and wildlife habitat(Allen et al. 2011). Proper maintenance, management and utilization of rangelands vegetation, require scientific and comprehensive cognition. Lack of knowledge about vegetation and related density of these ecosystems, cause accurate planning impossible, although these factors are index of destruction, and soil and environmental changes due to time (Mirzaiee et al. 2007). Grace (1999) suggested that species density is controlled by the effects of disturbance, total community biomass, colonization, the species pool and spatial heterogeneity (Grace 1999). The distribution of plants was largely affected by a moisture gradient that was controlled by elevation, slope, soil texture, sand, and the speed of winter and summer wind. The nature of the soil surface in the form of boulders, stones, cobbles and surface gravel is one of the most important factors controlling moisture availability and subsequently the distribution of plant communities in the mountains (Dianati Tilaki et al. 2011).

We investigated the effect of some soil factors on plant density in one of typical and important rangelands of Iran. We hypothesized that soil can be more efficient on rangelands ecosystems. The selected area is protected so we could waiver other probable effective factors.

MATERIAL AND METHODS

Study site

The study site was 482 hectares of typical rangelands of western Iran in Zagros Mountains with elevation from 1854m to 2460 m, between 48° 23' 45.3'' – 48° 26' 26'' of geographical length and 33° 46' 37.2'' –33° 47' 41.4'' of geographical width (figure 1). The mean annual temperature was 14.6 °C. Annual precipitation has averaged 458.8 mm since measurements from 1989 until 2009 and daily average is 91.6 mm. More than half of the rain falls in between November until March. The dominant soils could be classified in 3 types: clay, silt-clay and lomy-clay. The average of pH is 7.8 and EC is 1 mmhos/cm so its soil is non-salin type. All herbaceous species present were cool season plants that utilize the C_3 photosynthetic pathway. Its climate is semi-arid and cold (Emberger 1930). A GIS layer mapping in Arc View (3.2) from digitized maps and aerial photographs taken in 2005 was created.
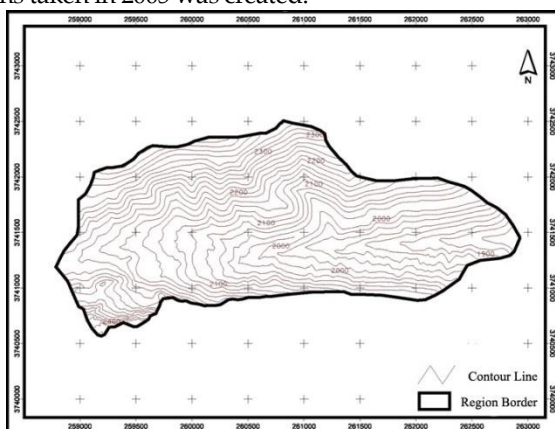

Figure 1 Hypsometric map of study site

Vegetation measurements

At first all of plant species in the area were specified and key area of each plant type were defined. Plant parameter measured was density. 16, 100-m transects, spaced random in each experimental unit. Density of species was determined by counting all rooted plants in 1 m^2 plots. Numbers of plots were 160 based on the minimum level method.

Soil study

32 soil samples at two depths of 0-30 and $\geq$ 30 cm (based on root depth of plant species) were collected from the beginning and the end of each transect. These samples were packed and labeled separately and were transported to laboratory. Then air-dried samples passed through a 2 mm sieve to remove stone, gravel, shavings and debris, and they were analyzed for texture by Bouyoucos hydrometric method (Bouyoucos 1962), soil organic material percent by Walkey and Black method (Walkley and Black 1934), total nitrogen percent by Kjeldahl method (Kjeldahl 1883), absorbable phosphorus by Olsen method (Olsen and Watanabe 1970) and with spectrophotometer, absorbable potassium by flame photometer, pH by pH meter, EC by electrical electric conductivity meter, and lime percent by calcimeter.

Data analysis

Classification was conducted with Two-Way Indicator Species Analysis (TWINSPAN) on a data matrix comprising 160 samples. All the default settings were used for TWINSPAN of the computer program PC-ORD for Windows version 4.17 (Mccune and Mefford 1999). Indicator species refer to the preferential species used by TWINSPAN to distinguish the sample groups. The stands are ordered first by divisive hierarchical clustering, and then the species are clustered based on the classification of stands. The TWINSPAN groups were subjected to ANOVA based on soil variables to find out whether there are significant variations among groups.

All data were analyzed by SPSS 17. Comparison of means of squares was performed by Duncan's multiple range tests. To test for the possibility that a significant effect of soil on plant density, we performed ANOVAs (analysis of variance). Significance of differences was tested by using a parametric F-statistics in ANOVA.

RESULTS AND DISCUSSION

a. Vegetation measurements

Based on the importance values of 8 species recorded in the 160 studied samples, TWINSPAN technique helped to distinguish four vegetation groups which each group have been named based on dominant species. A dendrogram is depicted in figure 2. The more eigenvalue the more separability, so overlapping between species was less.

Four plant types were determined and separated in study area as follows:

(1)*Agropyron libanoticum* H.- *Acantholimon bromifolium* B.:Distribution of this type was 20 hectare in north part of area. Soil texture of this type was clay. (2)*Hordeum glaucum* S. – *Taeniatherum crinitum* S.: This type area was 184 hectare in north part. Soil texture of this type was silt clay. (3)*Astragalus adscendens* B.& H. – *Agropyron trichophorum* L.: This type area was 138 hectare in south part. Soil texture of this type was clay. (4)*Astragalus adscendens – Daphne mucronata* R.: Distribution of this type was 140 hectare. Soil texture of this type was clay.
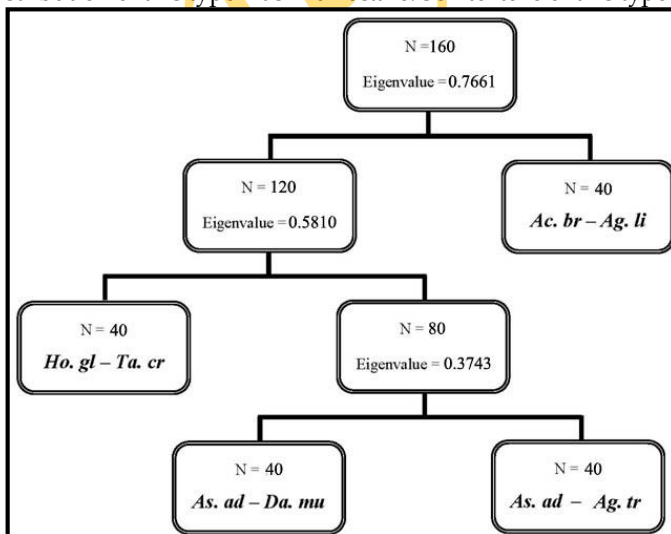

Figure 2 TWINSPAN classifications of the 160 samples in study area. For indicator species abbreviations, see Table 1

b. Effect of soil factors on species density

Because of mountainous condition and type of soil in the area, perennial plants have existed more than other types, these species were specific to semiarid areas. Density of them was affected by fertility elements (organic matter, nitrogen and potassium) and clay amount of soil, increasing of these factors caused increased studied plant density. Correlation between soil properties and density coefficients were assessed. Results of soil properties investigation between studied vegetation types, by one-way ANOVA showed that there are significant differences between soil properties of different types. Organic matter, phosphorus, potassium, EC, clay and sand percent, and lime in two depths are significantly different (P ≤ 0.01). Other information is available in Tables 2, 3 and 4. In this experiment *H. glaucum-T. crinitum* were abundant in silt clay soils and other studied plant types establish in clay soils. By Duncan's multiple range tests we can find that each soil factor in each vegetation type was different with another vegetation type. Same letters on columns showed that there is no significant difference between factors (tables 2 and 3). In middle rangelands of Taleghan the results have shown that, 28 plants species of 13 families are found in the study area, and the most density of them is related to *Geraminea* family. Also, because of mountainous condition, perennial plants with forbs life form were more than the others (Fahimipoor *et al.* 2010). In a research on seed treatment, between plant abundance there were differences which were due to differential responses of the seeds to heterogeneity. Heterogeneous environments were characterized by more species which reached greater abundances than homogeneous environments. However, there were some species that were abundant in both homogeneous and heterogeneous environments, particularly *Eleocharis ovata*, *Alisma triviale* and *Sparganium americanum* (Vivian-smith 1997). Total production of organic matter or consumption of carbon dioxide has been defined as ecosystem functioning (Hamiltin 2005). Where soil density increases significantly, it limits plant growth by physically restricting root growth. Severe compaction can limit roots to the upper soil layers, effectively cutting off access to the water and nutrients stored deeper in the soil. Near-surface roots, plant litter, and above-ground plant parts reduce the susceptibility to compaction by helping to cushion impacts. Vegetation also adds soil organic matter, which strengthens the soil, making it more resistant to compaction (USDA 2001). Organic matter level as an effective factor on species density was studied. The results showed that effects of organic matter on density of *Agropyron trichophorum-Acantholimon bromifolium* were more than the others. Clay soil of *A. adscendens-A. trichophorum* and *D. mucronata* had more nitrogen than *H. glaucum-T. crinitum* soil, density of *A. adscendens-A. trichophorum* affected more than other species from soil nitrogen. Salardini(2003) found that proper nitrogen permeation by rainfall is one of effective factors on high soil nitrogen level (Salardini 2003), our results consistent with this finding; the more density of *A. adscendens-A. trichophorum* and *A. adscendens-D. mucronata* region, the more maintenance of rainwater in soil, so nitrogen sedimentation will increase.

Another element which affected species density is potassium which its effect on *A. bromifolium-A. libanoticum* were more than other species. Najafitireshabankare (2008) showed that in Geno protected area, potassium had the most effect on separation of plant community (Najafi tireshabankare 2008). Lime influenced vegetation density too; its effect on *A. trichophorum* was more than other species. Moghimi (2005) revealed that habitat of *A. trichophorum* is calcareous region (Moghimi 2005). Pirisahragarad (2009) indicated that lime is an important property of soil in vegetation dispersion (Pirisahragarad 2009). Jafari *et al.*(2002) referred to this case (Jafari *et al.* 2002). According to these findings identification of soil factors is very necessary in determination of index environmental properties of each species, and reclamation and repair of rangelands.

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Table1 Species abbreviation of 4 ecological groups

species	Species abbreviation
Acantholimon bromifolium	Ac. br.
Agropyron libanoticum	Ag. li.
Hordeum glaucum	Ho. gl.
Taeniatherum crinitum	Ta. cr.
Astragalus adscendens	As. ad.
Daphne mucronata	Da mu.
Agropyron trichophorum	Ag. tr.

Table 2 Soil factors variation in vegetation types at first depth

Plant type \ soil factor	N	P	K	pH	EC	Clay	Silt	Sand	Lime
A. libanoticum A. bromifolium	0.18BC	24.02A	596.3A	7.88A	1.08B	50.87A	36.5B	12.62B	4.6D
H. glaucum T. crinitum	0.16C	13.6B	412.62C	7.78A	1.15AB	44.87B	40.62A	14.5B	8.9B
A. adscendens A. trichophorum	0.25A	22.17A	442.25B	7.81A	1.2A	47.12B	40A	12.87B	12.3A
A. adscendens D. mucronata	0.21B	14.95B	430.12BC	7.75A	1.91C	39.75C	40.87A	19.37A	6.9C

In each column same letters show that there are no significantly difference according to Duncan's multiple ranges

Table 3 Soil factors variation in vegetation types at second depth

Plant type \ soil factor	N	P	K	pH	EC	Clay	Silt	Sand	Lime
A. libanoticum A. bromifolium	0.13A	11.65A	391.12A	7.73AB	1.16A	58.12A	30C	11.87B	4.6D
H. glaucum T. crinitum	0.07A	2.72B	210B	7.68B	0.74C	64.75A	23D	12.25B	6.71C
A. adscendens A. trichophorum	0.09A	3.97B	175.12C	7.83A	0.99B	50.87C	36.25B	12.87B	11.96A
A. adscendens D. mucronata	0.18A	3.87B	202.37BC	7.75AB	0.75C	42.25D	39.87A	17.87A	9.18B

In each column same letters show that there are no significantly difference according to Duncan's multiple ranges

Table 4 One-Way ANOVA: soil factor effects

factor	Depth (cm)	MS Between groups (DF= -3)	MS Within groups (DF= -28)	Total (DF= -31)	F
Organic matter	0-30	9.734	6.422	16.156	14.147**
	>30	4.42	2.601	7.021	15.863**
Total nitrogen	0-30	0.035	0.023	0.058	14.158**
	>30	0.049	0.448	0.496	1.012*
Phosphorus	0-30	643.822	154.93	798.752	38.785**
	>30	403.701	317.257	720.958	11.876**
Potassium	0-30	172977.094	18758.125	191735.219	86.067**
	>30	234211.594	28679.625	262891.219	76.22**
pH	0-30	0.081	0.566	0.647	1.334*
	>30	0.093	0.306	0.4	2.848*
EC	0-30	0.375	0.215	0.59	16.303**
	>30	0.987	0.275	1.262	33.521**
Clay percent	0-30	519.094	346.125	865.219	13.997**
	>30	2243.25	356.75	2600	58.688**
Silt percent	0-30	99.25	182.75	282	5.069*
	>30	1318.094	220.375	1538.469	55.824**
Sand percent	0-30	235.594	96.625	332.219	22.757**
	>30	188.344	80.125	268.469	21.939**
Lime	0-30	254.823	81.559	336.382	29.161**
	>30	242.206	44.916	287.122	50.329**

**: significantly difference (P≤0.01)
*: significantly difference (P≤0.05)