**Determination of Indicator Species of Some Soil Characteristics by Ordination Method in Kooh -e- Namak Rangelands, Qom**

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**Introduction**

The vegetation structure is affected by different factors such as climate, topography, parent material and biological factors and special interactions between them. Soil and vegetation are two important elements of rangelands ecosystem that affect on biotic and abiotic factors. Therefore, identification of variations in rangeland ecosystem components, especially soil and plants are the most important tools for management of conservation, reclamation, improvement and utilization of rangelands. Hence, this research has been identified the indicator species in Qom dry rangelands as the most important tools in ecological management of these ecosystems.

**Materials and Methods**

The steppe and dry rangelands of Kooh -e- Namak in Qom province was selected in this research. The study area was 15077.2 ha in the northwest of Qom city between 50° 39’ 50” - 50° 52’ 24” E longitude and 34° 38’ 59” – 34° 48’ 15” N latitude. The study area was a plain region with north aspect, 1000-1100m elevation and <10% slope. The mean temperature and precipitation were 18.2°C and 143.2 mm respectively. The climate is arid based on Demarton system.

In this research, the provided slope, aspect and elevation layers based on topography map (1:50000) and the lithologic map (1:100000) were overlaid in GIS system by Arc GIS 9.3.1. The equal land units were determined in the study area and sampling was done by plotting in each land unit randomly. The plots sizes were determined based on canopy cover mean of the greatest species and the number of plots was determined by statistical method. The canopy cover percentage and topographic characteristics were recorded in each plot by GPS after plants identification. Then, Soil samples were taken from two depths (0–20 and 20–50 cm) in each plot based on mean root depth. The soil characteristics such as EC, pH, CaSO₄, CaCO₃, SAR and texture were determined in laboratory. The data analysis was carried out after normalization by logarithmic change. Then, the relations between soil parameters and plant species were obtained by Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA) techniques in Canoco for Win 4.0 software. The DCA analysis shows the plant ecological groups in the region and the CCA analysis investigates the effect of soil parameters on these groups. The meaning of correlation between the species and the soil parameters was obtained by Montcarlo test (with 99 frequencies) and the differences between soil parameters in the two depths were determined by T-test. Finally, the rate of each parameter in variations was calculated by Partial CCA analysis after the calculation of Trace and Total inertia in Trace/Total inertia *100 formula.
Results and Discussion

Nine units were identified in the study area. These units were similar in topography, climate and lithology conditions with different soil properties. The DCA analysis showed that four plant groups have formed in the region, as follows:

Group 1, shrubs: *Artemisia sieberi* Besser., *Acantholimon bracteatum* (Girard) Boiss., *Astragalus gossypinus* Fisch


Group 3: *Stipagrostis plumosa* L.

Group 4: *Tamarix passerinoides* Del. Ex Desv.

The CCA analysis showed that EC had the higher value in Axis 1 and sand and SAR had the next high amounts. This showed that Axis 1 is correlated to soil salinity. Axis 2 had the highest amount of clay, silt and pH in subsoil. This shows that it is affected by texture and acidity. The species distribution in the CCA diagram (figure 1) most likely influenced how the species were categorized into the four distinct groups, which is revealed by DCA. Regarding the species reaction to the different factors based on their position in the landscape, the results showed that: Group 1, shrubs, is indicative of clay and silt effect, not sand and pH; Group 2, invaders, is closest to the origin, indicating that it is moderately influenced by all soil components but it has low correlation with chalk, pH, EC, SAR and sand; Group 3, *Stipagrostis plumosa*, are normally found in places with higher sand; Group 4, *Tamarix passerinoides*, tend to occur on higher EC places and sandy soils. The T-test analysis showed that there are no meaningful differences between soil properties in the two soil layers.

![Plant species distribution to soil parameters in CCA analysis](image)

Results of partial CCA (table 1) showed that 77.64% of rangeland composition variations were explainable by the soil parameters. Among these, 24.17% belonged to salinity, 22.14% to texture components, 8.35% to acidity, 7.74% to lime, 5% to chalk and 10.38% to common effects of all soil parameters.
Table 1: Percentage of soil parameters that explain rangeland species composition in partial CCA analysis

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Trace (variance)</th>
<th>Total inertia</th>
<th>Percent of explained variation (trace/total inertia × 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity</td>
<td>0.546</td>
<td>2.259</td>
<td>24.171</td>
</tr>
<tr>
<td>Texture</td>
<td>0.500</td>
<td>2.259</td>
<td>22.142</td>
</tr>
<tr>
<td>Acidity</td>
<td>0.188</td>
<td>2.259</td>
<td>8.350</td>
</tr>
<tr>
<td>Lime</td>
<td>0.174</td>
<td>2.259</td>
<td>7.741</td>
</tr>
<tr>
<td>Chalk</td>
<td>0.112</td>
<td>2.259</td>
<td>5</td>
</tr>
<tr>
<td>Common effect</td>
<td>0.234</td>
<td>2.259</td>
<td>10.383</td>
</tr>
<tr>
<td>Total</td>
<td>1.754</td>
<td>2.259</td>
<td>77.644</td>
</tr>
</tbody>
</table>

Conclusion
This research showed that there is a special relation between soil properties and plant distribution in the Kooh -e- Namak rangelands. Soil texture, salinity, and acidity had a great role in plant ecological group's formation and lime and chalk had a minor effect. The effect of soil texture on plant composition is due to the effect of soil moisture that changes soil formation and aeration. *Stipagrostis plumose* had the most impressibility to soil texture and increased in sandy soils. These species have been determined as sandy soils indicator, because of the compatibility to moisture shortage in light soil textures. *Tamarix passerinoides* have been distinguished as halophyte species. We need to notice its capabilities for improvement plans in saline soils. Thus, soil salinity and texture are two determinant factors for the species in this area as a typical dry land in Iran.

The shrubs group had a negative reaction to soil sand and salinity as an ecological group. This shows that their habitat is places without the aforementioned limitations. The invader species in degraded zones did not have a clear reaction to edaphic parameters and appeared as a separate ecological group. The absence of distinct relationships between this group and abiotic factors is attributed to the effect of intensive grazing (human factor) as has been impressed by other environmental factors. This has rearranged the ecological balance in these sections and caused the invader species become abundant in these landscapes, irrespective of local ecological conditions.

The analysis of partial variance showed that soil factors (~78%) explain much of the total variance related to ecological groups' location in the landscape. Also, the soil texture and salinity were distinguished as two important factors in ecological group's formation (~46% changes). We assumed that the remaining variation arose from biotic factors (especially grazing). Although grazing was not considered as a variable in these analyses, the effect of grazing on plant composition and soil properties in the landscape is undeniable. This grazing effect appears to account for the appearance of Group 2, invader species.

Key words
Soil, Indicator species, Ordination, Dry regions, Qom