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Altitude and soil properties affected grassland and weed distribution

Elham Abbasvand, Sirous Hassannejad*, Jalil Shafagh-Kolvanagh, Saied Zehtab Salmasi

Department of Plant Eco-Physiology, University of Tabriz, Iran

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Abstract

Altitude and soil properties can influence vegetation community and their density in rangelands. Knowing the relationships between plant species distribution with environmental factors would allow choosing the best strategy for the moderate of plants. The aim of this study was to investigate the correlation between plant species density with altitude and soil parameters in Khalatposhan rangeland in Tabriz-Iran. For this reason, grids of 20 m x 40 m were established in this rangeland, and soil samples were collected at the intersection points for physical and chemical analysis, also altitude for this points was measured by GPS. The canonical correspondence analysis (CCA) used for assesses the effects of some soil factors and altitude on grassland species and weeds distribution. Results showed that altitude as an environmental factor and pH, electrical conductivity, phosphorus and potassium as soil factors had the most effect on grassland plants and weeds distributions. *Lepidium vesicarium* L. had the most correlation with altitude. In contrast, increasing of altitude was caused that the density of some species likes A*lyssum dasycarpum* stapf and *Rochelia macrocalyx* Bge. reduced. Increasing of nitrogen and organic material led to increasing of some plants density likes *Allium ampeloprasum* L., *Astragalus* (*Tragacantha*) *parrowianus*, *Chenopodium album* L. and *Salsola kali* L. subsp. Tragus (L.) Nyman, but, density of *Lolium rigidum* Gaudin declined in these conditions. As a result of this study CCA analysis is necessary to find relationships between environmental factors and weed species distribution.

***Corresponding Author:** Sirous Hassannejad ✉ sirous_hasannejad@yahoo.com

Introduction

Weed is not distributed uniformly along the ground, and the spatial variability of the infestation is observed, with stains or thick woods formations (Izquierdo *et al*., 2009; Iwara *et al*., 2011). The physical, chemical and biological soil properties also present spatial variability, assuming similar values to short distances and different values as the distance between observations increases. The spatial variability that soil properties and weed present occurs due to several factors, among which are: topography, structure and type of soil, groundwater characteristics, microclimate and management practices (Lousada *et al*. 2013). In recent years, many scientific efforts and economic resources have been spent on measuring the spatial variability of crop yield and for the distribution of weeds or soil nutrients, with the aim of minimizing pesticide use and optimizing crop yield (NRC, 1999).

Plants like animals and humans alike are attracted to locations where the site conditions are favorable to them, which suggest that differences in the distribution and abundance of plant species in any environment are an indication of the variation in soil properties (Graham*et al*. 2005; Engler and Guisan 2009). A sound understanding of soil properties and their relationships with flora distribution is believed to be highly essential for integrated and sustainable flora management programs (Udoh *et al*. 2007). Several studies have, however, emphasized the influence of varying soil properties on the distribution and abundance of flora species in different locations (Udoh *et al*. 2007; Zare *et al*.2011; Cannone *et al*. 2008).

Environmental factors that affectplant growth include light, temperature,water, humidity and nutrition (soil fertility). However, understanding the relationship between certain soil properties and specific flora species would act as a guide to farmers, horticulturists and land use planners alike to recognize the likely soil conditions that are suitable for a particular purpose. Thus, the aim of this research was assessments of soil and environmental factors and grassland and weeds distributions by CCA analysis.

Materials and methods

Survey of area and Data sampling

Khalatposhan rangeland is located at 8 km of Tabriz-Basmenj road in Tabriz-Iran. Grids of 20 m × 40 m were established in the areas, soil samples were collected at the intersection points for physical and chemical analysis, and also plant species were identified, counted, and recorded in plots (0.5 m × 0. 5 m) for subsequent data entry and analysis. In each plot, altitude was measured by GPS. The collected specimens were cataloged, pressed, and identified with the help of flora Iranica (Rechinger 1963–2007) and Turkey (Davis 1965–85).

Soil analysis

A mixed soil sample was collected from each plot (0.5 m × 0. 5 m) at the intersection points of grids of 20 m × 40 m as a profile of 0-30 cm below the ground surface. Soil texture (sand, silt and clay percentages), pH, electrical conductivity, organic materials, carbonate calcium equivalent, Nitrogen, Phosphorus, Potassium were determined.

Multivariate analysis

Canonical Correspondence Analysis (CCA) as one of the main ordination methods was done considering the presence and/or absence of 100 plant species using CANOCO v. 4.5 (Plant Research International, Wageningen, The Netherlands). The relationship between the vegetation, altitude, and soil gradients was assessed using the ordination diagram of CCA (Ter Braak and Smilauer 1998).

Results and discussion

The results of CCA vegetation observed in Khalatposhan-Tabriz clearly showed the relationships between plant species, altitude and soil factors. The first two CCA axes explained 35% of the variation in plant species distribution. In this analysis first axis had positively correlation with altitude (0.63%), pH (0.45%), organic material (0.15%), nitrogen (0.15%) and sand (0.06). In contrast, this axes with electrical conductivity (0.48%), carbonate calcium equivalent (0.23%), phosphorus (0.34%), potassium (0.04%),

silt (0.02%) and clay (0.28%) of soil had negative correlation (Tab. 1). The second axis had also positive correlation with altitude, pH, electrical conductivity, carbonate calcium equivalent, silt and clay (0.03, 0.08, 0.22, 0.26, 0.21 and 0.13, respectively), and with organic material, nitrogen, phosphorus, potassium and sand (0.36, 0.36, 0.45, 0.48 and 0.22 %, respectively) had negative correlation (Tab. 2). As a result of data analysis, altitude as an environmental factor and pH, electrical conductivity, phosphorus and potassium as soil factors had the most effect on pasture plants and weeds distributions.

Table 1. CCA analysis of soil characteristics (organic material; soil texture; essential elements like N, P,K; electrical conductivity; carbonate calcium equivalent and altitude) on grassland and weed distributions of Khalatposhan-Tabriz.

	Frist axis	Second axis	Third axis
Eigenvalues	0.536	0.416	0.324
Correlation of species with environmental	0.985	0.961	0.876
Cumulative percentage of species distribution	8.6	15.2	20.3
Cumulative percentage of relationship between species distribution and environment	19.8	35.1	47.1

Table 2. Correlation of three axes of CCA analysis on soil characteristics (organic material; soil texture; essential elements like N, P, K; electrical conductivity; carbonate calcium equivalent and altitude) on grassland and weed distributions of Khalatposhan-Tabriz.

Environmental factors	First axis	Second axis	Third axis
Altitude	0.63	0.03	0.13
pH	0.45	0.08	-0.53
Electrical conductivity	-0.48	0.22	0.26
Organic material	0.15	-0.36	-0.06
Carbonate calcium equivalent	-0.23	0.26	-0.04
Total N	0.15	-0.36	-0.06
P	-0.34	-0.45	-0.36
K	-0.04	-0.48	-0.06
Sand	0.06	-0.22	0.21
Silt	-0.02	0.21	-0.07
Clay	-0.28	0.13	-0.41

Between various factors (soil and altitude) in this study, organic material and nitrogen in soil had 100% correlation with each other's, as the axes of these factors were coincident on together. Followed by this correlation, the amount of clay with electrical conductivity and also the amount of sand with organic material and nitrogen had maximum correlation with each other's (Fig. 1).

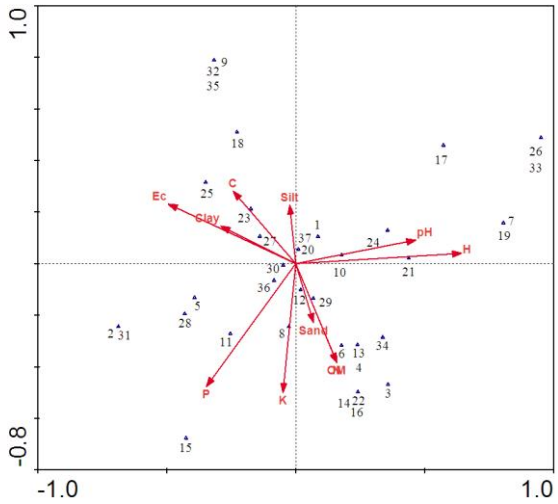

Fig. 1. CCA analysis of grassland and weed distribution of Khalatposhan-Tabriz. Correlation of three axes of CCA analysis on soil characteristics (organic material; soil texture; essential elements like N, P, K; electrical conductivity; carbonate calcium equivalent and altitude).

Relationships between plant species was showed that *Koelpinia linearis* Pall (code 20), *Salvia nemerosa* L. (code 30) and *Trigonella fischeriana* Ser. (code 37) that were near the origin of coordinates had approximately relationship with the most studied factors. *Lepidium vesicarium* L. (code 21) had the most correlation with altitude. In contrast, increasing of altitude was caused that the density of some species likes *Alyssum dasycarpum* stapf (code 5) and *Rochelia macrocalyx* Bge. (code 28) reduced. *Bromus arvensis* L. (code 8), *Bromos sterilis* L. (code 10) and *Muscari tenuiflorum*Tausch (code 23) had maximum correlation with potassium, pH and carbonate calcium equivalent, respectively. Increasing of nitrogen and organic material led to increasing of

some plants density likes *Allium ampeloprasum* L., *Astragalus* (*Tragacantha*) *parrowianus*, *Chenopodium album* L. and *Salsola kali* L. subsp. *Tragus* (L.) Nyman (cods 4, 6, 13 and 29, respectively), but, density of *Lolium rigidum* Gaudin (code 18) declined in this conditions (Fig. 1).

This research showed that soil parameters and altitude had effects on weeds or pasture plants in Khalatposhan rangeland. Similar relationships of species richness to altitude as found in this study were reported by Begon *et al.* (1990) and Pysek *et al.* (2002). Other recent investigations showed that vegetation community from place to place over time are dependent upon soil factors of the site and the regional climatic condition (Andreasen and Skovgaard 2009; Pinke *et al.* 2012; Gomaa 2012; Hassannejad and Porheidarghafarbi 2013). Soil texture may affect soil or productivity via influence on the soil water holding capacity, infiltration rate, moisture availability for plants and consequently plant nutrition (Sperry and Hacke 2002).

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