Study of Soil- Grass Species Relationship as a Pattern for Grasslands Rehabilitation, a Case Study from Iran

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***Abstract*—**The distribution of grasses under soil properties effects was examined in Zereshkin rangelands, in north of Iran. Six vegetation types were recognized in the study area. The research was conducted within vegetative types. Canopy cover percentage of plants in different types was estimated based on randomized – systematic vegetation sampling procedure within 1 m2 quadrats. Four transects each including 15 m2 quadrats were established for canopy cover percentage estimation in each type. Soil sampling was performed from 0-30 and 30-60 cm depths at the starting and end points of each transect. Texture, gravel percentage, pH, Ec, OM, N, CO32-, and HCO32- of soil samples in addition to slope, aspect and elevation of quadrats were considered to test their relation with distribution of vegetation using multivariate analysis (PCA technique). The results showed that separation of understudy types was mainly affected by texture, gravel percentage, N, OM, pH, and Ec. Slope, aspect and elevation showed non – significant relationships with plants of the study area.

***Keywords*—** Grass species, Soil properties, rehabilitation, Iran.

I. Introduction

INTEREST in how various landscape components affect biotic and abiotic resources has grown over the past 2-3 decades (Brosofske et al, 2001). The distribution and abundance of range species has been correlated with a variety of complex environmental gradients. Environmental factors affect range plant growth and need to be understood and considered by rangeland managers. Plant growth and development are controlled by internal regulators, which are modified according to environmental conditions (Manske, 1997). Of the most ecologically important environmental factors affecting rangeland plants growth and distribution are topography (slope, aspect, and elevation) and soil properties (Jafari et al, 2003). Environmental factors effects on vegetation could be considered as a main ecological subject during last recent decades.

Runkle and Whitney (1987) studied vegetation-site relationships in the Lake Katherine State Nature Preserve, Ohio. The results of Neave et al (1994) research on vegetation – site factors relationships in southern coast of New South Wales suggested that soil chemical properties is the main reason of vegetation changes. Zare (1998) showed that slope, aspect, saturation moisture percentage and soil depth had the most effective role in the yield of plant species in Kavir-e-Phino rangelands in Iran. de Blois et al (2002) investigated factors affecting plant species distribution in hedgerows of southern Quebec.

Abd El-Ghani and Amer (2003) examined soil – vegetation relationships in Egypt using ordination techniques. Application of CCA indicated that soil surface sediment, CaCO3, soil saturation, pH and organic matter are the main operating edaphic gradients in the study area.

The effect of environmental variables on the structure of woody vegetation within one geomorphological unit (500 ha) in Niokolo Koba National Park in Senegal was investigated by Hejcmanova¯-Ne”erkova´ and Hejcman (2006). The results demonstrated that soil type and topography were the main factors affecting woody vegetation of the locality.

Pueyo and Alados (2007) studied abiotic factors determining vegetation patterns in a semi-arid Mediterranean landscape. They found that gypsum substrate determines strongly the plant community patterns in a semi-arid Mediterranean landscape, as it can be observed by the strong response of gypsophile vegetation to the relaxation of the rigors of gypsum soils with topography.

In this study, we examined the effects of two major factors, soil and topography, on grassland composition in Zereshkin rangeland, north of Iran to find a relationship between environmental factors and grass species in order to apply these relations when a reclamation plan is going to be accomplished in similar grasslands.

II. Materials And Methods

Based on field surveys, six vegetation types (including grass types) were identified at the study area. Fifteen 1 m2 quadrats with 50 m distance from each other were established along each of four 200 m transects. Vegetative sampling method was randomized – systematic. Floristic composition and canopy cover percentage related to each quadrat was recorded. To examine the relationship of topography to vegetation, the data related to aspect, slope, and elevation of quadrats was recorded, too.

Soil samples were taken at the initiating and end points of each transect. Samples were gathered from 0-30 and 30-60 cm layers. Samples were air-dried at laboratory and passed through a 2 mm sieve to get ride of gravel and boulders. The

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weight of gravel in each sample was determined and expressed as a percentage of the total weight of the soil sample. The portion finer than 2mm was kept for physico-chemical analysis. Soil texture was determined by the hydrometer analysis (Bouyoucos, 1962), and the results were used to calculate the percentage of sand, clay and silt. Soil reaction (pH) and electric conductivity (EC) were evaluated in 1:5 soil – water extract using pH- meter and electric conductivity meter, respectively. Walkey and Black titration method (Black, 1979) was used to determine organic matter (OM) content and Kjeldhal method for estimation of N. Soluble carbonate and bicarbonate determined by titration with H2SO using methylorange and phenolphetalein, respectively.

Data matrix of environmental factors and vegetation types was made. The windows of PC-ORD (McCune and Mefford, 1997) was used for ordination of vegetation types in gradient of site factors. Data were analyzed by principal component analysis (PCA). PCA is the ordination technique that constructs the theoretical variable that minimizes the total residual sum of squares after fitting straight lines to the species data. PCA does so by choosing best values for the sites.

III. Results And Discussion

Surveys showed that among 6 grassy vegetation types, *Festuca ovina-Bromus tomentellus-Dactylis glomerata* has the largest area while *Bromus tomentellus-Poa bulbosa* is the smallest one. The most and least cover percentage is related to *Dactylis glomerata-Brachypodium pinatum-Poa* sp. and *Festuca ovina-Bromus tomentellus-Dactylis glomerata* , respectively. We recorded different species from 16 families in the study area. The most abundant families were Gramineae (53%), Compositae (18%) and Leguminosae(11%). *Festuca ovina, Bromus tomentellus* and *Dactylis glomerata* were the most abundant species in Zereshkin rangeland.

PCA results demonstrate that 44.39% and 28.52% of variance is accounted by the first and second principal components (PC1 and PC2), respectively. PC1 and PC2 together accounted for approximately 73% of the total variance in data set. The overriding factors of PC1 are gravel percentage, Ec, N, and OC in the first soil layer (0-30 cm) and gravel percentage, clay, silt, N, and OC in the second layer (30-60 cm). PCA_2 is correlated to pH, sand and clay at depth 0-30 cm and sand at depth 30-60 cm. According to the correlations between site factors and components, it seems that PC1 represents soil characteristics of salinity and nutrient while PC2 is related to texture and pH properties.

Fig 1 shows the distribution of vegetative types of Zereshkin rangeland defined by the first two axes of the PCA. As it is shown in Fig 1, the location of types in four quarters is different. The distance between the indicator points of the vegetation types on the diagram shows the degree of similarity and dissimilarity of types in the environmental factors. In axis 1, the coefficients of all factors except to gravel percentage of depths 0-30 and 30-60 cm are negative, thus those types located in quarter 1, have inverse relationship with PC1 factors except for gravel percentage and vice versa. In axis 2, coefficients of all factors except to clay of second layer are positive. Therefore, those types that are lying in the third quarter have inverse relationships with axis 2 factors except to clay of 0-30 cm.

As it is observed in Fig. 1, Da.gl-Bra.pin-Po.sp. type is relatively equally affected by PC1 and PC2. Since this type has been located in positive side of axes 1 and 2, therefore, it has a positive tendency to soils with heavy texture including high gravel percentage on top and relatively alkaline condition. The distribution of this type is inversely influenced by nitrogen percentage and EC of soil samples, that is, an increase in N and EC of soil leads to decrease of mentioned type occurrence in the study area.

Da.gl-Br.to-Bra.pin is equally affected by axes 1 and 2, too. This type lies in the fourth quarter, so one can conclude that this type has a direct relationship with gravel percentage, heavy texture and low acidity. In relation to Br.to-Po.bu, this type shows noticeable positive correlation with N and OC, while it is suggested that its relationship with clay percentage is negative. Since Fe.ov-Br.to-On.co is in left side of axis 1, hence is positively correlated with EC and percentage of N and OC of soil samples, but shows an inverse relationship with gravel percentage and heavy texture. According to the position of Fe.ov-Br.to-Da.gl in the fourth quarter, it is clear that this type is strongly affected by percentage of clay. Decrease of pH causes an increase in occurrence of plants belonging to mentioned type. Like Br.to-Po.bu, the type of Fe.ov-Br.to is located in left side of axis 1 but comparison of vector length of two types dedicates that effect of PC1 on the presence of Br.to-Po.bu is more significant. This means that presence of Fe.ov-Br.to is correlated with PC1 associated with PC2.

In accordance with Traore´ (1997), we selected soil and topography as the main factors influencing vegetation pattern in the Zereshkin rangeland. This is not in compliance with Lawesson's (1997) study of woody vegetation in Senegal that ascribes vegetation patterns to climatic factors. Results of similar studies are evidently scale dependent because a climate gradient can hardly exist in the relatively small study area.

Results showed that different vegetation types show different relationships with understudy soil characteristics while no relationship was recognized between topography and vegetation types. According to small area of the study area (2650 ha), topography changes is very tiny (aspect is steady, elevation ranges between 2050 and 2850 m a.s.l., and slope 21%), therefore no huge relationship was considered between topography and vegetation. It seems that the most effective factors on the occurrence and separation of vegetation in Zereshkin could be texture, N, and OC. Soil texture controls distribution of plants by affecting moisture availability, ventilation and distribution of plant roots (Jafari et. al 2004).The role of soil moisture, as a key element in the distribution of plants is described by Zohary and Orshan (1949) and El-Sheikh and Yousef (1981).

Soil organic carbon is an important determinant of soil fertility because of its impact on ion exchange capacities and its near – stoichiometric relationship to nitrogen. The magnitude of soil organic carbon pool and its rate of replenishment are determined in part by the rate that CO2 is incorporated into plant tissues by photosynthesis or net primary production followed by the addition of plant and animal residue into the soil, or direct carbon input to soil from plant roots (Tieszen et al, 2004). According to high cover percentage of different types and existence of livestock during grazing season, N and OC of study area soil is large which in turn, causes a noticeable positive correlation between most vegetation types and mentioned soil characteristics. On the other hand, the majority of study area plant species is comprised of gramineae which despite legumes are not able to fix nitrogen, hence are soil N dependence and show positive relationship with soil N.

IV. Conclusion

Our data suggest that the grass species of the Zereshkin rangeland is determined primarily by soil texture and nutrient properties. Therefore, when reclamation of similar grassland (in view point of soil properties) is needed, application of grasses like Festuca ovina,Bromus tomentellus and Dactylis glomerata is suggested to have a successful result.

References

[1] Abd El-Ghani, M. M., and Amer, W.M. , (2003). Soil-vegetation relationships in a coastal desert plain of southern Sinia, Egypt. Journal of Arid Environments 55: 607-628. http://dx.doi.org/10.1016/S0140-1963(02)00318-X

[2] Brosofske, K.D., Chen, J. and Crow, T.R., (2001). Understory vegetation and site factors: Implications for a managed Wisconsin landscape. Forest Ecology and Management 146: 75-87. http://dx.doi.org/10.1016/S0378-1127(00)00447-3

[3] de Blois, S., Domon, G. and Bouchard, A., (2002). Factors affecting plant species distribution in hedgerows of southern Quebec. Biological Conservation 105: 355– 367. http://dx.doi.org/10.1016/S0006-3207(01)00219-1

[4] El-Sheikh, A.M., and Yousef, M.M., (1981). Halophytic and xerophytic vegetation near Al-Kharg springs. Journal of Colloid Science University Riyadh 12 (1): 5-12.

[5] Hejcmanova-Ne”erkova, P., and Hejcman, M., (2006). A canonical correspondence analysis (CCA) of the vegetation–environment relationships in Sudanese savannah, Senegal. South African Journal of Botany 72: 256 – 262. http://dx.doi.org/10.1016/j.sajb.2005.09.002

[6] Jafari, M., Zare Chahouki, M.A., Tavili, A., Azarnivand, H. and Zahedi Amiri, Gh., (2004). effective environmental factors in the distribution of vegetation types in Poshtkouh rangelands of Yazd province (Iran). Journal of Arid Environment 56:627-641.

[7] Lawesson, J.E., (1997). Effects of species partition on explanatory variables in direct gradient analysis—a case study from Senegal. Journal of Vegetation Science 8: 409– 414. http://dx.doi.org/10.2307/3237332

[8] Manske, L.L., (1997). Effects from environmental factors of light, temperature, and precipitation on range plants in the Dickinson, North Dakota, region. NDSU Dickinson Research Extension Center. Range Research Report DREC 97-1015 (Compressed). Dickinson, ND. 22p.

[9] McCune, B., and Mefford, M.J., (1997). PC_ORD. Multivariate Analysis of Ecological Data Version 3.0. MjM software design. Glenden Beach, OR.

[10] Neave, I. A., Davey, S.M., Russell, S.M., Smith, J.J., and Florence, R.G., (1994). The relationships between vegetation patterns and environment on the south coast of New South Wales. Journal of Forest Ecology and Management 72: 71-80. http://dx.doi.org/10.1016/0378-1127(94)03410-X

[11] Pueyo, Y., and Alados, C.L., (2007). Abiotic factors determining vegetation patterns in a semi-arid Mediterranean landscape: Different responses on gypsum and non-gypsum substrates. Journal of Arid Environments 69: 490–505. http://dx.doi.org/10.1016/j.jaridenv.2006.10.008

[12] Runkle, J.R. and Whitney, G.G., (1987). Vegetation-site relationships in the Lake Katherine State Nature Preserve, Ohio: A northern outlier of the mixed mesophytic forest. Ohio Journal of Science 87: 36-40.

[13] -Tieszen, L.L., Tappan, G.G., and Toure, A. (2004). Sequestration of carbon in soil organic matter in Senegal: An overview. Journal of Arid Environments 59: 409-425. http://dx.doi.org/10.1016/j.jaridenv.2004.04.002

[14] - Traore´, S.A., (1997). Analyse de la flore ligneuse et de la ve´ge´tation de la zone Simenti (Parc National du Niokolo Koba), Se´ne´gal Oriental. The`se de doctorat du 3e`me cycle, ISE UCAD, p 136.

[15] - Zare, A., (1998). Survey of relationships between topography, soil and vegetation in Kavir-e-Phino rangelands of Hormozgan province in Iran. MSc. Thesis, Natural Resources College of Gorgan University (In Persian).

[16] - Zohary, M., and Orshan, G., (1949). Structure and ecology of the vegetation in the dead Sea region of Palestine. Palestine Journal of Botany 4: 177-206.

[17] W. D. Doyle, “Magnetization reversal in films with biaxial anisotropy,” in *1987 Proc. INTERMAG Conf.*, pp. 2.2-1–2.2-6.

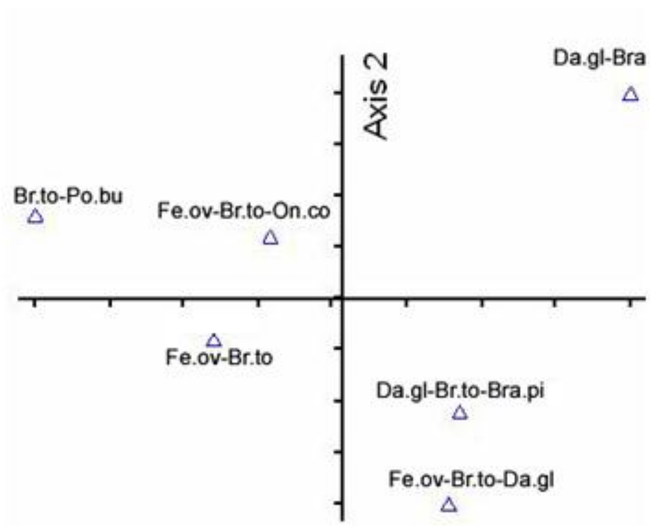

Fig 1- Distribution of Zereshkin rangeland types defined by the first two axes of PCA