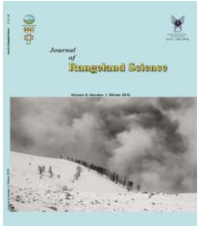
Contents available at ISC and SID

Journal homepage: www.rangeland.ir



Research and Full Length Article:

Variation of Plant Functional Groups along Livestock Grazing Gradient in Semi-steppe Rangelands (Case Study: Tangsayad Rangelands of Chaharmahal Bakhtiari Province, Iran)

Elham Bani Hashemi[A*], Pejman Tahmasebi Kohyani [B], Esmaeil Asadi[B]
[A]Graduated in M.Sc. of Rangeland Management, Shahrekord University, Iran *(Corresponding Author),
Email: banihashemi.elham.m71@gmail.com
[B]Associate Professor of Rangeland Management Department, Shahrekord University, Iran

Received on: 02/02/2017
Accepted on: 28/05/2017

Abstract. Assessment and monitoring of rangeland in different grazing managements seems necessary to manage rangelands. The plant functional groups can be used as appropriate responders for rangelands condition and management. Therefore, this study was performed and aimed to determine the most important traits that are influenced by rangeland variation and management. In order to this, three areas along a grazing gradient including national parks, protected area and free grazing were selected in Tangsayad rangelands of Chaharmahal Bakhtiari Province, Iran in 2015. A 100 m transect was established randomly in each site and within it five plots of 4 m^2 area at 20 m intervals along transects were determined systematically. Plant species were identified and vegetation cover was recorded in each plot. The number and size of plots and transects were determined regarding to semi-arid rangeland sampling guidelines as well as the dimension of dominant plant species in plant community. Finally, some traits as leaf dimension, plant biomass and cover of species were measured. The results showed that the traits such as leaf length, leaf width, leaf area and leaf weight, grass growth forms and life forms of Hemicryptophyes and Geophytes had significant differences at least in one of three grazing managements sites (P<0/05). Also Principal Component Analyses (PCA) showed that traits as yield, overall weight of plants and perennial plants had high correlation with the first component and the traits such as leaf length, leaf width, leaf area, Hemicryptophyes had also high correlation with the second component. In general conclusion; leaf traits as leaf length, leaf width, leaf area and leaf weight, grass growth form, Hemicryptophytes and Geophytes life forms were introduced as good indicators for assessing and monitoring of grazing management.

Key words: Plant traits, Grazing managements, Growth forms, Tangsayad

Introduction

Rangeland ecosystems are composed of biotic (plants and animals) and abiotic (topography, soils, climate) components, which awareness of them has important role in the ecological management of rangelands. Vegetation as one of the most important element of terrestrial ecosystems appears in form of plant communities under influence of various environmental factors. Survey the relationship between plant communities and environmental elements possess a certain complexity (Jongman *et al.*, 1995). In addition, distribution of vegetation in mountain landscapes is characterized by spatially heterogeneous conditions including of climate, soil and geology as well as grazing management (Sheidai Karkaj *et al.*, 2012). The information of vegetation cover can be used for solving ecological issues such as ecological protection and management of natural resources (Mesdaghi, 2001). Especially in arid and semiarid areas; the role of grazers in changing composition of the plant communities has caused particular attention to the interaction between animals and plants (Tahmasebi Kohyani *et al*., 2011; Takehiro *et al*., 2011). Understanding the role of grazing in the rangelands vegetation is essential to make rational decisions on proper range management practices, as such particularly in the case of arid and semi-arid rangelands where rainfall is the most important limiting environmental factor (Sharafatmand rad *et al*., 2014).

Functional traits provide an appropriate framework in predicting ecosystem responses against humans induced changes (Lavorel and Garnier, 2002). Thus using functional traits, the functional groups of vegetation are often determined to overcome the limitations of taxonomic descriptions and summarize the species complexity in describing patterns of plant communities processes (Walker, 1992). Currently plants are categorized into the plant functional types (a group of plant species having the same characteristics that response to environmental factors similarly as well as have the same roles and impacts in an ecosystem) (Grime, 2001; McIntyre *et al*., 1999). For example, plant species that have short growth period or do similar photosynthesis pathway all are classified in a unique plant functional group. All annual plants regarding to the fact that they have the same life period, are grouped in the same plant functional type and probably response similarly to the biotic and abiotic factors (But this case may not consistent in different palatability levels of species) (Suding *et al*., 2008).

Understanding vegetation response to various grazing intensities is important to conserve natural resources and also facilitate the ecosystem management (Hoshino *et al*., 2009). Defining the all of functional traits is time and cost-consuming, therefore only some specific ecological indicators are used to assess these characteristics (Pyke *et al*., 2002). According to the previous studies, plant traits are largely influenced by livestock grazing intensity and climate changes so the traits having the most variation along gradients are used as indicators in different rangelands (Nikan *et al*., 2010; Meng *et al*., 2009). In this regard, Khosravi Mashizi and Heshamti (2011) in a study at summer shrub lands of Kerman province in Iran have reported; that vegetation composition have changed drastically as well as the palatable and permanent species were replaced by non-palatable species such as annual and perennial forbs but by getting away from watering points along the grazing gradient, the perennial and palatable species have increased. Also Xia *et al*. (2009) examined the effects of grazing on species diversity and biomass of desert grassland in New Mexico. They believe that grazing leads changing plant community’s structure in grasslands and variation level depends strongly on grazing intensity and amount of grassland biomass. They found that grazing by goats in this grassland reduces the grass cover and species diversity. Klimesova *et al*. (2008) used the Plant Functional Types (PFT) to predict the effect of grazing management in different areas. Their result showed that some of the characteristics were more appropriate for certain regions. For example the plant height, lateral spread, shoot number and persistency was introduced as the best attributes for predicting the response of species against grasslands management in temperate grasslands of Europe. Zhao *et al*. (2007), in a study on the effects of grazing gradient on vegetation of North China concluded that heavy grazing not only impacts on palatable forage, but also the structure and distribution pattern of dominant species are changed too.

In summary the literature shows that any trait subsets are not distinguished yet which show the more of variation in livestock grazing. Various studies have outlined a unique trait subset depending on environmental and historical grazing condition. A suitable subset of plant traits can help to assess and monitor the rangelands quickly and exactly. The research in semi-arid regions could lead identifying the most important traits and creating the plant community dynamic models. Therefore, the main question regarding to various studies is; which functional traits of plants can be good indicators for assessing the effect of grazing on rangeland condition? Thus this study aimed to identify the plant functional traits that can be used to monitor and evaluate the effect of grazing with spending less time and cost in semi-steppe Tangsayad rangelands of Chaharmahal Bakhtiari province.

Materials and Methods

Study area

Tangsayad study area is a mountainous region with an average elevation of 2720 m above sea level. This region has an area of 27,000 hectares, which about 21,600 ha is counted as protected zone and 5400 hectares allocate to national park. Tangsayad region is located in north-east of the Chaharmahal Bakhtiari province, Iran, between the geographical coordinates 50º58‘44‘’ to 51º10‘25’’ east longitude and 32 º3‘6.2‘’ to 32 º17‘7.5‘’ north latitude (Fig. 1).

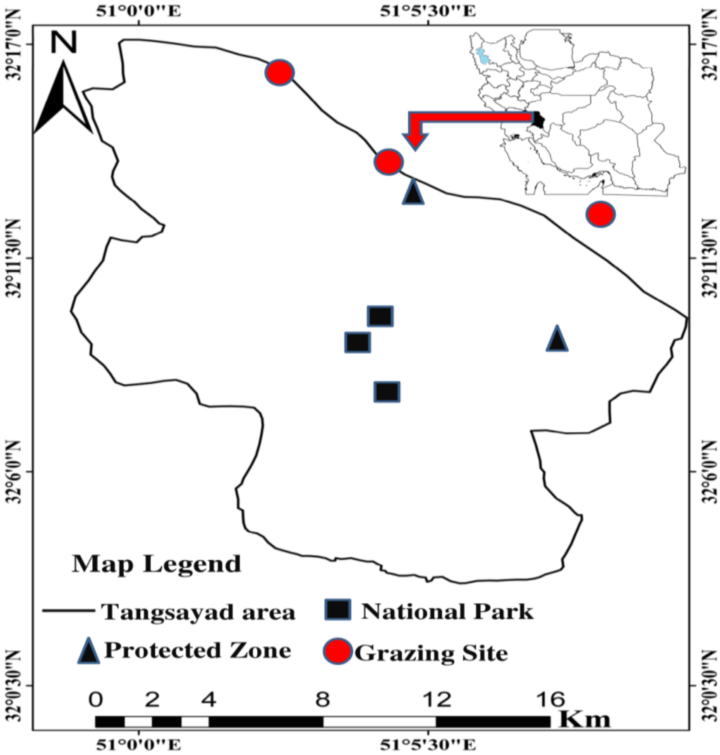


Fig. 1. Location of study sites in Chaharmahal Bakhtiari province, Iran

Tangsayad maximum elevation of sea level is 3140 m. long-term average annual precipitation is 329 mm, ranged 625 to 170 mm and the annual mean temperatures is 11.9°C. The minimum temperature in the coldest month (December) is -6.87°C and July is the warmest month with temperate of 32.90°C. Snow in cold seasons and rain in warm seasons is the common type of precipitation. The highest and lowest precipitation allocated to spring and summer, respectively. Plants growing season period is seven months. According to Emberger climate curve, the climate of region is arid and semi-arid. The soil classification is Typic Xerorthents and Lithic Xerorthents. Soil depth is low to moderate (Iranian Department of environment, 2002). Generally study area is in the eastern part of Shahrekord in Chaharmahal Bakhtiari province. The distance between study area and Shahrekord is 15 km. This area was declared as forbidden hunting region in 1970 by the Supreme Council of environment and latterly in 1973 with the approval of the Supreme Council; the management method was changed to protected area. In 1995, approximately 5,400 hectares of the middle part of the area became as form of national park. Lori and Bakhtiari sheep is the common grazers in the area. Tangsayad study area included National Park in the middle and protected area in surrounding part (Iranian Department of environment, 2002).

The national park is a suitable habitat for *Capra aegagrus* and *Ovis orientalis isphahanica.* Vegetation types are *Astragalus myriacanthus*, *Agropyron intermedium*, *Astragalus susianus*, *Cousinia tenuiramula*, *Scariola orientalis*. The plant families of Compositae, Gramineae, Umbelliferae and Papilionaceae are the most dominant plants in the area.

Sampling method

Vegetation sampling was taken in grazing site, protected area and national park on vegetation growth season (late May and early June). A 100 m transect was randomly established in each site and five plots with four-square-meters area were placed systematically at intervals of 20 m along transect (Arzani and Abedi, 2015). The number of plots was 15 for each site. The vegetation sampling was taken randomly at the plant community level. Then, the species identified in each plot and the cover percentage of each species was estimated. Qualitative traits such as life forms (Therophytes, Geophytes, Hemicryptophytes, Chamaephytes, Phanerophytes) (Raunkiaer, 1934), persistency (Annual and Perennial), growth form (Grass, Forb, Shrub), palatability classes (Class I, II, and III) (Fayyaz and Yeganeh badrabadi, 2015) were determined. Finally quantitative traits including plant height, leaf length, leaf width, leaf area, leaf weight, Specific Leaf Area (SLA), and production and plant weight were measured according to (Cornelissen *et al*., 2003). Harvesting and weighing method was applied to measure the plant production and double sampling method was used to measure above ground plant biomass.

All the leaves were separated from the plant and were scanned using software Image J 1032 (In Processing and Analysis in Java), then length, width and leaf area were determined. Measured leaves were dried and then each leaf weight was determined. Finally the SLA was determined using (Equation 1).

$$(\text{SLA}) = \frac{\text{Leaf area (mm}^2)}{\text{Leag dry weight (mg)}}$$

(Equation 1)

Statistical analyses

Analysis of variance (ANOVA) was done using SPSS v21 software. The mean comparisons of plant functional traits among three sites were made using Tukey's test. The standard deviation and standard error of the means were estimated. Also, PCA was conducted to assess variation in functional traits of plant community’s outlining by grazing using software Pc-Ord version 4.

Results

Results of one-way ANOVA and means comparisons of traits in three areas are given in Table 1. Leaf length, leaf width, leaf area, leaf weight, grass form and life form of Geophyte had significant difference ($P<0.05$) among three management areas. There were no significant differences between three sites for plant height, leaf area index, forage production and plant weight, percentage of annual and perennial species, palatable species Classes I, II, III, percentage of forb and shrub species, Therophytes, Chamaephytes and Phanerophytes. The means of leaf width and leaf area of protected area were significantly higher than other sites. The percentage of grass species in national park was significantly higher than protected area. Geophyte form was also different between national park and grazing area (Table 1).

Table 1. Variance analysis and mean comparisons of traits in three management areas of Tangsayad

Traits	Sites			F-value
	National park	Protected area	Free grazing	
Height (cm)	29.38^{a}±9.30	25.46^{a}±7.68	33.04^{a}±11.70	1.763^{ns}
Leaf length(cm)	9.28^{a}±2.51	8.92^{a}±1.57	6.94^{b}±2.75	3.919*
Leaf width(cm)	0.73^{b}±0.35	1.98^{a}±0.74	0.48^{b}±0.19	37.642**
Leaf area (mm^2)	450.7^{b}±176.5	734.6^{a}±226.0	303.8^{b}±167.0	16.092**
Leaf weight (mg)	34.18^{b}±15.73	66.83^{a}±20.49	24.74^{b}±14.25	20.430**
SLA (mm^2/mg)	18.88^{a}±7.15	15.85^{a}±3.76	16.97^{a}±6.49	0.769^{ns}
Production (g)	6.84^{a}±4.14	8.08^{a}±1.66	6.69^{a}±3.97	0.503^{ns}
plant weight (g)	10.69^{a}±7.81	11.53^{a}±4.38	12.58^{a}±9.55	0.215^{ns}
Annual (%)	0.38^{a}±0.28	0.26^{a}±0.17	0.44^{a}±0.29	1.373^{ns}
Perennial (%)	0.61^{a}±0.28	0.73^{a}±0.17	0.55^{a}±0.29	1.373^{ns}
Palatability class I cover (%)	0.04^{a}±0.05	0.03^{a}±0.04	0.05^{a}±0.10	0.287^{ns}
Palatability class II cover (%)	0.23^{a}±0.23	0.19^{a}±0.15	0.12^{a}±0.14	1.214^{ns}
Palatability class III cover (%)	0.71^{a}±0.22	0.77^{a}±0.18	0.81^{a}±0.18	0.812^{ns}
Grass (%)	0.49^{a}±0.19	0.28^{b}±0.17	0.36^{ab}±0.26	3.213*
Forb (%)	0.33^{a}±0.24	0.46^{a}±0.19	0.26^{a}±0.27	1.963^{ns}
Shrub (%)	0.17^{a}±0.15	0.25^{a}±0.22	0.37^{a}±0.31	2.601^{ns}
Therophytes (%)	0.38^{a}±0.28	0.26^{a}±0.17	0.44^{a}±0.292	1.373 ^{ns}
Geophytes (%)	0.05^{a}±0.04	0.01^{b}±0.03	0.01^{b}±0.03	3.468**
Hemicryptophytes (%)	0.40^{a}±0.22	0.45^{a}±0.15	0.16^{a}0.13	9.402^{ns}
Chamaephytes (%)	0.16^{a}±0.15	0.25^{a}±0.22	0.37^{a}±0.31	2.784^{ns}
Phanerophytes (%)	0.10^{a}±0.13	0.08^{a}±0.17	0.25^{a}±0.31	2.204^{ns}

*, ** and ns= significant at 0.05 and 0.01 probability levels and non-significant, respectively
Means of each rows followed with the same letters are not significant

PCA was conducted to determine the most important traits that explain variation in three sites. In the present study the PCA is effective rather than discriminant analysis because our objective was to assess differences among traits along the most important dimensions of trait variation, rather than simply differentiate traits from different sites. We used PCA to obtain a visual approximation of the trait correlations within each site.

Eigenvalues are given in Table 2. The amount of the first, second and third axes eigenvalues (eigenvector) are higher than Broken Stick statistic, therefore these axes had significant contribution for variation and the other axes were not significant. As shown in Table 3, the traits as plant production, plant weight, perennial and shrub species had the most negative correlation with first axis. In contrast, Therophytes, annual species and SLA had positively correlated with the first axis. Leaf length, width, area and life form of Hemicryptophytes and Phanerophytes had a high negative association with the second axis. Life forms of grasses and palatability class I in negative direction and life forms of forbs and palatability class III in positive direction had the most contribution in the extraction of the third axis. In overall, 41.81%, 25.77% and 14.07% of variation were explained by the first, second and third axes, respectively. Two-dimensional diagram (bi-plot) of the first and second axis is shown in Fig. 1. Plots number of N1 to N15, P16 to P25, and G26-G40 were sampled in the national park, protected area and grazing site respectively. From Fig. 2 it is obtained that the majority of plots of national park are located in right of the first axis and bottom of second axis relatively but gradient length have not been clearly extracted by the two axes.

Plots of protected area obviously are placed at the bottom of the second axis. The plots of this site were related to higher leave size and palatability classes I and II and life form of Hemicryptophytes. The plots of grazing site are plotted in the upper part of the second axis. This site is related to palatability classes III, life form of Chamaephytes Therophytes, annual species, plant weight, shrubs and plant height. Therefore this axis is presenting the variation length of traits between two management areas clearly. But the gradient length is not very noticeable along the first axis. Based on these results it can be concluded that environmental factors have also been from influential factors (Fig. 2).

Table 2. Results of eigenvalues, variation and Broken Stick statistic in PCA analysis in the Tangsayad area

Axis	Eigen vector	Explained variation %	Broken stick statistic
1	8.781	41.81	3.64
2	5.414	25.77	2.64
3	2.956	14.07	2.14
4	1.204	5.73	1.81
5	1.163	5.54	1.56
6	0.801	3.81	1.36
7	0.354	1.68	1.19
8	0.149	0.71	1.053
9	0.081	0.384	0.928
10	0.049	0.234	0.816

Table 3. Result of eigenvectors from the first three principal component axes for plant traits in Tangsayad area

Plant trait	Axis1	Axis 2	Axis 3
SLA	**0.291**	-0.055	-0.196
Annual	**0.325**	0.092	-0.022
Therophytes	**0.325**	0.092	-0.022
Production	**-0.304**	-0.035	0.003
Overall plant weight	**-0.314**	0.114	-0.029
Perennial	**-0.325**	-0.092	0.022
Shrub	**-0.264**	0.227	-0.025
Chamaephytes	**-0.262**	0.230	-0.027
Leaf length	-0.032	**-0.328**	-0.345
Leaf width	-0.080	**-0.301**	0.297
Leaf area	-0.093	**-0.373**	0.081
Leaf weight	-0.146	**-0.332**	0.169
Hemicryptophyes	-0.089	**-0.369**	0.087
Phanerophytes	-0.232	**-0.296**	0.023
Palatability class I	-0.021	-0.101	**-0.370**
Grasses	0.151	-0.082	**-0.454**
Forb	0.129	-0.155	**0.442**
Palatability class III	0.150	0.232	**0.299**
Palatability class II	-0.158	-0.217	-0.187
Geophyte	0.003	-0.074	-0.133
Plant height	-0.218	0.177	-0.154

Boldface factors loadings are considered highly weighted value

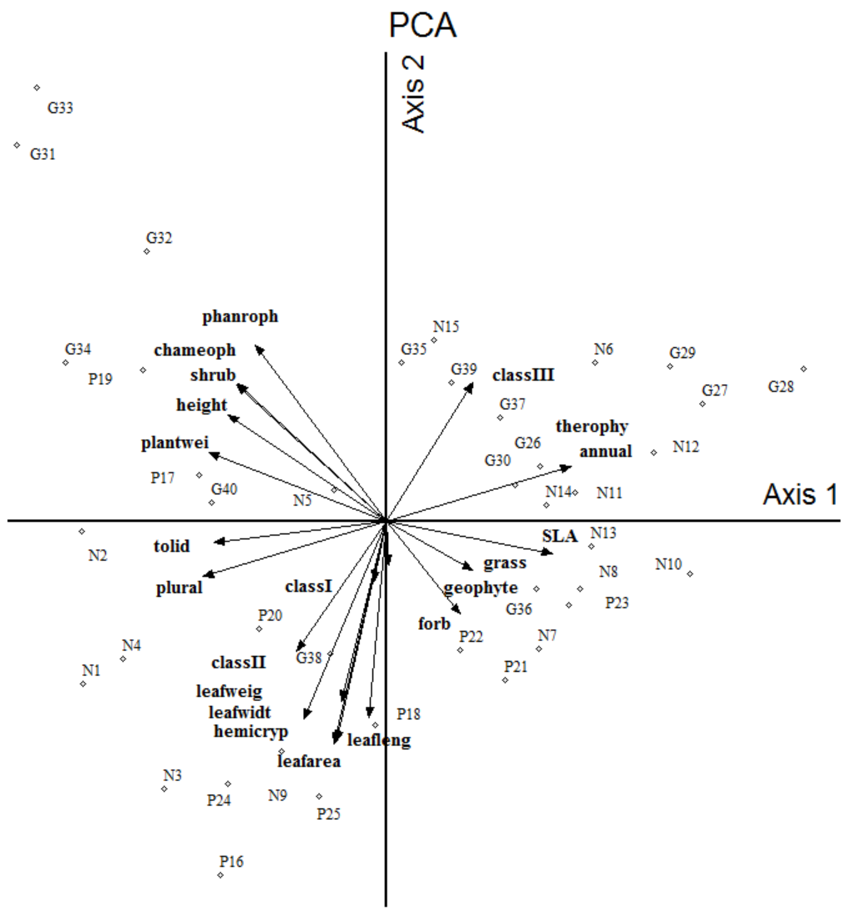


Fig. 2. PCA diagram of two axes 1 and 2 in Tangsayad (National Park plots: N1-N15, protected area plots: P16-P25 and grazing protected plots: G26-G40)

Discussion

The results of this study showed that the leaf traits have changed largely under the influence of different grazing livestock managements. Similarly, Nikan *et al.* (2010) found in their study that some of traits as plant height; SLA had higher variation in two low and moderate grazing intensities. In this regard Gholami *et al.* (2011) showed that all plant functional groups except perennial plants, Cryptophytes, Hemicryptophytes, Chamaephytes and shrubs have significantly responded to different grazing intensities.

It seems that low grazing can stimulate the plant regrowth and accumulate nutrient in the plant organs. This stimulation may be due to sexual regeneration (Grime, 2006). Therefore, the plants try to produce seeds and plant size is involved in the response to both resource availability and disturbance, as it relates to both competitive ability and tolerance/avoidance of disturbance and drought (Osem *et al.*, 2004).

An experiment was conducted by Azimi and Mozafari (2017) in study of the effects of three deferred grazing systems (15, 30, 45 days delay) in Semnan province, Iran. They found significant effects of deferred grazing systems on the growth of shrubs in terms of canopy cover. Also they declared the lowest shrub canopy cover in 45-day delay of grazing and the 15-day delay are suggested to the reaching highest forage production. Adaptations to grazing, such as small stature, basal meristems and drought-deciduous leaves, also prove advantageous in preventing or recovering from herbivory (Coughenour, 1985). In the context of grazing defense, these traits can be viewed as ‘exaptation’ rather than adaptations (Gould and Lewontin, 1979). The evolutionary history of grazing (Mack and Thompson, 1982) refers to the history of selective pressure on plants exerted by populations of generalist herbivores. Grazing-resistance traits that evolve in response to these selective pressures are true adaptations to grazing.

Motamedi *et al*. (2016) conducted a research to study the effects of various grazing intensities (low, moderate and high) on some traits of *Artemisia fragrans* Wild. The results indicated that there was a significant difference between the quantity of investigated parameters (except for the canopy area and diameter of the plant collar) of the studied species under three grazing intensities. The highest and lowest aerial biomasses with average values of 5.18 and 76.42 g/plant were obtained in low and high grazing intensities, respectively. Moreover, the maximum and minimum underground biomass with average values of 95.32 and 46.56 g/plant allocate to low and high grazing intensities, respectively. In high grazing intensity, the means of collar diameter and plant cover was the lowest and the characteristics of leaf litter, underground and aerial biomass was the highest. The findings of Motamedi *et al*. (2016) in case of decreasing the plant cover and weight of leaf due to grazing is in line with the findings of this study.

Palatable plants were replaced by plants which had low palatability. In this research the plants with palatability class III had higher frequency in grazing site. Chamaephytes are often assumed to be intolerant to grazing due to the non-accessibility of the buds (McIntyre and Lavorel, 1994). The plants with palatability class III had poor-quality leaves that these are an effective defense against herbivores. Herbivores do, in fact, avoid the plants that are difficult to digest (and decompose) in favor of their more palatable competitors (Augustine and McNaughton, 1998). This type of avoidance is further enhanced by tough leaves that result in large quantities of standing dead biomass, which even large herbivores avoid (Cruz *et al*., 1998). When the plants grow to mid or low-level of harvesting, palatable species had a competitive advantage and the succession goes to the climax (Mesdaghi, 2009). Plant responding to grazing depends on the ability of this species in recovering and restoring the lost tissues.

A combination of several regenerative strategies in one species may act as insurance for surviving an unpredictable disturbance; species with multiple regenerative strategies are more likely to inhabit a variety of environments (Grime, 2001). A study by Sharafatmand rad *et al*. (2014) also was done to analyze the effects of grazing (low grazing, medium and high grazing intensity) on plant species diversity of arid and semi-arid rangelands. They found that as grazing intensity increased, total species richness and diversity will be decreased. They found no significant differences between richness and diversity of the low and moderate grazing intensity treatments although the indices of low grazing intensity were significantly higher than the severe grazing intensity.

By increasing the capability of producing in a habitat (especially humidity), the ratio of aboveground to the underground and also canopy development will increase (Tahmasebi Kohyani and Ebrahami, 2012). Negative associations have also been reported between stress and consumption for dicots due to the increase in secondary compounds observed in stressed plants (Bryant *et al*., 1989). Consequently, only small changes in plant community and plant trait composition in response to grazing are to be expected at these sites, in comparison with nutrient rich sites. In the latter, competition for light will favor for the species with traits such as taller growth form, leafy structure, tall shoots and a strong lateral extension, which increase the species' vulnerability to grazing. Diaz *et al*. (2001) in a study about response of plants to grazing in semi-humid rangelands showed that plant height, longevity, leaf size and specific leaf area may be the best variable in predicting the grazing effects which the results are completely compatible with findings of this research.

Finally, considering to the results it was concluded that leaf traits like leaf length, leaf width, leaf area and leaf weight, forbs, grass and life forms Hemicryptophyes and Geophytes can be used as indicators for assessing and monitoring of grazing management in rangelands. The results of this study can be used to evaluate the semi-steppe rangelands with similar situation, although more researches are necessary to achieve accurate measures in different rangelands. In overall, our results state the fact that the expected convergence in plant attributes conferring tolerance to both resource scarcity and grazing disturbance. The main implication of these results is that in order to attain a general model of vegetation dynamics in response to management conditions, we should encourage comparative studies in different trait scaling relationships, especially in relation to the structure of different vegetation types. In general conclusion; leaf traits as leaf length, leaf width, leaf area and leaf weight, grass growth form, Hemicryptophytes and Geophytes life forms were determined as the good indicators for assessing and monitoring of grazing management.

References

Arzani, H. and Abedi, M., 2015. Rangeland assessment: Vegetation measurement. University of Tehran press, 304pp. (In Persian).

Augustine, D.J. and McNaughton, S.J., 1998. Ungulate effects on the functional species composition of plant communities: herbivore selectivity and plant tolerance. *Jour. Wildlife Management*, 62: 1165–1183.

Azimi, M. and Mozafari, M., 2017. The Effects of Deferred Grazing System on Vegetation Parameters in Semi-Arid Rangelands (Case Study: Jashlubar, Semnan, Iran). *Jour. Rangeland Sciences*, 7(1): 11-19. (In Persian).

Bryant, J.P., Kuropat, P.J., Cooper, S.M., Frisby, K., Owen Smith, N., 1989. Resource availability hypothesis of plant anti-herbivore defense tested in a South African savanna ecosystem. *Nature*, 340: 227-229.

Cornelissen, J.H.C., Lavorel, S., Garnier, E., Díaz, S., Buchmann, N., Gurvich, D.E., Reich, P.B., ter Steege, H., Morgan, H.D., van der Heijden, M.G.A., Pausas, J.G. and Poorter, H., 2003. A handbook of protocols for standardized and easy measurement of plant functional traits worldwide. *Australian Jour. Botany*, 51: 335-380.

Coughenour, M.B., 1985. Graminoid responses to grazing by large herbivores: adaptations, expatiations and interacting processes. Annals of the Missouri Botanical Garden, 72: 852–863.

Cruz, R., Ganskopp, D. and Vavra, M., 1998. Modeling Habitat Preferences of Cattle on Eastern Oregon Rangelands. Eastern Oregon Agricultural Research Center Annual Report 1998, Special Report 991. Agricultural Research Station, Oregon State University, Oregon.

Diaz, S., Noy-Meir, I. and Cabido, M., 2001. Can grazing response of herbaceous plants be predicted from simple vegetative traits, *Jour. Applied Ecology*, 38: 497–508.

Fayyaz, M. and Yeganeh Badrabadi, H., 2015. Preference value of Iranian rangeland plants: semi-steppe and high mountain rangelands. Iranian organization of rangeland and forest researches, 382 pp.

Gholami, P., Ghorbani, J. and Shokri, M., 2011. Changes in diversity, richness and functional groups of vegetation under different grazing intensities (Case Study: Mahoor, Mamasani Rangelands, Fars province). *Iranian Jour. Range and Desert Research*, 18 (4): 662-675. (In Persian).

Gould, S.J. and Lewontin, R.C., 1979. The spandrels of San Marcos and the Panglossian paradigm: a critique of the adaptationist program. Proceedings of the Royal Society of London B, 205, 581–598.

Grime, J.P., 2001. Plant strategies, vegetation processes, and ecosystem properties, 2nd . ed. Wiley, Chichester, UK.

Grime, J.P., 2006. Trait convergence and trait divergence in herbaceous plant communities:

mechanisms and consequences. *Jour. Vegetation Science*, 17: 255–260.

Hoshino, A., Yoshihara, Y., Sasaki, T., Okayasu, T., Jamsran, U., Okuro, T. and Takeuchi, K., 2009. Comparison of vegetation changes along grazing gradients with different numbers of livestock. *Jour. Arid Environment*, 73: 687-690.

IDEPA (Iranian Department of Environment Protection Agency), 2002. National parks and protected area management plan of Tangsayad, identification vegetation, Volume 9, (In Persian).

Jongman, R. H. G., Ter braak, C. J. F. and Van Tongeren, O.F.R., 1995. Data Analysis in Community and Landscape Ecology. Cambridge University Press, 301pp.

Khosravi Mashizi, M. and Heshmati, Gh.A., 2011. Introduce of a biosphere by pattern of vegetation composition along grazing gradient in shrub lands of cold season rangeland of Kerman province. *Iranian Jour. Range and Desert Research*, 18 (5): 547-557. (In Persian).

Klimesova, J., Latzel, V., de Bello, F. and van Groenendael, J. M., 2008. Plant functional traits in studies of vegetation changes response to grazing and mowing: towards a use of more specific traits. *Perslia*, 80: 245-253.

Lavorel, S. and Garnier, E., 2002. Predicting changes in community composition and ecosystem functioning from plant traits: revisiting the Holy Grail. *Functional Ecology*, 16: 545-556.

Mack, R.N. and Thompson, J.N., 1982. Evolution in steppe with few large, hooved mammals. American Naturalist, 119: 757–773.

McIntyre, S. and Lavorel, S., 1994. How environmental and disturbance factors influence species composition in temperate Australian grasslands. *Jour. Vegetation Science*, 5: 373-384.

McIntyre, S., Lavorel, S. and Landsberg, J., 1999. Forbes TDA. Disturbance response in vegetation towards a global perspective on functional traits. *Jour. Vegetation Science*, 10: 621–630.

Meng, T., Jian, Ni., Sandy, P. and Harrison, S.P., 2009. Plant morphometric traits and climate gradients in northern China: a meta-analysis using quadrat and flora data. State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, Xiangshan Nanxincun 20, 100093 Beijing, China.

Mesdaghi, M., 2001. Description and analysis of vegetation. Jihad Daneshgahi of Ferdowsi University. 283 pp. (In Persian).

Mesdaghi, M., 2009. Range management principles and techniques. (Translation of Holchek, J. Pieper and Herbol, K.). Mashhad University Press Center, Iran, 709 pp. (In Persian).

Motamedi, M., Sheidai Karkaj, E. and Alilou, F., 2016. Variation in biomass and morphology of Artemisia fragrans Willd. Under grazing in northwest mountainous rangelands of Iran. Acta Ecologica Sinica, 36: 477-482.

Nikan, M., Ejtehadi, H., Jangjou, M., Memariani, F., Noduoust, F., Hassanpour, H., 2010. Variation in morphological and functional traits of rangelands plants along the grazing gradient in a semi-steppe rangeland, 16th National and 4th International Conference of Biology, Ferdowsi University of Mashhad, Mashhad, Iran, 14-16 September,886-892. (In Persian).

Osem, Y., Perevolotsky, A. and Kigel, J., 2004. Site productivity and plant size explain the response of annual species to grazing exclusion in a Mediterranean semi-arid rangeland. *Jour. Ecology*, 92: 297–309.

Pyke, D.A. Herrick, J. E., Shaver. P. and Pellant, M., 2002. Rangeland health attributes and indicators for qualitative assessment. *Jour. Range Management*, 55: 584–597.

Raunkiaer, C., 1934. The life forms of plants and statistical plant geography. Clarendon Press, Oxford University Press. 162 pp.

Sharafatmand rad, M., Sepehry, A. and Barani, H., 2014. Plant Species and Functional Types' Diversity in Relation to Grazing in Arid and Semi-arid Rangelands, Khabr National Park, Iran. *Jour. Rangeland Sciences*, 4 (3): 203-215.

Sheidai Karkaj, E., Motamedi, J., Akbarlou, M. and Alijanpour, A., 2012. Floristic structure and vegetation composition of Boralan mountainous rangelands in north-western Azerbaijan, Iran. *Jour. Rangeland Sciences*. 2(4): 697–706. (In Persian).

Suding, K.N., Lavorel, S., Chapin, F.S., Cornelissen, J.H.C., Diaz, S., Garnier, E., Goldberg, D., Hooper, D.U., Jackson, S.T. and Navas, M.L., 2008. Scaling environmental change through the community-level: a trait-based response-and-effect framework for plants. Global Change Biology, 14: 1125–1140.

Tahmasebi Kohyani, P., Bossuyt, B., Bonte, D. and Haffman, M., 2011. Grazing impact on plant spatial in distribution and community composition, Plant Ecology and Evolution, 144:19-28.

Tahmasebi Kohyani, P. and Ebrahimi, A., 2012. Plant Animal Interaction. Shahrekord University Publications, Iran: 193pp. (In Persian).

Takehiro, S., Satoru, O., Tomoo, O., Unddarma, J., Toshiya, O. and Kazuhiko, T., 2011. Indicator species and functional groups as predictors of proximity to ecological thresholds in Mongolian rangelands, Plant Ecology 212: 327-342.

Walker, B. H., 1992. Biodiversity and ecological redundancy. Conservation Biology, 6: 18-23

Xia, Y., Koontz, T. L., Collins, S. L., Friggens, M. T. and Moore, D. I., 2009. Grazing effect on plant species diversity and above-ground biomass in desert grassland. 94th ESA Annual meeting, Albuquerque Convention Center, Albuquerque, New Mexico, USA.

Zhao, W.Y., Li, J.L. and Qi, J.G., 2007. Change in Vegetation Diversity and Structure in Response to Heavy Grazing Pressure in the Northern Tianshan Mountains, China. *Jour. Arid Environments*, 68:465-479.

تغییرات گروه‌های عملکردی گیاهی در طول گرادیان چرای دام در مراتع نیمه استپی (مطالعه موردی: مراتع تنگ صیاد استان چهار محال بختیاری)

الهام بنی‌هاشمی[الف]*، پژمان طهماسبی کهیانی[ب]، اسماعیل اسدی[ب]
[الف]دانش آموخته کارشناسی ارشد مرتعداری دانشگاه منابع طبیعی و علوم زمین دانشگاه شهرکرد *(نگارنده مسئول)، پست الکترونیک: banihashemi.elham.m71@gmail.com
[ب]دانشیار گروه مرتعداری دانشگاه منابع طبیعی و علوم زمین دانشگاه شهرکرد

تاریخ دریافت: ۱۳۹۵/۱۱/۱۴
تاریخ پذیرش: ۱۳۹۶/۰۳/۰۷

چکیده. ارزیابی و پایش مراتع تحت مدیریت‌های چرایی مختلف ضروری به نظر می‌رسد و هنوز شاخص‌های مشخصی برای ارزیابی این مراتع با صرف وقت و هزینه کمتری معرفی نشده است. در این خصوص گروه‌های عملکردی گیاهی می‌توانند به عنوان پاسخ دهنده‌های مناسب به تغییر شرایط محیطی و مدیریتی مورد استفاده قرار گیرند. لذا این تحقیق با هدف معرفی مهمترین صفات گیاهی که می‌توانند تغییرات را در مراتع نشان دهند در سال ۱۳۹۴ در منطقه تنگ‌صیاد واقع در استان چهار محال بختیاری انجام شد. بدین منظور در امتداد یک گرادیان چرایی سه منطقه پارک ملی، حفاظت شده و چرای آزاد انتخاب شد. ضمن استقرار یک ترانسکت ۱۰۰ متری به طور تصادفی و ۵ پلات چهار مترمربعی به شکل سیستماتیک به فواصل ۲۰ متر در طول این ترانسکت، در هر پلات پس از شناسایی گونه‌های موجود درصد پوشش هریک از گونه‌ها تخمین زده شد و صفات گیاهی اندازه‌گیری شدند. تعداد و اندازه پلات‌ها و ترانسکت‌ها با توجه به واقع‌شدن این تحقیق در منطقه نیمه خشک، دستورالعمل‌های نمونه‌برداری و اندازه ابعاد تاج بزرگترین گونه گیاهی تعیین شد. در نهایت برخی صفات گیاهی مربوط به اندازه برگ‌ها، بیوماس و پوشش گونه‌ها اندازه‌گیری شد. نتایج نشان داد که تفاوت بین سه منطقه از لحاظ صفات طول برگ، عرض برگ، مساحت برگ و وزن برگ فرم رویشی گندمی و اشکال زیستی همی‌کریپتوفیت و ژئوفیت دارای اختلاف معنی‌داری بودند ($P\leq۰/۰۵$). همچنین نتایج آزمون PCA نشان داد صفات تولید، وزن گیاه و چندساله بودن دارای بیشترین همبستگی با محور اول و صفات طول، عرض، مساحت برگ و همچنین فرم زیستی و همی‌کریپتوفیت دارای همبستگی بالایی با محور دوم داشتند. به طورکلی نتیجه‌گیری شد صفات مربوط به برگ نظیر طول برگ، عرض برگ، مساحت برگ و وزن برگ، فرم رویشی گندمی و اشکال زیستی همی‌کریپتوفیت و ژئوفیت می‌توانند به عنوان شاخص‌هایی مناسب برای ارزیابی و پایش مدیریت چرا در مراتع مورد مطالعه به کار روند.

کلمات کلیدی: صفات گیاهی، مدیریت چرا، فرم رویشی، تنگ صیاد