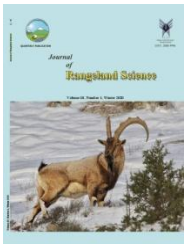
Contents available at ISC and SID

Journal homepage: www.rangeland.ir



Research and Full Length Article:

Effects of Fire on Composition, Biodiversity, and Functional Groups Changes in Semi-Steppe Rangelands of Southern Zagros, Iran

Parviz Gholami[A], Mohammad Reza Mirzaei[B]*, Ehsan Zandi Esfahan[C], Alireza Eftekhari[C]
[A] Ph.D in Rangeland Science, Department of Range Management, Sari University of Agriculture Sciences & Natural Resources, Sari, I.R. Iran
[B] Assistant Prof., Department of Forestry and Institute of Natural Resources and Environmental, Yasouj University, Yasouj, I.R. of Iran *(Corresponding Author), E-mail: mrm.mirzaei@gmail.com
[C] Assistant Professor, Rangeland Research Division, Research Institute of Forests and Rangelands, Agricultural Research Education and Extension Organization (AREEO), Tehran, Iran

Received on: 28/11/2018
Accepted on: 25/05/2019

Abstract. Fire as an ecological factor has both positive and negative effects on components of the ecosystem. The aim of the present study was to investigate the effects of fire on composition, diversity, and functional groups changes in the Tangesorkh rangeland of Boyer-Ahmad County, Iran. The fire took place in the summer of 2015. Two years after the fire, the characteristics of vegetation were measured in the 1 m^2 plots. The results showed that 17 species were exclusively found in the fire region, 14 species exclusively in the control region, and 37 species were shared between the two regions. The results of means comparison showed that among the study species, 21 species had a significant response to the fire in terms of canopy cover percent. Fire in the area increased the Simpson and Shannon diversity index and Margalef richness index. The fire caused the canopy cover percent of annuals, perennials, grasses, forbs, Throphytes, Cryptophytes, Hemicryptophytes, Chamaephytes, Asteraceae, Caryophyllaceae, Fabaceae and Rubiaceae and Poaceae increased significantly as compared to control. The redundancy analysis (RDA) results showed that the species had different responses to fire so that the canopy cover of *Bromus danthoniae, Vicia villosa, Bromus tomentellus, Astragalus hispanicus, Ziziphora tenuior, Bunium rectangulum, Ferulago angulate* and *Gundelia tournefortii* were increased in the regions where fire occurred. According to the results of this research, functional groups have important roles in determining the responses of plant species to the environmental disturbances; hence, they can affect the secondary succession after the wildfire in rangelands.

Keywords: Fire, Multivariate analysis, Biodiversity indices, Grasses, Zagros

Introduction

Fire as an important ecological factor causes vegetation changes. Since this phenomenon can negatively or positively affect the components of each ecosystem, from the perspective of natural resources management, it is a central important factor for planners (Bowman and Murphy, 2010). Most of the ecologists believe that fire is one of the essential characteristics of ecosystems, playing an important role in the process of regeneration and evolution. Besides, the fire is known as an important management tool for ecosystem regeneration (Moreira *et al*., 2003; Shahrokhi Sarduo *et al*., 2012). Making a fire in rangelands as a restoration method has always been discussed among the world's ranchers. Fire as an ancient method of rangeland improvement is used to control and eliminate invasive plants; however, this method is along with risks and limitations. According to the response of plants to fire, this method can be used for the management of vegetation (Azarnivand and Zare Chahooki, 2008; Ahmadi *et al*., 2017).

In Iran, especially in the Zagros region, limited studies have been done on the effects of fire on vegetation. Some researches mentioned the positive effects of fire such as increasing production, increasing diversity, and richness of species, increasing perennial grasses, and plants with high palatability (Fattahi and Tahmasebi, 2010; Mirdavoodi *et al*., 2013; Jamshidi Bakhtar *et al*., 2013; Rafiee *et al*., 2014; Mirzaei Mossivand *et al*., 2015). On the other hand, some other studies showed the negative effects of fire such as reduced plant biomass and diversity and species richness (Tahmasebi, 2013).

Atrakchali, (2000) proclaimed that fire increased herbal species cover in the burned area but did not affect the biodiversity indices in a temperate forest of northeast of Iran. Banj Shafiei *et al*. (2006) studied the effects of fire on herbal layer biodiversity in a temperate forest of northern Iran and results showed that the biodiversity indices and coverage percent of shade tolerant species in the unburned area were higher than that of the burned area. Pourreza *et al.* (2009) investigated the preliminary results of post-fire resprouting of manna oak (*Quercus brantii* Lindl.) in the Zagros forests and results showed that post-fire resprouting was positively related to the number of pre-fire sprouts and the fire intensity.

The Zagros region is considered as one of the most important natural ecosystems in Iran with its unique diversity of species (Jazirehi and Ebrahimi Rostaghi, 2005). However, unfortunately, its floristic composition and diversity of plant communities have been affected by factors such as Understory cultivation, excessive grazing of livestock and fire (Gholami *et al*., 2012). The fire in the Zagros region including Kohgiluyeh and Boyer-Ahmad province is unexpectedly and deliberately repeated during the summer when herbaceous plants have completed their vegetative period. The type and severity of the fire, the time of occurrence, the climate, and geographical conditions of the region can have different effects on the ecosystem.

Since the composition and diversity of plant communities are changed over time by changing environmental conditions and the occurrence of disturbances such as fire, the present study allows obtaining information about the composition and vegetation diversity after the occurrence of fire in order to estimate the potential of rangeland restoration in the Zagros region in the short-term. Therefore, the aim of the present study was to investigate the effects of fire on composition, diversity, and functional groups changes in the Tangesorkh rangeland of Boyer-Ahmad county, which took place in the summer of 2015.

Material and Methods

Study area

The study area, located in the left valley of Sartang Tangesorkh, is 45 km far from

Yasooj city between the longitudes 51°40′ 04″ - 51°46′ 08″ E and latitudes 30°22′ 35″ - 30°27′ 37″ N (Fig. 1). The altitude above sea level is 2200 to 2400 m. The climate of the study area was evaluated based on 15-year information of the Yasooj meteorological station (the nearest station to the study area). The results showed that the average annual rainfall was 832.3 mm and the average minimum and maximum temperatures were 2.5 and 45.1° C, respectively. Besides, the coldest months of the year are January and February, and the hottest months of the year are July and August. In this area, a species like *Ferula assa-foetida* is cultivated for sustaining the livelihood of the region's beneficiaries. In summer of 2015, about 25 ha of this land were slightly destroyed by fire and its evidence can be observed on the trunk of shrubs. The dominant vegetation types in the study area were *Gundelia tournefortii, Bromus tomentellus,* and *Vicia villosa.*

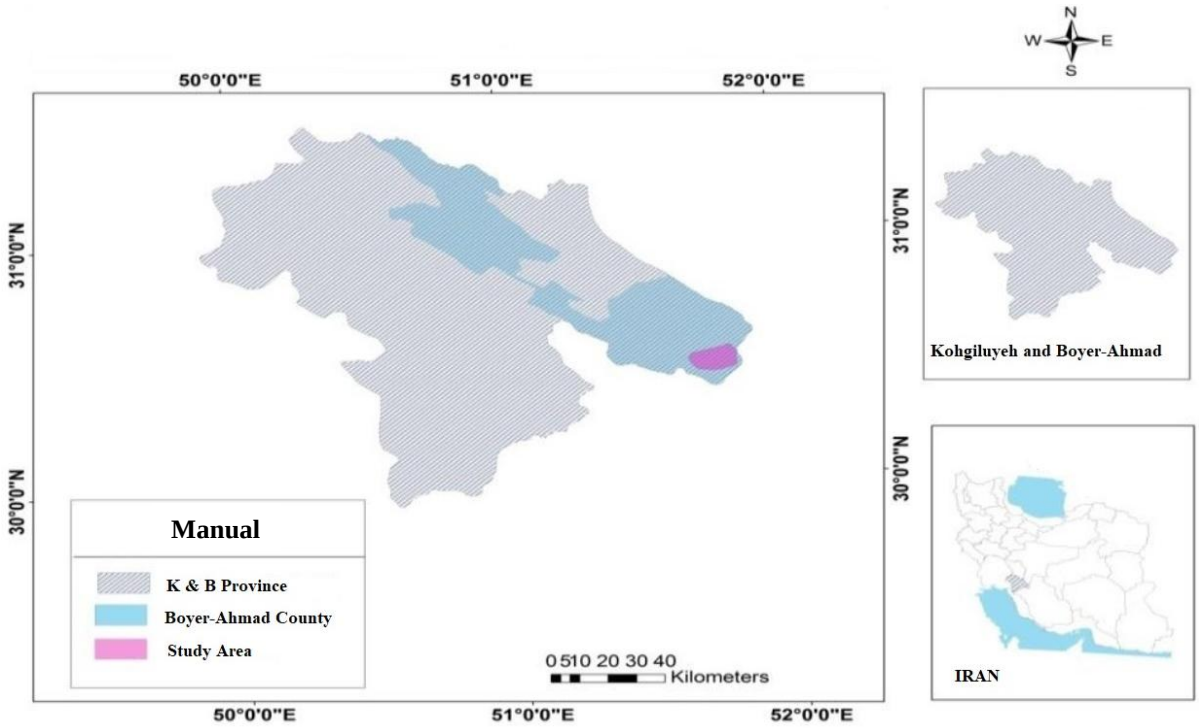


Fig. 1. The case study area location in the southern Kohgiluyeh and Boyer-Ahmad province situated in Iran

Vegetation sampling

Vegetation sampling was performed in the spring of 2017, two years after the fire. Initially, an area that was well exposed to the fire and its entire surface was continuously burned was determined. In order to make a comparison, a control region near the study area was selected. It should be noted that the landslide conditions of the control region (slope, direction, and altitude), vegetation, and area were similar to the study area. Then, sampling was done in both areas (control and the fire area). In doing so, in each region, three 100 m transects (two transects in the direction of the dominant slope of the area and one perpendicular to the direction of the dominant slope) were used and $1m^2$ plots were placed on each transect through random-systematic method (Mirzaee *et al.*, 2018). It is worth pointing out that in order to determine the number of plots required for sampling, the minimum number of needed samples in each region was used and the size of the plot was determined according to the canopy of the largest dominant species. Finally, 30 plots were established in the fire zone and 30 plots in the control area. In each of the plots, the parameters of

canopy cover percent, rock, gravel, and bare soil percent were determined. The plant species were identified using authentic botanical sources such as the Colored Flora of Iran (Ghahraman, 1978-2003; Assadi *et al.,* 1991-2005). Moreover, Raunkiaer classification method was used to determine the biological form of plants.

Statistical analysis of data

The distribution of canopy cover percent was not normal; therefore, it was normalized using a logarithmic transformation. A non-paired t-test was used in SPSS Ver.22 software to investigate the effects of fire on vegetation indices (species composition, diversity, species richness, and plant species). Diversity (Shannon-Weiner and Simpson) and species richness (Margalef and Menhinick) were calculated in PAST software. In order to evaluate the effects of fire on vegetation analysis, a multivariable analysis was employed. In doing so, the gradient length was calculated to be less than three using Redundancy Analysis (RDA). These analyses were conducted in CANOCO 4.5 software.

Results

The composition of plant pieces in fire and control regions

The results of the composition of plant species showed that 54 and 51 species were identified and recorded in fire and control regions. Also, 37 species were in common in both fire and control regions while 17 and 14 species were only observed in fire and control regions, respectively. The dominant species of the fire region with the highest canopy cover percent included *Aegilops triuncialis, Gundelia tournefortii, Bromus danthoniae, Bromus tomentellus*, and *Vicia villosa*, covering 25.79% of the area (Table 1). On the other hand, the dominant species of control region with the highest canopy cover percent included *Eryngium bourgatii, Bromus tectorum, Bromus catharticus, Avena fatua,* and *Cirsium arvense,* covering 28.22% of the area (Table 1).

Individual response of plant species in fire and control regions

A comparison between the canopy cover percent of 37 species common in fire and control regions performed using t-test indicated the importance of 21 plant species (Table 1). The mean values showed that the canopy cover percent of *Astragalus hispanicus, Bromus danthoniae, Bromus catharticus, Bunium rectangulum, Cerastium inflatum, Bunium paucifolium, Ferula assa-foetida, Gundelia tournefortii, Gypsophila bicolor, Minuartia meyeri, Onobrychis cornuta, Poa bulbosa, Scariola orientalis, Sonchus tenerrimus,*and *Taeniatherum crinitum* in the fire region were higher than that of the control region (Table 1). While, the canopy cover percentage of *Astragalus susianus, Avena fatua, Bromus tectorum, Cirsium arvense, Cousinia calocephala,* and *Eryngium bourgatii* were increased in the control area compared to the fire region (Table 1).

Changes in biodiversity indices in fire and control regions

The results of t-test showed a significant relationship between fire and diversity and richness indices (Table 2). The means comparison indicated the significant difference among all indices, except Menhinick's richness index and evenness. Besides, in the fire region, the number of species, the Simpson and Shannon-Weiner diversity indices, and Margalof richness were higher than those of the control area (Table 2).

Changes of functional groups in fire and control regions

The results of t-test showed the significant effect of fire on most of the functional groups indices (Table 3). Comparing mean changes of plant groups in both fire and control regions indicated the significant difference in plant groups between fire and

control regions so that in the fire region, the canopy cover percent of all groups except Shrubs, Phanerophytes, Class III plants, Apiaceae, and Brassicaceae was higher than that of the control group (Table 3).

Table 1. The results of t-test in order to compare the mean value of Individual response of plant species in fire and control regions in semi-steppe rangelands of Southern Zagros

Species Name	Abbr.	Canopy cover %		t	P
		Fire	Control		
Aegilops triuncialis L.	*Ae.tr*	2.65	-		
Allium ampeloprasum Thunb.	*Al.am*	0.02	0.02	0.00	1.00
Alyssum linifolium Wild.	*Al.li*	0.25	0.16	0.57	0.31
Alyssum marginatum Timb.-Lagr. and Jeanb.	*Al.ma*	0.14	0.16	-0.21	0.73
Amygdalus lycioides Spach	*Am.ly*	0.06	0.06	0.00	1.00
Anchusa italica Retz.	*An.it*	0.08	0.05	0.37	0.47
Astragalus hispanicus Coss. ex Bunge	*As.hi*	0.50	0.03	2.12**	< 0.001
Astragalus rhodosemius Boiss. and Hausskn.	*As.rh*	0.37	-		
Astragalus susianus Boiss.	*As.su*	0.06	0.50	-2.07**	< 0.001
Avena fatua L.	*Av.fa*	0.11	0.62	-2.07**	< 0.001
Bromus catharticus Vahl	*Br.ca*	1.30	0.72	1.09**	0.007
Bromus danthoniae Trin. ex C.A.Mey.	*Br.da*	0.81	0.21	3.46**	< 0.001
Bromus tectorum L.	*Br.te*	0.11	0.72	-2.42**	< 0.001
Bromus tomentellus Boiss.	*Br.to*	**1.67**	-		
Bunium rectangulum H.Wolff	*Bu.re*	0.75	0.06	2.86**	< 0.001
Bunium paucifolium DC.	*Bu.pa*	0.16	0.02	1.47**	0.002
Callipeltis cucullaris (L.) Rothm.	*Ca.cu*	0.11	0.09	0.14	0.76
Cerastium dichotomum Schangin	*Ce.di*	-	0.30		
Cerastium inflatum Link ex Sweet	*Ce.in*	0.30	0.05	1.52**	0.002
Cerasus microcarpa K.Koch	*Cr.mi*	0.10	0.12	-0.23	0.56
Ceratocephala falcata (L.) Pers.	*Ce.fa*	-	0.08		
Chaerophyllum macropodum Boiss.	*Ch.ma*	0.43	0.25	0.72	0.064
Cichorium intybus L.	*Ci.in*	0.30	-		
Cirsium arvense (L.) Scop.	*Ci.ar*	0.26	0.6	-1.16*	0.018
Campanula humillima A.DC.	*Ca.hu*	**1.27**	-		
Convolvulus arvensis L.	*Co.ar*	0.81	-		
Cousinia calocephala Jaub. and Spach	*Co.ca*	0.12	0.52	1.93**	< 0.001
Crepis sancta (L.) Babc.	*Cr.sa*	0.08	0.12	-0.38	0.37
Eremostachys macrophylla Montbret and Aucher	*Er.ma*	0.06	0.12	-0.44	0.41
Eryngium bourgatii Gouan	*Er.bo*	0.19	0.76	-1.76**	< 0.001
Erysimum repandum L.	*Er.re*	-	0.03		
Euphorbia helioscopia Hausskn. ex DC.	*Eu.he*	-	0.46		
Ferula assa-foetida L.	*Fe.as*	0.30	0.11	0.94*	0.04
Ferulago angulata Boiss.	*Fe.an*	0.27	-		
Fibigia macrocarpa Boiss.	*Fi.ma*	-	0.23		
Geranium tuberosum Boiss.	*Ge.tu*	-	0.13		
Galium aparine L.	*Ga.ap*	0.24	-		
Gundelia tournefortii L.	*Gu.to*	1.90	0.17	3.67**	< 0.001
Gypsophila bicolor Grossh.	*Gy.bi*	0.27	0.03	1.71**	< 0.001
Hordeum bulbosum Sieber ex Kunth	*Ho.bu*	0.59	-		
Hordeum murinum L.	*Ho.mu*	0.55	-		
Hypericum perforatum L.	*Hy.pe*	-	0.16		
Lappula barbata Gürke	*La.ba*	-	0.14		
Lathyrus aphaca L.	*La.ap*	0.38	-		
Minuartia meyeri Bornm.	*Mi.me*	0.27	0.06	1.72**	< 0.001
Morina persica L.	*Mo.pe*	-	0.20		
Odontites vernus (Bellardi) Dumort.	*Od.ve*	-	0.06		
Onobrychis cornuta (L.) Desv.	*On.co*	0.22	0.02	1.52**	0.001
Plantago lanceolata L.	*Pl.la*	-	0.03		
Poa bulbosa L.	*Po.bu*	0.51	0.13	1.74**	0.001
Pterocephalus canus Coult. ex DC.	*Pt.ca*	0.16	0.24	-0.47	0.29
Ranunculus grandiflorus L.	*Ra.gr*	0.33	0.04	1.05	0.29
Scabiosa olivieri Coult.	*Sc.ol*	0.02	0.04	-0.44	0.35
Scandix stellata Banks and Sol.	*Sc.st*	-	0.07		
Scariola orientalis (Boiss.) Soják	*Sc.or*	0.25	0.03	1.64**	0.001
Scorzonera calyculata Boiss.	*Sc.ca*	0.01	0.013	0.12	0.80
Sonchus tenerrimus L.	*So.te*	0.30	0.04	1.60**	0.001

Species Name	Abbr.	Canopy cover %		t	P
		Fire	Control		
Taeniatherum crinitum (Schreb.) Nevski	*Ta.cr*	1.01	0.38	1.48**	0.001
Torilis arvensis (Huds.) Link	*To.ar*	0.02	0.02	0.00	1.00
Torilis leptophylla Rchb.f.	*To.le*	0.07	-		
Tragopogon graminifolius DC.	*Tr.gr*	0.44	0.25	0.88	0.11
Trigonella monantha C.A.Mey.	*Tr.mo*	0.35	-		
Vaccaria grandiflora Jaub. and Spach	*Va.gr*	0.30	-		
Valerianella tuberculata Boiss.	*Va.tu*	-	0.02		
Vicia ervilia Willd.	*Vi.er*	0.92	-		
Vicia villosa Roth	*Vi.vi*	1.33	-		
Viola odorata Thunb.	*Vi.od*	0.32	-		
Ziziphora tenuior Falk	*Zi.te*	0.22	-		

**, *= difference between two regions significant at 1 and 5% probability level.

Table 2. The results of t-test to compare the average values of diversity, richness, and evenness indices in fire and control regions of semi-steppe rangelands of Southern Zagros

Index	Fire	Control	T **values**	P **values**
Number of Species	9.87	5.13	7.19**	< 0.001
Simpson Diversity	0.82	0.68	4.07**	< 0.001
Shannon-Weiner Diversity	1.98	1.38	5.97**	< 0.001
Margalef Richness	2.09	1.32	3.41**	0.001
Menhinick's Richness	1.2	1.07	1.34^{ns}	0.18
Evenness	0.77	0.82	-1.84^{ns}	0.07

**= difference between two reigns is significant at 1 probability level.

Table 3. The results of t-test to compare the mean canopy cover percentage of functional groups in fire and control regions of semi-steppe rangelands of Southern Zagros

Plants Groups		Canopy cover %		T values	P values
		Fire	Control		
Longevity	Annals	27.90	6.45	7.04**	< 0.001
	Perennials	35.76	12.95	3.12**	< 0.001
Life Forms	Therophytes	28.05	8.12	6.38**	< 0.001
	Hemicryptophytes	24.54	8.26	5.34**	< 0.001
	Cryptophytes	3.39	0.49	4.2**	< 0.001
	Chamaephytes	1.04	0.58	1.04*	0.03
	Phanerophytes	0.17	0.19	-0.18	0.85
Growth Forms	Grasses	23.73	5.38	6.99**	< 0.001
	Forbs	35.58	13.37	6.29**	< 0.001
	Shrubs	1.04	0.58	1.03	0.31
	Sub-Tree	0.17	0.19	-0.18	0.85
Palatability Class	Class I	31.14	2.22	10.78**	< 0.001
	Class II	12.43	1.79	5.45**	< 0.001
	Class III	11.71	12.12	-0.13	0.89
Plants Family	Apiaceae	3.14	1.74	1.42	0.16
	Asteraceae	5.31	2.06	2.43*	0.03
	Brassicaceae	0.37	0.39	-0.09	0.92
	Caryophyllaceae	1.54	0.50	2.21*	0.03
	Fabaceae	6.85	0.58	5.78**	< 0.001
	Poaceae	23.73	5.38	6.99**	< 0.001

**, *= difference between two regions significant at 1 and 5% probability level.

Group response of plant species in the fire and control regions

The group response of plant species in the fire and control regions was investigated using RDA analysis. In this method, a significant effect of fire on plant community was observed (P=0.001 and F=6.62). Species in the two-dimensional space of this analysis were affected by fire (Fig. 1). Species such as *Bromus danthoniae*, *Bromus tomentellus*, *Vicia villosa*, *Astragalus hispanicus*, *Ziziphora tenuior*, *Bunium rectangulum*, *Ferulago angulate*, and *Gundelia tournefortii* were increased in the regions where fire occurred (Fig. 1). On the other hand, species such as *Scorzonera calyculata*, *Eremostachys macrophylla*, *Crepis sancta*, *Amygdalus lycioides*, and *Torilis arvensis* showed no response to fire (Fig. 1).

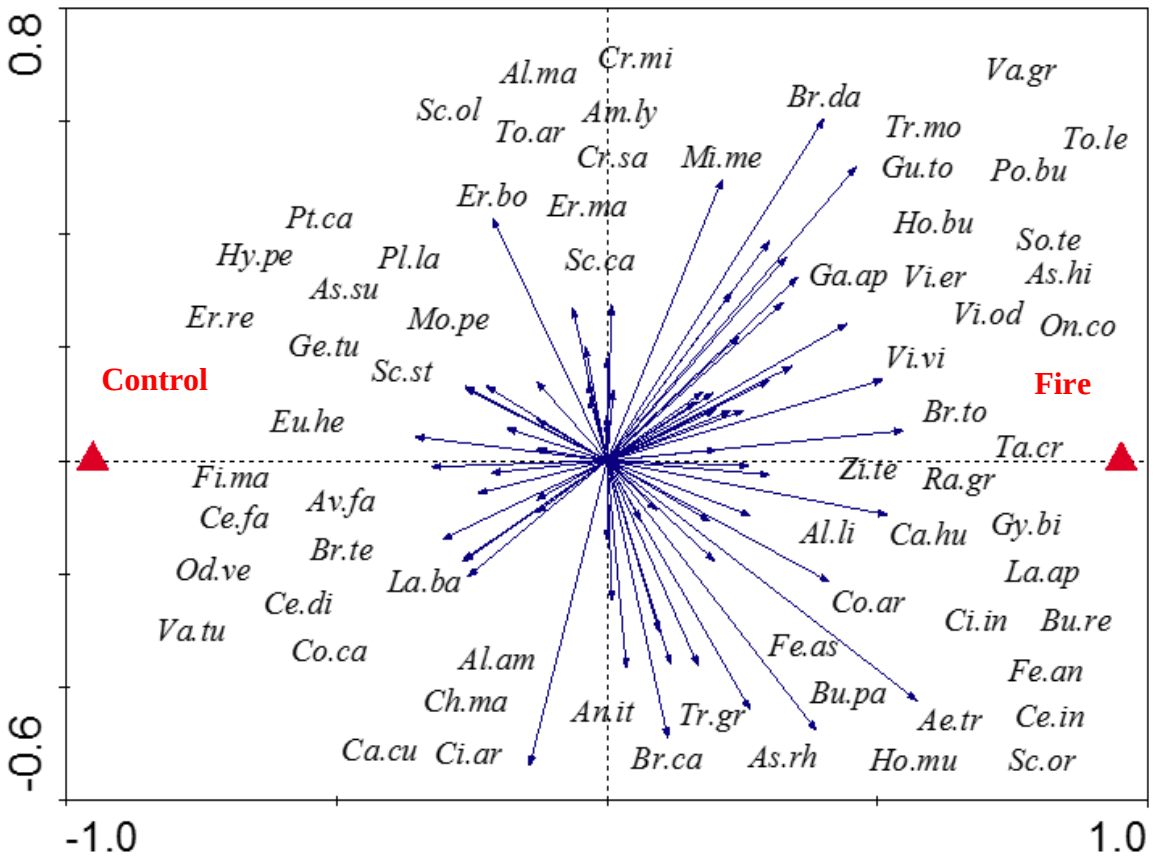


Fig. 2. Binary diagram of species- environmental factors in RDA analysis. Triangles signs on the diagram are environmental factor including fire and control regions. The first two-letter represents the scientific name of the genus and the second two letters are the species, which are marked with an arrow, and their full name is given in Table 1.

Discussion

Considering the increasing number of fires in rangeland ecosystems in the country, it seems that the study of the changes caused by fire in various parts of the ecosystem is necessary for post-fire management. The results of the present study showed that the plant composition of the study area was changed by fire. Among all species identified in the study area, 17 species were related to the fire region, and 14 species were found only in the control region, also 37 species were common in the fire and control regions. The fire caused the species to be present exclusively in the control area and not found in the fire area, indicating their sensitivity to the fire (Mansouri, 2009). The exclusive establishment of some species after the fire could be due to the growth and presence of opportunistic annual plants with a short lifespan, growing rapidly and producing seeds (Rafiee *et al*., 2014; Mirzaei Mossivand *et al*., 2015). The results indicated that 22 out of 37 common species showed a significant response to fire, of which 15 species had a positive response and six species had a negative response. Baghestani Maybodi *et al*. (2010) reported the various effects of fire on vegetation of rangelands in Yazd province. The fire was effective in eliminating the unfavorable species; however, all of them were not removed.

The results of the present research also demonstrated that fire had a significant effect on richness and diversity indices in the study area. Also, the fire resulted in the increased species diversity and richness due to the reduction of perennials and creation of proper soil moisture and soil

fertility (Haubensak *et al.,* 2009). The results of our study were in agreement with those of Killgore *et al*. (2009) (Southwest New Mexico), Fattahi and Tahmasebi (2010) (central Zagros, Iran), and Rafiee *et al*. (2014) (Jozak, north Khorasan, Iran).

The increase of annuals such as grasses in the fire region can be resulted from the destruction of litter and the creation of open spaces, providing a suitable bed for the germination of seeds available in the soil seed bank (Zida *et al*., 2007; Mirzaei Mossivand *et al*., 2015). The results of our study were also consistent with those of Mirdavoodi *et al*. (2013) who performed a study on Iranian oak forests in Dalab area, Ilam province, Iran after three years of fire. They reported that the fire led to a change in vegetation (converting the species to annual and opportunistic species). Moreira *et al*. (2003) studied the sea pine forests in northern Portugal for five years and reported the growth of herbaceous species in the fire area after one year.

Among the functional groups, the Asteraceae, Caryophyllaceae, Leguminosae, and Poaceae were increased in the fire zone because the plants had small seeds and after the fire, the seed reserves in the soil seed bank caused the germination and growth of the plants of these seeds (Fenner and Thompson, 2005). Besides, in the arid and semi-arid regions, the seeds of most species of legumes and grasses are dormant after falling, but fire triggers them and their seeds start to grow from the seed bank of soil (Gholami *et al*., 2012). In terms of biological form, the highest percentage of the canopy in the fire area belonged to the Therophytes whose presence indicated the degradation conditions and pressure in the region. Rafiee *et al*. (2014) also achieved similar results in their study in semi-arid rangelands of North Khorasan, Iran at different times after the fire. The seeds having germination capability after the fire mainly consist of annual species, which generally have small seeds and make seed banks durable (Fenner and Thompson, 2005). According to the results of the present study, in the fire region, the plants with life forms of Cryptophytes, Hemicryptophytes, Chamaephytes had higher vegetation cover than that of the control regions due to the resistance of perennials against fire and their cover is increased after fire occurrence. Fire is one of the determinant disturbances affecting vegetation structure and functions. The post fire vegetation recovery is influenced by fire derived smoke influencing seed germination. This influence could play an important role in vegetation restoration (Abedi *et al.,* 2018).

In general, it can be said that the vegetation of the Zagros area is adapted to this phenomenon due to the occurrence of fire. In spite of the tangible changes in composition, diversity and functional groups of vegetation during the first years over time, it tends towards the primary composition before the fire. Since the lack of livestock grazing and its pressure could be effective, the continuous study after the fire is recommended. Meanwhile, the plant composition can change with opportunistic management after the fire.

References

Abedi, M., E. Zaki, R. Erfanzadeh, and A. Naqinezhad. 2018. Germination patterns of the scrublands in response to smoke: The role of functional groups and the effect of smoke treatment method. South African Journal of Botany, Vol. 115: 231–236.

Ahmadi, J., M. Farzam, and A. Lagzian. 2017. Investigating Effects of a Prescribed Spring Fire on Symbiosis between Mycorrhiza Fungi and Range Plant Species. Journal of Rangeland Science, Vol. 7, No. 2: 138-147.

Assadi, M., A.A. Masumi, M. Khatamsaz, and V. Mozaffarian. 1991-2005. Flora of Iran, No. 1-43. Research Institute of Forests and Rangelands Press., Tehran. (In Persian).

Atrakchali. A, 2000. Fire effects on vegetation changes in Golestan National Park, Iran. Range management M. Sc. Thesis, University of Mazandaran, 85p.

Azarnivand, H, and M.A. Zare Chahooki. 2008. Rangeland restoration. Tehran Univ. Press, 354p. (In Persian).

Baghestani Maybodi, N., M. Farahpour, and M.T. Zare. 2010. Effects of fire on vegetation cover

in steppe rangelands of Iran (case study: rangelands of Yazd province). Journal of Environmental Science, Vol. 7, No. 3: 37-42. (In Persian).

Banj Shafiei, A., M. Akbarinia, Gh. Jalali, P. Azizi, and M. Hosseini. 2006. Effect of Fire on Herbal Layer Biodiversity in a Temperate Forest of Northern Iran. Pakistan Journal of Biological Sciences, Vol. 9, No. 12: 2273-2277.

Bowman, D.M, and B.P. Murphy. 2010. Fire and Biodiversity: Conservation Biology for All, Oxford University Press. New York, 163-196.

Fattahi, B, and A. Tahmasebi. 2010. Fire influence on vegetation changes of Zagros mountainous rangelands (Case study: Hamadan province). Rangeland Journal, Vol. 4, No. 2: 228-239.

Fenner, M, and K. Thompson. 2005. The Ecology of Seeds. Cambridge University Press.

Ghahraman, A. 1978-2003. Colorful Flora of Iran. Vol.1-20. Research Institute of Forests and Rangelands Press. (In Persian).

Gholami, P., J. Ghorbani, and M, Shokri. 2012. The similarity between species composition of vegetation and soil seed bank under different grazing intensities in Mahoor, Mammasani rangelands, Fars Province. Journal of Range and Watershed Management, Iranian Journal of Natural Resources, Vol. 64, No. 4: 437-451. (In Persian).

Haubensak, K., C. D'Antonio, and D, Wixon. 2009. Effects of fire and environmental variables on plant structure and composition in grazed salt desert shrub lands of the Great Basin (USA), Journal of Arid Environments, Vol. 73, No. 6: 643–650.

Jamshidi Bakhtar, A., M.R. Marvie Mohadjer, Kh. Sagheb-Talebi, M. Namiranian, and H. Maroufi. 2013. Alteration of plant diversity after fire in Zagros forest stands, case study: Marivan forests. Iranian Journal of Forest and Poplar Research, Vol. 21, No. 3: 529-541. (In Persian).

Jazirehi, M.H, and M. Ebrahimi Rostaghi. 2005. Silviculture in Zagros. Tehran Univ. Press. 560 p. (In Persian).

Killgore, A., E. Jackson, and W.G. Whitford. 2009. Fire in Chihuahuan Desert grassland: Short-term effects on vegetation, small mammal populations, and faunal pedoturbation. Journal of Arid Environments. Vol. 73: 1029-1034.

Mansouri, A., 2009. Effect of fire as an ecological factor on vegetation composition and dynamics in semiarid rangelands (Case study: Bamo National Park of Shiraz). M.Sc. thesis in rangeland science,University of Mazandaran, 83p (In Persian).

Mirdavoodi, H.R., M.R. Marvi Mohadjer, Gh. Zahedi Amiri, and V. Etemad. 2013. Distribution effects of plant diversity and invasive species in western Oak communities of Iran (Case study: Dalab forest, Ilam). Iranian Journal of Forest and Poplar Research, Vol. 21, No. 1: 1-16. (In Persian).

Mirzaee, M.R., P. Gholami, and E. Jahantab. 2018. Species composition and diversity changes in semi-steppe rangelands of Zagros under biological restoration. Journal of Rangeland Science, Vol. 12, No. 3: 330-340.

Mirzaei Mossivand, A., F. Keivan Behjou, E. Zandi Esfahan, and A. Ghorbani. 2015. Assessment of Fire Effects on Surface Cover Changes and Forage Production (Case Study: Delfan County, Lorestan Province, Iran). Journal of Rangeland Science, Vol. 5, No. 1: 60-71.

Moreira, F., A. Delgado, S. Ferreira, R. Borralho, N. Oliveira, M. Inacio, J.S. Silva, and F. Rego. 2003. Effects of Prescribed Fire on Vegetation Structure and Breeding Birds in Young *Pinus pinaster* Stands of Northern Portugal. Forest Ecology and Management, Vol. 184: 225-237.

Pourreza, M., H. Safari, Y. Khodakarami, and S. Mashayekhi. 2009. Preliminary results of post fire resprouting of manna oak (Quercus brantii Lindl.) in the Zagros forests, Kermanshah. Iranian Journal of Forest and Poplar Research, Vol. 17, No. 2: 225-236.

Rafiee, F., H. Ejtahadi, and M. Jankju. 2014. Study of Plant diversity at different time intervals after burning in a semiarid rangeland. Journal of plant Researches (Iranian Journal of Biology), Vol.27, No. 5: 854-864. (In Persian).

Shahrokhi Sarduo, S., R. Bagheri, H. Ahmadi, and Fatemeh Mahdavi. 2012. Investigation of Fire Effects on Physical and Chemical Characteristics of Soil in Golandaz Dehbekri Rangeland. Journal of Rangeland Science, Vol. 2, No. 2: 465-471.

Tahmasebi, P. 2013. The survey of damaging effects and potential use of fire as a vegetation management tool for Semi-Steppe rangelands. Journal of Rangeland and Watershed Management, Vol. 66, No. 2: 287-298. (In Persian).

Zida, D., L. Sawadogo, M. Tigabu, and P.C. Oden. 2007. Dynamics of sapling population in savanna woodlands of Burkina Faso subjected to grazing, early fire and selective tree cutting for a decade.Forest Ecology and Management, Vol. 243: 102- 115.

اثر آتش‌سوزی بر تغییرات ترکیب، تنوع زیستی و گروه‌های گیاهی در مراتع نیمه-استپی زاگرس جنوبی

پرویز غلامی[الف]، محمدرضا میرزائی[ب*]، احسان زندی اصفهان[ج]، علیرضا افتخاری[ج]
[الف]دکتری علوم مرتع، گروه مرتع‌داری، دانشکده منابع طبیعی، دانشگاه علوم کشاورزی و منابع طبیعی، ساری، ایران
[ب]استادیار، گروه جنگلداری و پژوهشکده منابع طبیعی و زیست محیطی دانشگاه یاسوج، ایران *(نگارنده مسئول)، پست الکترونیک: mrm.mirzaei@gmail.com
[ج]استادیار، بخش تحقیقات مرتع، مؤسسه تحقیقات جنگلها و مراتع کشور، سازمان تحقیقات، آموزش و ترویج کشاورزی، تهران، ایران

چکیده. آتش به‌عنوان یک عامل بوم‌شناختی بر اجزای تشکیل دهنده هر اکوسیستم اثرات مثبت و منفی دارد. هدف از انجام این تحقیق بررسی تأثیر آتش‌سوزی روی تغییرات ترکیب، تنوع و گروه‌های کارکردی پوشش گیاهی در مراتع تنگ‌سرخ شهرستان بویراحمد می‌باشد. آتش‌سوزی در تابستان ۱۳۹۴ صورت گرفت و ویژگی‌های پوشش گیاهی پس از گذشت دو سال از آتش‌سوزی در پلات‌های یک مترمربعی اندازه‌گیری شد. نتایج نشان داد ۱۷ گونه فقط در منطقه آتش‌سوزی و ۱۴ گونه نیز تنها در منطقه شاهد حضور داشته و ۳۷ گونه بین دو منطقه مشترک بودند. نتایج مقایسه میانگین‌ها نشان داد که از بین گونه‌های گیاهی مختلف، ۲۱ گونه از لحاظ درصد تاج پوشش پاسخ معنی‌داری نسبت به آتش‌سوزی داشتند. آتش‌سوزی در منطقه سبب افزایش شاخص‌های تعداد گونه، تنوع سیمپسون و شانون-وینر و شاخص غنای مارگالف شده است. آتش‌سوزی موجب شد تا درصد تاج‌پوشش گیاهان یکساله، علفی چندساله، گندمی، پهن‌برگ علفی، تروفیت‌ها، کریپتوفیت‌ها، همی‌کریپتوفیت‌ها و تیره‌های Asteraceae، Caryophyllaceae، Fabaceae و Poaceae به طور معنی‌داری نسبت به شاهد افزایش یابد. نتایج آنالیز افزونگی (RDA) نیز نشان داد که گونه‌ها پاسخ‌های متفاوتی نسبت به آتش‌سوزی داشتند، به طوری‌که درصد تاج‌پوشش گونه‌های *Bromus danthoniae*، *Vicia villosa*، *Bromus tomentellus*.، *Astragalus hispanicus*، *Ziziphora tenuior*، *Bunium rectangulum*، *Ferulago angulate* و *Gundelia tournefortii* در منطقه آتش‌سوزی بیشتر بود. براساس نتایج این تحقیق، گروه‌های گیاهی نقش مهمی در تعیین پاسخ گونه‌های گیاهی به عوامل مخرب محیطی دارند و از این‌رو می‌توانند بر مسیر توالی ثانویه مرتع پس از آتش‌سوزی تأثیرگذار باشند.

واژه‌های کلیدی: آتش‌سوزی، آنالیز چند متغیره، شاخص‌های تنوع زیستی، تیره گندمیان، زاگرس