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The effects of fire on the shrubs in a semiarid region of Iran

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Abstract

This study explores the effects of fire on changes of shrubs coverage percentage in a semi-arid region in southern Alborz Mountain northeastern of Iran. Effects of the fire on shrubs were investigated by means of transects and quadrates in the first spring season after a fire with one-year intervals during the research. In each quadrate, percentage of canopy cover measured. A completely randomized block design used with two treatments (control and burned rangelands) for 3 years (2008-2010). The results showed that the effect of fire on shrubs was negatively significant and the difference between year and studied areas was significant. The cover percentage of shrubs such as *Rosa persica, Amygdalus lycioides and Astragalus gossypinus* were decreased duration 2008-2010 in burned area in compare of unburned rangelands. In fact, fires have a significant negative effect on changes of shrub plants cover. These findings indicate that rangeland management strategies in semi arid regions should be flexibly take into account disturbances based on fires.

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Introduction

Shrubs are a dominant component of many vegetation formations and provide important ecosystem services including supporting herbivores and preventing soil erosion. Many natural fires occur in arid and semi arid rangelands that may result in destruction of desirable forage and also erosion of valuable rangeland's soil which eventually will lead to great environmental and financial losses. If prescribed burning is implemented according to rangeland management principles, it will be one of the factors of management and improvement of rangeland vegetation in different ecosystems, especially in the Mediterranean climate (Abbasi *et al*., 2010). The role of fire in shrubs ecosystems has been intensely investigated in recent years (Worthington and Corral, 1983., Platt *et al*., 1988., Moreno and Oechel, 1991., Drewa *et al*., 2002).

In the early 1920s, in the United States, fire was used to improve rangeland management (Moghaddam 2005). The use of fire to control shrubs has been encouraged by the belief that repeated burning has been responsible for maintaining certain sub climax and disclimax grass land types in various parts of the world (Cable, 1967). Fire may be effective on different aspects of growth and development of plant communities. Burning is one way of removing invasive and inferior species from pastures. So that in later years they will be replaced by palatable herbaceous species.

Firing is one of the managing tools to maintain grasslands and wildlife. Controlled fires eliminate woody shrub plants and improve pasture forage. Prescribed fire is one way to prevent the spread of invasive and unconscious plants, This method is used in countries such as America and Australia as a pasture improvement method (Sharifi and Iemanie., 2006). One of the main objectives of grassland fires is increasing forage production. Fires may be a suitable prevention for the reduction in grazing capacity caused by the invasion of woody plants, or may be programmed for increasing forage production of the pasture by converting shrub land to grassland. Reduction or delay in the growth of woody plants will provide opportunities to improve livestock distribution and more uniform forage utilization (Mesdaghi, 2009).

Shokri *et al*., (2002) when observing the impact of fire on vegetation found that grass species such as *Stipa pennata* and *Festuca valessiana* compared with the control area, are Significantly higher (at 1%), while woody species such as *Rosa persica* and *Acanthophylum punges* have been significantly reduced. Moreover, the study of Safaian *et al*., (1998) in researching the role of fire in plains grasslands of northern Iran shows that in the early years of firing, woody species, population decreases. Sharifi and Iemanie (2006) with studies performed in the Khalkal exclosure research found out that in the second year after the fire, the amount of perennial grasses, such as *Bromus tomentellus* and *Festuca ovina* increased from 51.97 percent to 63.80 percent (total coverage). Hundred percent of perennial grasses had revived in the fourth year, Moreover it was shown the reaction of the grass to fire was different in a way which had a positive effect on *Agropyron* sp. and negative effect on *Stipa* spp. production. Also, the second year after firing vegetation cover acanaceous shrub such as *Astragalus persicus* and *Onobrychis cornata* were decreased from 34.28 % to 18.68%. Khodagoli *et al*., (2001) showed the effects of fire on Semirom rangeland, production of shrub plants decreased and consequently, conditions to develop other species, particularly grass kinds, has been is provided. Also the second years after firing Golestan National Park, perennial grass such as *Festuca drymeia* were rehabilitated (Zare-Maivan and Memariani. 2002). In the Steppe Rangelands of Yazd, grass *Stipa Barbata* was almost destroyed by fire (Baghestani and Zare. 2008). In North American Ciska *et al*., (2004), showed which fire and grazing often has disparate effects on plant resources and plant diversity. They conducted a field study to determine the interactive effects of different long-term fire regimes (annual four-year fire frequency). Annual fire increased

community dominance and reduced species richness and diversity, particularly in the absence of grazing, but had no effect on community heterogeneity. We investigated the effects of fires in eliminate of shrubs in semi arid areas by measuring changes in shrub cover after burning and unburned areas to determine the direct effects of burning on decreasing of cover percentage of shrubs after three years of burning.

Materials and methods

Study area

The study area is located at 30 km North east of Karaj in the Alborz zone, north of Iran. This area is a part of the Rangeland plan Kordan Research, located between the latitudes 35° 50´ and 35° 55' North and the longitudes 50° 51' and 50° 55' East, with altitude is about 3500 m asl. Based on Demartan's classification, the area is classified in semi-arid climatic regime, which is characterized by a cold winter and mild summer. The average annual precipitation is about 22 mm, 35.9 percent of which falls as snow. The area receives the maximum rainfall in spring and the minimum in summer. The mean annual temperature is 10.4 °C. The soils of area are shallow to moderately deep with stoniness and clay loam texture. According to studies dominant vegetation type in the study area consists of perennial grasses, forbs and shrubs, which form different vegetation types (table. 1), (Karimi and Goudarzi 2011).

Table 1. Dominant and common shrubs species of the study area.

Scientific name	Family name
Acantholimon sp	Plumbaginaceae
Acanthophyllum glandulosum	Caryophyllaceae
Ajuga chamaecistus	Labiatae
Amygdalus lycioides	Rosaceae
Artemisia sieberi	Compositeae
Asperula glomerata	Rubiaceae
Astragalus molis	Fabaceae
Astragalus spp	Fabaceae
Centaurea virgata	Compositeae
Convolvulus arvensis	Convolvulaceae
Eryngium bungei	Umbelliferae
Heliochrysum oligocephalum	Compositeae
Noaea mucronata	Chenopodiaceae
Stachys inflate	Labiatae
Ziziphora clinopodioides	Labiatae

Statistical Analysis

The distribution map of burned area was prepared using aerial photographs, topographic map and by visits to the study area. Then two 100 m transects were positioned within the burned areas and a parallel transect to each was established in similar unburned habitat (control treatment). Density of shrubs coverage was determined in 10 1m² plots for 3 years from 2008 to 2010. To compare different between control and burned rangelands, a nested completely randomized design with following model was used:

$$X_{ijk} = \mu + \tau_i + \varepsilon_{ij} + \delta_{ijk}$$

(i=1, 2, 3, j=1, 2, 3, and k=1, 2, 3)

μ is the general mean of plant canopy cover. τ_i Is location effect, and ε_{ij} and δ_{ijk} are experimental and sampling errors, respectively. Data were analyzed using Minitab, version 16 and SAS then means were compared with Duncan test.

Results and discussion

The fire in burned areas duration tree years, evidently reduced shrubs coverage from %0.41 to %0.24. In compared the plant coverage (shrubs) in unburned areas in increased from %0.28 to %0.43.

Comparing the densities of the shrubs plant species in the burned and unburned transects are showed in table 2.The results showed that average percent of cover of shrubs in the burned area was more than control area in the first year. But the second and the third year canopy cover of shrubs in the control area was more than the burned pastures.

Table 2. Average of shrubs coverage percents within burned and unburned plots from 2008-2010.

Year	Areas	Mean of cover percent
2008	Burned	0.41
	Un burned	0.28
2009	Burned	0.28
	Un burned	0.41
2010	Burned	0.24
	Un burned	0.43

The ANOVA test of differences on shrubs coverage percents between two treatments (burned and unburned areas) showed that the area*year interaction term is significant (table 3). In fact fires for consecutive years have a negative significant effect on changes of the shrubs coverage.

Table 3. Results of ANOVA for the differences on shrubs coverage percents within burned and unburned plots from 2008-2010.

Source of variance	Mean squares of year	Mean squares of area	Interaction mean square of year *area	The mean square error (MSE)	Coefficient of variation (C.V)
cover percentage of shrubs	0.005 $^{n.s}$	0.11*	0.26 **	0.025	26%

$^{n.s}$ No significant differenc** 1% level at Significant differences.

Changes of shrubs canopy percent in two areas and their trends are shown as diagram in fig. 1. According to this fig. 1, it's distinguished that the fire has a positive and significant effect on reduction of shrub cover. While fire to increase the coverage of shrubs only the first year after the fire has had a positive effect.

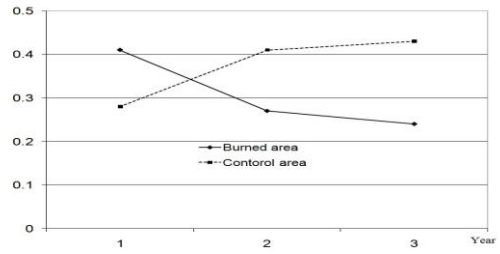
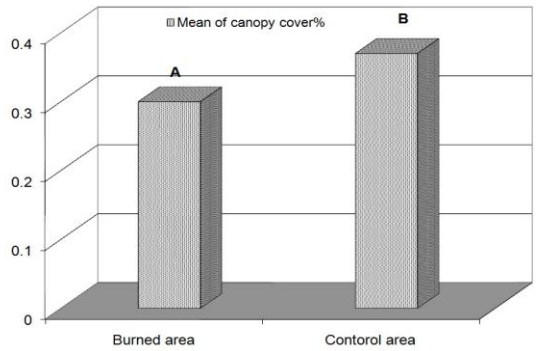


Fig. 1. Changes of shrub average canopy cover in burned and unburned areas during 2008-2010.

It is clear that means shrubs coverage in three years was not statistically significant but in two treatments of region was significant (fig 2). In other words, fires for shrub cover has negative effect after a time and over time it caused reduction in shrub cover percentage in the burned area and a raise in the cover percentage was observed only in the first year.



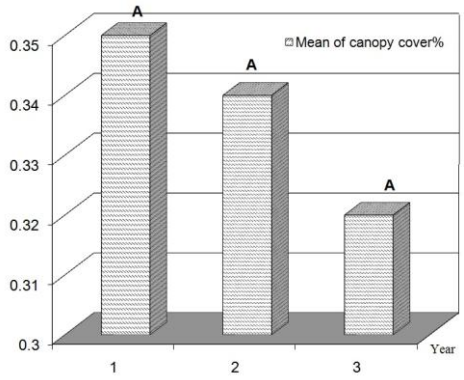


Fig. 2. Comparison of mean shrubs canopy cover% in three years Statistical in two burned and control area.

Conclusion

Fires in many years were negative significant effect on the amount of vegetation on shrubs. Over time, in the burning area percentage of canopy cover of shrubs such as *Rosa persica, Amygdalus lycioides and Astragalus gossypinus* were decreased and their tissues (living and non-living) had been eliminated. This corresponds with the results of other researchers such as Safaian and Shokri, (1998), Sharifi and Iemanie (2006), Baghestani and Zare (2008), Revitalization of shrubs was shown four years after burning in protection research area of Khakhal, Only about 30 percent of plant regeneration have been determined (Sharifi and Iemanie, 2006). The study of Effects of the fire on stepped grassland in Yazd Province was shown that rangeland burning has led destruction of plant species such as *Artemisia siberi, Noaea mucranata, stipa barbata* and *Cousinia deserti* approximately (Baghestani and Zare, 2008). Lonsdale *et al.*, (1998) examined plots that had been

burnt, and compared them with adjacent un-burned plots they found that vegetation components responded to the fires differently: forbs (dicotyledonous herbs) increased in cover, while perennial grasses, woody plants, and overall species richness, were not significantly affected. Shrub species may be reduced for the following reasons: In shrub lands of arid and semi-arid area a significant portion of the seeds are destroyed by fire and seed germination is related to seed bank (Abbasi Moselow *et al.*, 2010). The shrub losses is due to, in shrubs seedlings grow above the ground that more damage in front of fire and woody stems also adds intense strength and heat to burn them and the rising vulnerability of plants is determined (Fattahi and Tahmasebi, 2010). Also, fire decreases woody plants and shrubs, and reduces their ability to compete with grasses for light, moisture and nutrients absorption (Carleton and Loftin, 2000).

In general, rangeland management strategies in semi arid regions should be flexibly take into account disturbances based on fires, because recent analysis of fire frequency and associated long-term patterns of shrub expansion documented that periods without fire (>4 years) are necessary for recruitment of new shrub species and individuals (Heisler *et al.*, 2003).

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