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ORIGINAL ARTICLE

An Investigation on Effect Fire on Soil Surface Cover in Grasslands and Shrubbery in Homo Climatic Condition

R. Siahmsnsour[1], H. Arzani[2]. M. Jafari[3], S, A. Javadi[4], A. Tavili[5]
1- Science and Research Branch, Islamic Azad University,Tehran, Iran.
2- Faculty of Natural Resources,University of Tehran, Karaj, Iran.
3- Faculty of Natural Resources, University of Tehran, Karaj, Iran.
4- Department of Range Management, Science and Research Branch, Islamic Azad University, Tehran, Iran.
5- Faculty of Natural Resources, University of Tehran, Karaj, Iran.
Email:siahmansour191@gmail.com

ABSTRACT
Fire difference influence on plant production in variant habitats this cause for reduce plant production and it is influence on soil negative. But may be opportunity for plant growth or increasing production, seeds disperse and reduce of plant competition. This project accomplished in Zagheh and Frakash with 500 meter distance to first region, these sites in 35 km of north eastern of Khorramabad, they sites climate condition is resembling each other, with 18.4 °c temperature average, 119 glacial days and 1183 mm yearling average evaporation, in longtime. Average in density and stone % cover non shown significant difference between of average treatments, but in burnt area in Zagheh increased of 14 % to 16 %. In Farakash site fire could canopy cover as a factor of soil conservation of 72 and 71 % in control area reduction to 53 and 57 % in 2012 to 2013. Average total factors of soil surface cover in control and burnt areas are significant differences between meaning ($p < 0.01$). In Farakash site is not significant between meaning of litter factor in control and burnt areas in 2012 and 2013. But in Zagheh region burnt area with 16 % meaning of litter cover in 2013, burnt area was high group compare than control area.
Key words: *"fire " , "canopy cover", "density", "litter", "soil conservation ", "rangelands"*

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INTRODUCTION

Most scholars believe that fire has negative impacts on soil as it destroys soil and ecosystem nutrients and exhausts soil fertility seriously [8, 19]. Fire, in any scale, has different natures with different environmental impacts [20]. Despite the fact, there are only a few studies on these relations in different ecosystems. Literatures and observations show that fire has a broad range of effects on ecosystems with different consequences. Burning is a natural event with vital effect on natural cycles. Today, after man-kind activities, whether civil or agricultural, fire is the most comprehensive element destroying natural ecosystems [42]. By burning plants and changing sequence pattern as well as plant resources [38] fire affects natural ecosystems [38]. It has been introduced as the most important and economical tool for brush management purposes. Also, [17] stated that managerial tools of fire and grazing intensity in brushes result in a relative increase in fodder production and species diversity. According to [25], some species are very sensitive to fire and never recovered following a fire unless via seed. However, the controlled fire or combustible substance role in the progress of gross growth through destroying woody plants has been well documented all over the world [9, 20, 10, 25, 15, 16, 11, 13, 22]. Controlled fire, however, decreases strong fire risk which in turn prevents the destruction of wildlife and rangeland structure [18, 39]. In a short term, of course, controlled fire may show the same effects of destructive fires [1, 9, 41] and in addition to vegetation they may destroy soil horizon and nutrients but the sources are rehabilitated and re-grown very soon and vegetation becomes denser. [31] Stated that the fact that fire decreases canopy cover and brush aerial parts and woody plants is a definite fact. The decline is apparent in the frequency and density of plants which in turn prepares a proper environment for growth and

establishment of perennial grasses and forbs thanks to the decreased competition on light and accessible nutrients. Plants are seriously affected by fire in the meaning that in combination with fire low dense brushes result in the decrease or elimination of competition between perennial and local grass seedlings due to increased accessibility to nutrient, light and soil [5,27,33]. Accordingly, grass and forbs covers and biomass are increased [3, 7].

Although fire has different effects on production rate of different sites and it can decrease the production rate of pasture species with negative effect on soil quality [34] sometimes, however, it serves as a proper opportunity promoting plant production and seed dispersal and decreasing plants competition [30]. Differences of post and pre fire results have made it a managerial technique which is widely used for achieving different objectives [21]. With its different effects fire is a main and essential tool in rangeland management [41] and it can be employed as a cheap and economical tool for this purpose [22]. Therefore, investigating fire behavior in different plant species and in different sites has research value so that based on the obtained results decisions may be made about the implementation of controlled fire as a method for improving rangelands in different ecological regions.

MATERIALS AND METHOD

This study was carried out in Zaghe station of pasture plants research located 35 km from north east of Khorramabad with 33°, 29″ N latitude and 48°, 42″ E longitude with an average altitude of 1960m as well as Farakesh site, located 500 meters from the former site, with 33°, 29′, 33″ to 33°, 30′, 12″ N latitude and 48°, 38′, 57″ to 48°, 40′, 56″ E longitude. Since the sites are adjacent to each other with the same altitude, they have the same climate. In the region, relative humidity, annual average temperature, number of frozen days and annual evaporation rate are 54%, 18.4 centigrade degrees, 119 days and 1183 mm, respectively. Type *Agropyron trichophorum- Bromus tomentellus- Festuca ovina* with 500 hectares area and type *Astragalus adscendens-Daphne mucranata-Agropyron trichophorum* with 173 hectares area fired in Zaghe Pass heights and Farakesh heights, respectively. The key areas were determined and a total of four 200-m transects were created in each treatment in each site. Ten stationary one square meter plots on each transect formed one of the sample units. An area next to the study area, which was not damaged by conflagration, was also selected as the congruent are (Figs. 1 and 2). In the context of this research, production refers to the germination of plants in the growing season under study by employing precise methods of cutting, balancing and concentrating plants. The basic numbers of plants per area unit (inside of plots) and canopies were obtained by calculating the perpendicular cross sections of plants. In this study, the statistic population included four 200-m transects with ten one square meter plots that are situated every 20 meters. A total of 320 plots existed in the study areas and 32 two hundred meter transects existed in the control area (containing 160 plots annually). Samples were taken from the site from 2012 to 2013. In sum, 160 one square meter plots were studied each year and a total of 320 plots had been studied by the end of the research. All of the parameters in the study area were measured as well. Following the sampling phase data was normalized using the natural logarithm (LN) and was analyzed using the T-TEST and ANOVA analysis method. A comparison was also drawn between the data using the DUNCAN method. Results of the aforementioned analyses and comparisons are presented in the following section.

Figure (1): images of control area (left hand) and fire area (right hand) in Zaghe site in one picture

Figure (2): image of control area (left site) and fire with uncovered blotches and bare soil (right side) in Farakash site

RESULTS AND DISCUSSION

Statistical Distribution

First of all it should be checked that whether data have normal distribution in order to decide that whether they could be statistically processed and to define their reliability. Fig. 3 shows the studies statistics and normality test results.

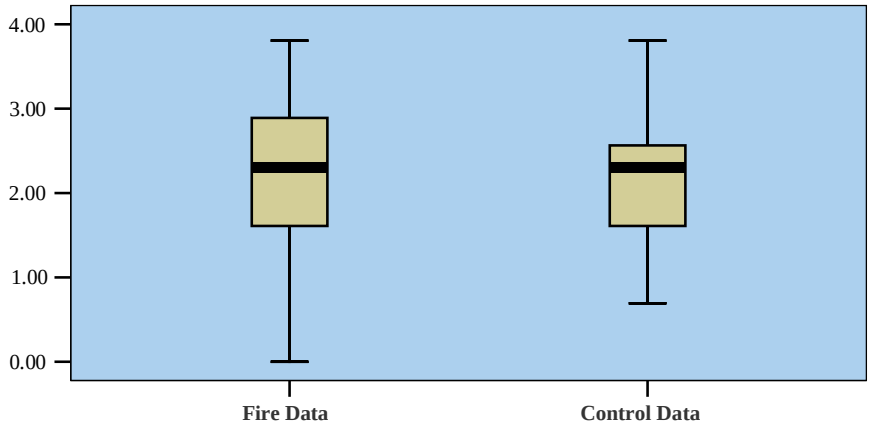

Figure (3): data mean normality curve in terms of treatment

Statistical assessments reveal that the collected data have a normal distribution and they could be statistically analyzed.

Statistical Analysis of Data

ANOVA analysis of between-group comparisons indicates that in a sig. level of 1%, there is a significant difference in canopy cover and bare soil percentage indices between both sites and both representative and fire treatments (see table 1).

Table (1): ANOVA analysis of surface soil coverage factors

S.V	Site	F		MS	S.S	Sig level
		Treatment	Groups			
Density	Farakash	3	599	186	557.8	ns
	Zagheh	3	502	572.4	1717.2	ns
Canopy	Farakash	3	815	18781.24	56154.7	0.01< P
cover	Zagheh	3	737	5429.7	16289.2	0.01<P
Litter	Farakash	3	815	100.3	300.9	ns
	Zagheh	3	737	591.9	1775.6	0.01< P
Stone	Farakash	3	815	57.6	172.8	ns
	Zagheh	3	737	0.83	2.48	ns
Bare soil	Farakash	3	815	18855.2	54765	0.01<P
	Zagheh	3	737	8255.1	26853.32	0.01<P

Table (2): comparison of mean of indices in the studied sites in terms of data collection year and treatment using Duncan test

Year / treatment	Site	S.D) ± Factors and (M				
		Density(n/m²)	Canopy cover %	Litter %	Stone %	Bare soil %
Fire 2012	Farakash	a 2.3 ± 37.9	c 1.6 ± 53	a13 ±0.820	a4 ± 4.3	a30 ± 1.5
	Zagheh	a 1.6 ±21.2	a 0.76 ± 82	bc14 ± 0.73	a0.3 ± 0.12	c3.7 ± 0.31
Fire 2013	Farakash	a 4.1 ± 40.6	b 1.3 ± 57	a12 ± 0.72	a4.5 ±0.44	a26.5 ± 1.2
	Zagheh	a 1.3 ± 20.9	b 0.85 ±80	a16 ±0.67	a0.2 ± 0.05	c3.8 ± 0.31
Control 2012	Farakash	a 2.9 ± 36.6	a 1.2 ± 72	a12 ± 0.72	a3.8 ± 0.34	b12.2 ± 0.86
	Zagheh	a 3.2 ± 44.7	d 0.61 ± 70	c12.5 ± 0.54	a0.1 ± 0.04	a17.4 ± 0.88
Control 2013	Farakash	a 3.8 ± 40.4	a 1.1 ± 71	a13 ± 0.73	a5.1 ± 0.47	b10.9 ± 0.79
	Zagheh	a 1.74 ± 22	a ±0.57 75.5	ab15.2 ±0.46	a0.2 ± 0.11	b 9.1 ± 0.59

Assessment of Density Index

The Studies show, however, that mean values of density, stone percentage and gravel percentage indices show no significant difference in the sites (see table 1). In Zaghe site, however, under the influence of organic residuals of annual plants, one year after fire the mean of litter percentage increased from 14% in 2012 to 16% in 2013 in fire area and promoted from (bc) class to (a) class in 2013 (see table 2).

According to statistics, *Agropyron trichophorum* species has the highest density index among other species with an average density of 30.9 unit per m² in fire area and 24 unit per m² in representative area in 2012 while in the same site the average density was 30.3 and 30.5 unit per m² and class (a) in representative area in 2012 and 2013, respectively. Among perennial species, the mentioned species has the highest density index in Zaghe site similar to Farakesh site so that in 2012 and 2013 i.e. one and two years after the fire the mean values were respectively 7.4 and 5.4 unit per m² in fire area and 30.4 and 39.02 unit per m² in representative area. This implies that fire has drastically affected density and resulted in a considerable decrease of the species. Fire, however, has resulted in a significant decrease in density and canopy cover of *Daphne mucronata, Astragalus adscendens* species so that the mean difference of density in two areas is significant ($P<0.01$). The extent of decrease is so high that the density of brush species of *Astragalus adscendens* in representative area is 45 times more than that of fire area. However, the density of *D. mucronata* species in representative area is 6 times more than that of fire area. The findings agree with [23, 24, 28].

Assessment of Canopy Cover

In Farakesh site fire has decreased canopy cover, as the most effective factor of soil prevention, in representative area respectively from 71 and 72 in 2012 and 2013 to 53 and 57 so that comparisons reveal that (see table 2) in representative area it has been decreased from class (a) to class (c) in 2013 and class (b) in 2013 and the difference between average values in representative and treatment is significant in sig. level of 1% (see table 1). The situation is different to some extent in Zaghe site so that the mean of canopy cover has been increased respectively from 72 and 75.5 in 2012 and 2013 in representative area to 82 and 80 in fire area. In other words, canopy cover has been increased from classes (d) and (c) in representative area to classes (a) and (b) in fire area in 2012 and 2013, respectively. Generally, fire has decreased canopy cover in Farakesh site while it has increased it in Zaghe site. The contradiction can be traced in the difference of location and related dominant vegetation. Although the sites have no significant difference due to adjacency, in Farakesh site, however, woody species like brush species of Astragalus adscendens and daphne plant are dominant and they have been substituted with *Ag. trichophorum* species following fire (see figure 2). In Zaghe, however, stable grass species like *Ag. trichophorum, Festuca ovina, Bromus tomentellus, Hordeum bulbosum* are dominant in representative area and following the fire, site type changes to annual plants type with *Taeniatherum crinitum, Heteranthelium piliferum, Helianthemum ledifolium* species as the dominant plant (see figure 1).

Clearly, due to its dense species and lots of litter and residuals from previous years Farakesh site is capable to experience more serious fire with higher temperature and duration. This serious fire can exhaust vegetation of parts of soil and destroy a main part of seed bank of soil. In Zaghe, however, due to decreased competition, which is a result of the elimination of perennial plants and low intense fire compared with Farakesh, the distance between perennial plants' bases are filled with annual plants which in turn results in canopy cover increases. This argument can justify the decrease and increase of canopy cover in Farakesh and Zaghe, respectively. The results agree with [26,35] results but disagree with [32] results stating that one year after a fire the density of annual plants increases again (which is in contrast with observations of this research in Zaghe).

Assessment of Litter and Organic Residues

In Farakesh site, there was no significant difference between mean values of treatments and their repeating in 2012 and 2013 while in Zaghe site fire treatment with a litter coverage of 16% was placed in the high rank (a) in 2013 (P<0.01). This could be attributed to the existence of annual plants residuals in 2012 in the site which had not been used due to the enclosure of the site. However, the canopy cover in the site is 80% of which 47.7% i.e. more than 59% belong to annual plants which are converted to litter after death. In 2012, canopy cover of the fire area in the site was 82% of which 58.6% i.e. 71.5% belong to annual plants canopy cover and considering the short life of the plants they are converted to litter following full growth. Therefore, in the studied two years, the mean result of two years is 53.2% annual plant coverage in fire area. If they are not used, the accumulation of combustible and dry materials in the site will seriously increase fire risk. [4, 12, 37] stated as their findings that if dense grassland are used for grazing purposes before fall, fire risk will be decreased.

Assessment of Stone, Gravel and Bare Soil

Clearly, burning of vegetation and organic residues in rangelands does not result in the increase or decrease of stone or gravel but it affects their appearance so that following a fire and destruction of vegetation and litter, as two important layers protecting soil surface, stone and gravels become more apparent in soil surface so that layers overlap disappears. It could be argued that, therefore, if the surface of a rangeland has a lot of stone and gravel with a considerable amount of vegetation and litter, a significant increase in the amount of stone and gravel will be expectable after a fire. Since there are not so much stone in the rangeland of representative area they do not experience serious changes following a fire and there is no significant change in the factor between the treatment and representative areas (p<0.01 , 0.05).

Following an intense fire, the amount of bare soil, in the lack of many stones in a site, is the inevitable product of burning and one can expect that it will be increased following every fire. However, the comparison of means shown in table 2 as well as cumulative mean shown in table 4 implies that fire treatment in Zaghe site with the least mean of bare soil of 3.7% and 3.8%, in 2012 and 2013 respectively places in the lowest rank of (c). Conversely, in Farakesh site fire treatment in 2012 and 2013 with a mean bares soil of 30% and 25.5%, respectively places in the highest rank of (a). Therefore, in Zaghe the mean soil percentage is lower in fire area while in Farakesh, it is more in both years in representative area (p<0.01). This indicates that the effect of fire on soil coverage will differ depending on vegetation type and location and it depends on fire mechanism, produced temperature, fire intensity and duration, litter amount and combustible substance portion in vegetation and soil surface.

Germination mechanism of plants regrowth process is an effective factor in the establishment of plants in the burnt areas. According to the mentioned matters, brush plants in Farakesh site experience more temperature, ash and fire, both intensity and duration, compared with perennial grasses. On the other hand, the growth rate of brush plants and shrub is very slower than annual and perennial grasses. To this end [2] states that following a fire, the amount of grasses increases while the amount of brush plants decrease due to the fact that woody brushes no longer germinate on one hand and on the other hand seed seedlings have been established there for many years. [6,36] have confirmed this theory.

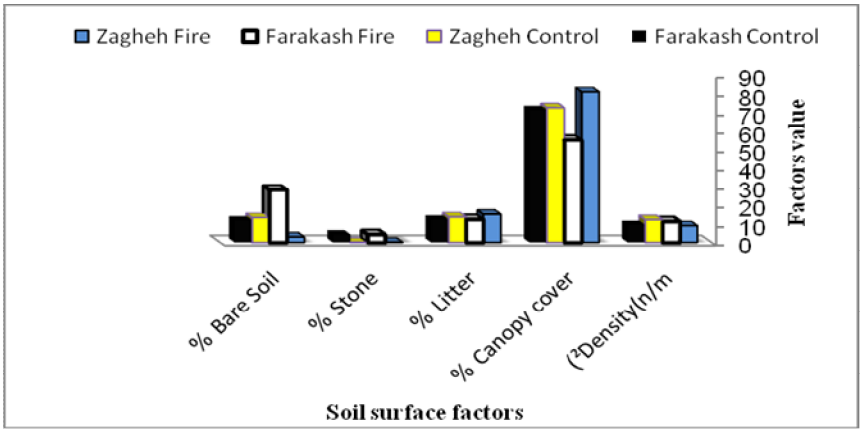

Figure (4): Cumulative mean of soil surface coverage in Zaghe and Farakesh sites

CONCLUSION

In different locations fire shows different behaviors with different impacts in terms of fixed factors. This means that the ecological impacts of fire should be assessed in laboratory scale. Fire could be considered as a strong protective factor for growth of brush and woody plants so that controlled fire can be used as

an efficient and cheap corrective tool for controlling and decreasing non qualified and woody plants. Fire makes changes in soil surface coverage and decreases positive factors of soil protection in a short term. Among different factors of soil surface coverage, litter and bare soil percentages have the maximum decrease and the maximum increase, respectively.

Livestock grazing in rangelands and grasslands should be managed in order to stabilize and preserve rangelands ecosystem. Non proportional grazing will result in the accumulation of litters which in turn increases temperature during fire due to the increased amount of combustible substance in pastures, especially during long-term enclosures, which in turn increases fire risk. The results obtained from the enclosure of Zaghe site and comparison of species and types variation in different sites strongly emphasizes on this argument.

Fire considerably decreases production rate and canopy cover and reduces relatively stabilized grasses in short terms. Different species show different resistances against the same growth form. *Bromus tomentellus, Festuca ovina* , *Agropyron trichophorum* species, for example, are all stabilized grasses and bromus and festuca species are degraded under the influence of fire and while agropyron species more resists and presents in fire area. The difference may be attributed to volume, phonology, part configuration and more scattered root system of the species compared with *Bromus tomentellus, Festuca ovina*. This matter, therefore, must be considered by authors and planners in rangeland management and livestock grazing as well as rangeland rehabilitation programs Range management does not welcome accidental and mistaken fire. Instead, pre and post fire planning along with grazing management is necessary.

In the sites where annual plants are dominant, production, accumulation, canopy cover and soil surface coverage are drastically decreased resulting in the increase of soil sensitivity to splash erosion. In this condition short term enclosure and grazing management are necessary actions which should be practiced.

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