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Investigation of Fire Effects on Physical and Chemical Characteristics of Soil in Golandaz Dehbekri Rangeland

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Abstract. Awareness of the effects of fire on various aspects of an ecosystem after the fire, is important for range management. Changes in soil physical and chemical properties caused by fire can be the cause of changes in the vegetation. In this study, effects of fire on physical and chemical characteristics of soil were investigated. This research was carried out in a randomized block design method in the Golandaz rangeland of Bam. The variables in two treatment sites (with firing and without fire treatment) were organic carbon, nitrate, phosphor, potassium, EC, pH, percentage of sand, silt and clay, and soil structure. The results showed that absorbed potassium, silt, nitrate, organic carbon, EC, and pH are increased in fired site comparing to control site. Other elements including clay content, absorbed potassium, phosphorus, EC, and pH in fire site were not significantly different from control site.

Key words: Fire, Ecological factors, Chemical/Physical characteristics of soil, Golandaz dehbekri rangelands.

Introduction

There are some severe threats in considerable areas from firing event all years that effect on their health and qualities. All natural or/and anthropogenic firing events that occur in these areas change nutrient cycle, biological cycle, chemical and physical properties of soil, and moisture and temperature of soil (Banj Shafii, 2006). Intensity and duration of firing event are determined by some factors such as damaging power of fire, moisture and soil type, percentage and kind of vegetation, topography, fire season, and weather condition before and after firing event. Intense firing event oxidizes many nutrient components as nitrogen and causes disturbances in soil and its relationship for many decades. Firing event causes oxidizing of organic material, converts them into CO_2 and water, and realizes energy as heat.

One of the important factors for rangeland soil conservation is litter extended by firing event. Furthermore, vegetation cover prevents soil landslides, avalanche, movement of fine sands and soil erosion. Thus, survival of vegetation cover causes slowly water flow on soil surface and therefore modulates water sources, and conservation values of vegetation cover reduces in firing events. Lombardero (2004) compared physical and chemical properties in burned site with intact site in first 10 cm of soil in 1998, 1997, 1996. She reported that pH, EC, K, Na, Mg, Ca and absorbed phosphorus are increased significantly while organic carbon and nitrogen are decreased. In another research, Adhami *et al.*, (2009) investigated fire effects and burning of unharvested field on clay fraction modification and some physico-chemical characteristics of soil surfaces. They found increasing in pH and percentage of sand in 0-5 cm and absorbed phosphorus and potassium in both sampled depths in forest soil.

The objectives of this research are to investigate the effect of fire intensity on quantity/quality changes of forest herb vegetation and some physico-chemical features of range soil. These features include percentage of organic carbon, pH, EC, N, absorbed phosphors and potassium.

Materials and Methods

Characteristics of the study area

The study area located in South East Iran-Kerman, Bam city- part Dehbakri-Golandaz rangeland in the North West city of Bam, 55 kilometers distance from Bam. The latitude and longitude of the site are between 3210000 to 3210400 and 591500 to 592100, with a height of 2530 meters above sea level and the average slope of 35 degrees (Fig. 1).

The climate of this area is mountain climate with cold winters and mild summers. Average ten-year rainfall is 370 mm and maximum average temperature $21/2^{\circ}\text{C}$ and minimum average temperature $8/7^{\circ}\text{C}$. The number of frost days is 71 days.

The understudy rangeland is covered by tree, bush, shrub, and forbs. Dominant species in this area are *Acer monspessulanum*, *Amygdalus elaeagnifolia*, *Astragalus glumaceus*, *Artemisia aucheri* and *Taeniatherum*.

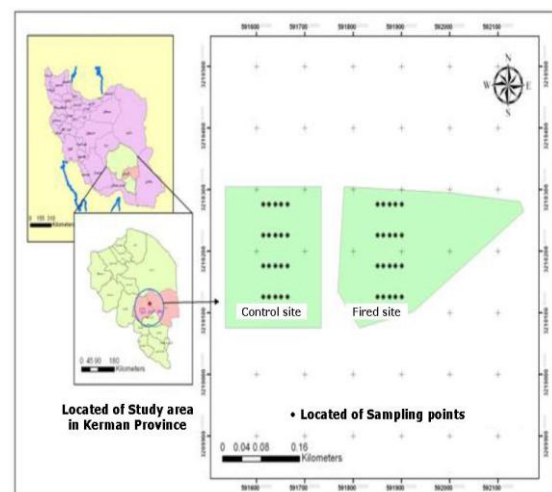


Fig. 1. Map of study area location in the Kerman province, Iran

This rangeland was damaged because of over grazing and excessive livestock before exclusive and also range condition was poor. Exclusion of this rangeland was announced by expert in 2005 in order to prevent destruction of the natural resources. However, in July 2008, 5 hectares of these areas were fired by the negligence of the tourists.

This study was conducted in two sites including control and firing site.

Statistical Design and Analysis Methods

After collecting the data, Golandaz rangeland was selected. Map of rangeland was prepared by GPS and more than 5 hectares of this firing rangeland were selected for the study.

The other region was selected near the firing site with similar habitat conditions. It is because of elimination the margin effects in proper distance from firing site. The data was collected in randomized block design and four replications were used in order to compare with the effects of firing in soil characteristics. For soil sampling, four transects located along 100 meters in each site. Five profiles with 0-30 cm depth were dug with 25 m

distance from each other and finally 40 soil profiles were sampled (Fig. 1). Some researches show that it can be at depth of 0-10 cm (Savado *et al.*, 2007) therefore in this investigation only depth of 0-30 cm was studied. 40 soil samples on each area (e.g. 20 samples in fired site and 20 samples in control site that was not burned), and 40 soil samples totally were drawn out and moved to the laboratory. They were dried out in the open air. Roots, leaves and others serrated from samples. Then samples were grinded and passed from 2 mm mesh and also studying factors were measured in the lab.

Statistical Analysis

The gathered data were processed using Excel software 2007, and their analyses were performed on the SPSS Version 17. The factors of two sites were compared by Paired Samples Statistics T-test method. The graphs were depicted by Excel soft wear. The results of soil experiments in 0-30cm depth have been presented in (Tables 1 and 2). Tables 3 and 4 show the taken compared analysis in two sites.

Table 1. Collected data of soil analyzing in firing site (soil depth 0 – 30 cm)

Soil Texture	K p.p.m	P p.p.m	Total N %	Organic Carbon O.C%	Clay %	Silt %	Sand %	pH	EC×10 ³	Soil Characters
										Sampling Location
S-L	250	14.6	0.091	1.108	13	28	59	7.6	1.76	Transects 1
S-L	391	4.8	0.075	0.879	11	29	60	7.5	1.78	Transects 2
S-L	242	2.8	0.091	1.108	15	21.4	63.6	7.6	0.824	Transects 3
S-L	228	19.2	0.135	1.758	10.4	24.8	64.8	7.2	1.45	Transects 4

Table 2. Collected data of soil analyzing of soil in control site (was not burning). (soil depth 0 – 30 cm)

Soil Texture	K p.p.m	P p.p.m	Total N %	Organic Carbon O.C%	Clay %	Silt %	Sand %	pH	EC×10 ³	Soil Characters
										Sampling Location
S-L	242	58.2	0.046	0.459	7.4	20.8	66.8	7.6	0.500	Transects 1
S-L	328	4.2	0.057	0.612	11.4	19.8	68.8	7.2	1.43	Transects 2
S-L	235	21	0.046	0.459	5.4	19.8	74.8	7.5	0.999	Transects 3
S-L	257	8.6	0.049	0.497	11.4	18	70.6	7.4	1.04	Transects 4

The Electrical Conductivity (EC) EC × 103, soil reaction (pH), percentage of Sand%, Silt%, Clay%, Organic Carbon (O.C)%, Total N%, Total absorbed phosphorus, P (ava) ppm, potassium absorbed K (ava) ppm and Soil texture

Results

Results of soil experiments in 0-30 cm depth indicate that average percentages phosphors and sand in firing site is lower than the control site, but EC, pH, percentage of silt, percentage of clay, percentage of organic carbon, percentage

of Nitrogen and percentage of potassium in higher than the control site. Table 3 - Comparison of results of soil parameters show average difference between the average standard deviation of 95% of the difference between safe top down.

Table 3. Comparison of results of soil parameters in two sites with standard deviation of 95%

Soil Characters	Mean	Std. Error Mean	Mean Difference	95% Confidence Interval of the Difference		T test	Significant
				Lower	Upper		
EC	0.4613	0.5938	0.2696	-0.4836	1.4061	1.554	0.281 ns
pH	5.0	0.2028	0.1014	-0.2812	0.3812	0.48	0.688 ns
Sand %	-8.4	2.2450	1.1225	-11.9723	-4.8277	-7.453	0.005 **
Silt %	6.2	3.2414	1.6207	1.0422	11.3578	3.826	0.031*
Clay %	3.45	5.0587	2.5343	-4.6152	11.5152	1.361	0.276ns
O.C %	0.7065	0.4112	0.2065	5.22	1.3608	3.434	0.041*
N %	4.85	2.805	1.403	3.861	9.314	3.458	0.041*
P %	-12.65	23.838	11.9193	-50.5825	25.2825	-1.061	0.366 ns
K %	11.985	37.4838	18.7419	-47.6602	71.6302	0.639	0.58ns

The asterisk (*) shows the significant at P level (P< 0,05), The asterisk (**) shows the significant at P level (P< 0,01), n.s do not significant

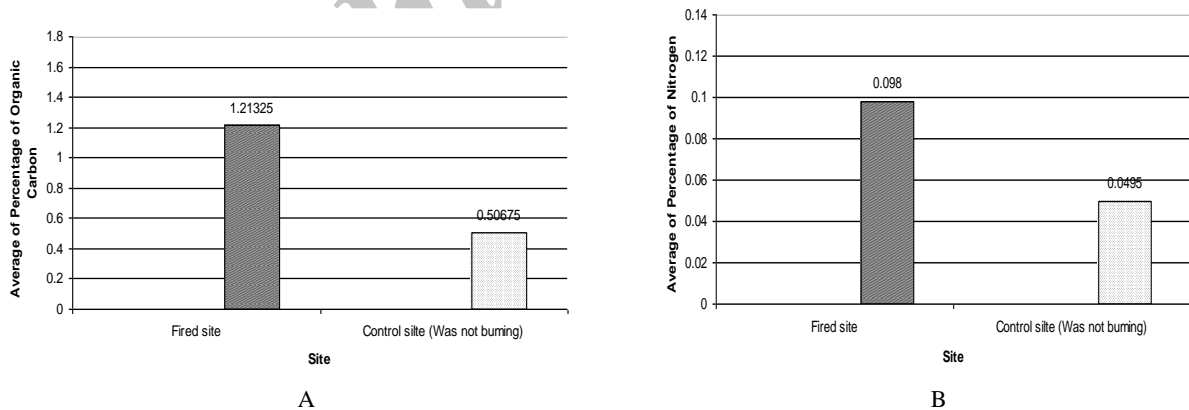


Fig. 2. Comparing Graph of the significant characters in this study, A (Percentage of Organic carbon), B (Nitrogen)

Conclusion and Discussion

After 2 years of firing, results showed that fire had no significant effect on EC, pH, percentage of clay, absorbed potassium, but it significantly affected

organic carbon, and nitrogen. Percentage of organic carbon and nitrogen are increased due to fire. The main effects of fire on soils are: loss of nutrients during burning and increased risk of erosion

after burning. In fact, the latter is related to the regeneration traits of the previous. This reduction in percentage of sand is probably because of high temperature of fire that fractures sand particles and converts them to silt. Because of losing of water by clay particles, other elements such as P and K could become lower or higher might reduces or increase. (Malakoti and Homaii, 1994).

Fire effect on EC (Electrical Conductivity)

Electrical Conductivity (EC) did not show a significant difference in two sites and it is different from the results of Banj Shafii (2006), Alavziz *et al.*, (2004) and Lombardero (2004) which reported significant increasing in this factor.

After firing, salt P and K neither reduces nor increase, and therefore salinity is not changed. In some cases, if the plants were halophytes, it is possible that after firing event, these elements deliver to soil and cause the increasing of soil EC (Malakoti and Homaii, 1994).

Fire effect on pH (potential of Hydrogen)

pH didn't show any significant difference and it is different from results reported by Banj Shafii (2006), Adhami *et al.*, (2009), Ballard (2000), Arocena and opio (2002), C. C. Rhoades *et al.*, (2004) and Lombardero (2004) that remarked significant increasing of soil pH in firing site. Abarsaji *et al.*, (2011) showed that controlling fire in the short term had no effect on the pH, EC and soil texture. Changing of soil pH condition by a firing event or by increasing or decreasing an element in soil is called tampon feature. This soil tampon indicates power of soil in tolerance against increase or decrease of soil pH and therefore unchanging in pH caused by firing might be due to high power of soil tampon that maintains soil pH constantly. In this condition, changing in pH in short time comes back to balance situation.

vegetation and to the environmental conditions (Certini, 2005). Rouhani *et al.*, (2011) showed that % sand particles, pH, bulk density and soil strength were increased in burned area. The study also showed that soil moisture in burned forest area has been decreased due to fire that reduces the amount of forest litter and humus on the ground and, by doing so; it reduces the soil's capacity to retain water. White-ash on soil indicated intense fire (>400 C) in the study area as consequence clay content was reduce.

Fire effect on O.C % (Percentage of Organic Carbon)

Percentage of organic carbon in firing site showed a significant increase compared to control site, and it is different from results of Banj Shafii (2006) Deban and Neary (1998-1999), Lombardero (2004) which reported a significant reduction in percentage of organic carbon in firing site compared to control site.

Burned organic composition released CO₂ and H₂O by firing, so it seems that there is a reduction in percentage of organic carbon. Nevertheless, results of some researcher showed that grasses cause increasing in organic carbon after firing in soil. Because of low density, firing does not cause mineralization of plants and some of organic matter come back to soil that resulted in increasing of organic carbon in soil (Katherine *et al.*, 1999).

Fire effect on N % (Percentage of Nitrogen)

Percentage of Nitrogen showed a significant increasing in firing site compared to control site. But results of Banej Shafii (2006), C. C. Rhoades *et al.*, (2004) did not show a significant differences in the two sites.

Results of Ballald (2000) and Alavziz (2004) indicated a significant reduction in firing site that differs from another's.

The results observed by this research is in line with the results of Banej Shafii (2006), C. C. Rhoades *et al.*, (2004) that showed significant in percentage of Nitrogen in firing site.

Increasing in percentage of soil Nitrogen after firing might be due to coming back of Nitrogen content of plant to soil. Firing induces bacterial actives and other micro organism and causes increasing in soil Nitrates. (Sazirehe, 2005).

Fire effect on K (Absorbed potassium)

In this investigation, absorbed potassium content did not show a significant difference in two sites and it is in line with results of Banj Shafii (2006). The results of Adham *et al.*, (2009), Alavzis and Coworker (2002), C. C. Rhoades and *et al.*, (2004), showed a significant increasing in firing site that differs from the results of this research.

Results of Arocena and Opia (2002), Alavzia and coworkers (2004), C. C. Rhoades and *et al.*, (2004) and Lombardero (2004) showed a significant increasing in firing site compared to control site that is different form the results of this study.

Suggestions:

- Fire season is very important because phonology of plants are different from each other. If the objective is removing of special plants, firing should be carried out before seeding of plants.

- If the aim is increasing in soil fertility, it should be carried out after seeding. In this way, it did not have an effect on foliage production. Firing season should be selected correctly for removing deleterious plant and improving in growth of useful plant.

- This need is studied regarding the growth and development of plants and this is because of the reason that not only some adverse plant do not remove after firing but also due to temporary fertilization in soil, it is possible to

improve in plants that make a homogenous community.

- The survey was conducted two years after fire Ecological characteristics and the impact of fire on pasture over time is different. Recommended similar studies are done in different time elapsed from the fire burning.

- Because of the effect of fire on soil and runoff increasing, it is recommended for studies to be done in the field of fire and soil erosion.

- Because of relationship between micro-organisms in soil and vegetation, recently and primary the species should be investigated after firing. It is suggested to study the impact of fire on soil micro-organisms occurrence.

- In situations where soil erosion is not limited, removing invasive plants through the barbed fire burning permanent grass plants can be improved and expanded.

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