ECOPERSIA

2015, 3 (1), 901-916

Effects of Grazing and Fire on Soil and Vegetation Properties in a Semi-Arid Rangeland

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Received: 14 February 2015 / Accepted: 18 April 2015 / Published Online: 15 July 2015

ABSTRACT Livestock grazing and rangelands fire are important ecological disturbances influencing the vegetation and soil properties in rangelands ecosystem. This study was conducted to determine the effects of different burned treatments and distances from the water sources on some soil and vegetation properties of rangelands ecosystem. The experiment was conducted in Lashgar Dar Rangelands. Vegetation samplings were done based on the randomized systematic method across transects. Fifty randomized quadrats were sampled at each transect. One hundred soil samples per each transect were systematically taken by auger along each transect. The ANOVA and Duncan tests were employed for statistical analyses. The results indicated that the highest and the lowest above-ground biomass production (630 and 117 kg ha^{-1}), Shannon-Wiener diversity index (2.37 and 1.07), soil TOC (18.34 and 6.66 g kg^{-1}), soil gravimetric water content (16.4 and 6 %) and soil porosity (69.43 and 57.74%) values were found in the unburned rangelands with 2000 m distance from the water source and the one year post burned rangelands with 10 m distance from the water source, respectively. Whereas, the maximum and the minimum values of soil bulk density and soil EC were seen in the one year post burn with 10 m distance from the water source and the unburned rangelands with 2000 m distance from the water source, respectively. There were no relations between the soil pH change trends and the different burned treatments or distances from the water source.

Key words: *Burned rangelands diversity, Ecological disturbances, Soil management, Water resource*

1 INTRODUCTION

Fire as an important disturbance factor alters properties of vegetation (Satterthwaite *et al.*, 2002) in rangelands ecosystems. Several studies have shown that fire significantly increased (Brys *et al.*, 2005) or decreased (Bennett *et al.*, 2002) above-ground biomass production. It has been reported that rangelands plant community diversity may be affected by fire (Whelan, 1995). Vegetation diversity has been reported to increase due to rangelands fire (Safford and Harrison, 2004). Also, vegetation diversity increased by dormant-season fire and decreased by growing-season fire (Brockway *et al.*, 2002). Several reports indicate that the soil bulk density values were higher in burned than in

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unburned sites (Pierson *et al.,* 2008; Wohlgemuth and Hubbert, 2008). So, above ground biomass production, plant community diversity and soil bulk density may positively or negatively change following by fire occurrence. Based on the literature review, several investigators have reported that surface soil water content may be affected (Pierson *et al.,* 2001) or not altered (Soto and Diaz-Fierros, 1997; Vermeire *et al.,* 2005) by fire. The soil moisture content was reduced after fire (Litton and Santelices, 2003; Wohlgemuth and Hubbert, 2008). It was reported that the soil porosity may be affected by fire (Eldiabani *et al.,* 2014). Compared with preburn measurement, the soil porosity of post-burn sites reduced (Wells *et al.,* 1979). Soil surface porosity decreased significantly after fire occurrence (Eldiabani *et al.,* 2014). Therefore, fire occurrence can make some changes in surface soil water content and soil porosity.

In noncalcareous soils, the soil pH increased (Ulery *et al.,* 1996) ephemerally after the fire (Certini, 2005). However, within six months, soil pH in post-fire site returned to pre-fire levels (Boerner *et al.,* 2000).

Literature review indicates that, burning caused a significant increase (Alauzis *et al.,* 2004) or decrease (Dennis *et al.,* 2013) in soil electrical conductivity (EC). Concentrations of total organic carbon (TOC) of soil may be altered (Medvedeff *et al.,* 2013) or not affected (Dai *et al.,* 2006) by fire. The mean soil organic carbon values were reduced (Ekinci, 2006) or increased (Scharenbroch *et al.,* 2012) by burning.

The effects of livestock grazing on rangelands ecosystems were also assessed based on soil and vegetation conditions (Li *et al.,* 2011). Vegetation and soil properties can be affected by grazing (Frank *et al.,* 1995). A wide range of factors may characterize the rangelands changes direction (Bardgett and Wardle, 2003). Based on soil and vegetation conditions, livestock overgrazing may lead to rangelands degradation (Li *et al.,* 2011).

Biomass production is maintained by compensatory growth in response to grazing (Stowe *et al.,* 2000). Compared with the heavily grazed rangelands, light or moderate grazing intensity improved biomass production in the rangeland (Frank *et al.,* 2003). Generally, vegetation biomass is reduced as grazing intensity increased (Milchunas *et al.,* 1988). However, there is some debate about positive (McNaughton, 1983) or negative (Li, 1997) effects of grazing on biomass production.

Defoliation, leaving excreta (Duncan, 2005) and transport of seeds (Olff and Ritchie, 1998) caused by livestock grazing can influence plant diversity. Animal grazing may cause decrease (Zhao *et al.,* 2006) or increase (Proulx and Mazumder, 1998) in the vegetation diversity of the rangeland ecosystems.

Light or moderate grazing may lead to increased plant diversity and altered species composition (Wu *et al.,* 2009). However, heavy grazing has been documented by Zhao *et al.* (2006) to reduce vegetation diversity of the rangeland.

Soil bulk density was significantly higher in the grazed than that in the un-grazed rangelands (Laycock and Conrad, 1967). The study of Tollner *et al.* (1990) indicated that heavy grazing caused an increase in soil bulk density. Soil moisture content as a key indicator of rangelands health may be altered by livestock grazing (Weber and Gokhale, 2011). Soil water content was enhanced significantly by increased livestock grazing intensity (Li *et al.,* 2011). While based on LeCain *et al.* (2000) and Olofsson *et al.* (2008) studies, soil moisture in exclosure livestock grazing was higher than that in the grazed rangelands. Livestock grazing lead to soil compaction which reduces soil porosity (Blackburn, 1984). Soil porosity

[DOR: 20.1001.1.23222700.2015.3.1.3.7]

decreased significantly across increasing grazing intensity (Azarnivand *et al.*, 2011).

It has been reported that soil pH as a main factor of soil chemical characteristics could be altered by livestock grazing (Ratliff, 1985; Firestone, 1995). Soil pH was higher in the low grazing intensity than that in the high grazing intensity (Yates *et al.*, 2000). However, Milchunas and Lauenroth (1993) reported that there were no relationships between grazing and soil pH.

Soil EC in the high grazing intensity rangelands was significantly higher than that in the low grazing intensity (Shahriary *et al.*, 2012).

Livestock grazing alters the organic C supply of the soil in rangelands ecosystem (Wang *et al.*, 2008). Some researchers reported that soil organic C increased by livestock grazing (Reeder and Schuman, 2002). While, other studies showed that soil organic C decreased (Ingram *et al.*, 2008) or was not affected by livestock grazing (Milchunas and Lauenroth, 1993; Wang *et al.*, 1998).

Livestock grazing and accidentally or intentionally fires are the main ecological disturbances which occurred in Lashgar Dar Rangelands. Based on Literature review, the numerical values of biomass production and vegetation diversity (which shows vegetation properties), bulk density, gravimetric water content, porosity, pH, EC and TOC (which shows soil properties) may positively or negatively change following by fire occurrence or grazing intensity.

Therefore, it seems necessity to evaluate and highlight the effect of grazing intensity and fire on soil and vegetation characteristics. So, the present research aimed at study the effect of different burned treatments and distances from the water sources on soil and vegetation properties.

2 MATERIALS AND METHODS

This study was carried out in Lashgar Dar Rangelands at 1750 to 2928 m a.s.l. with 364 mm average annual precipitation (N 34° 12', E 48° 58'). This area is located near Malayer City in Hamedan Province, Iran (Figure 1).

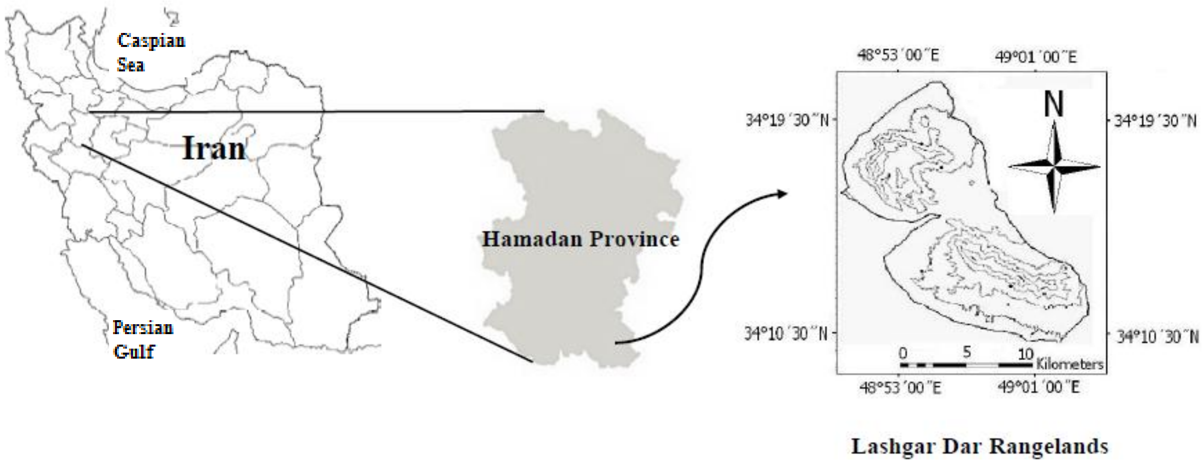

Figure 1 Location of Lashgar Dar Rangelands in Hamedan Province and Iran

Based on piosphere concept (Andrew, 1988), grazing intensity decreased exponentially with increasing distance from the water sources. According to Todd (2006) and Sasaki *et al*. (2012) reports the distance from the water source was surrogated as relative grazing intensity decreased.

So, in the present study 10, 100, 500, 1000, and 2000 m distances from the water source represent various grazing intensities.

One water source was selected in unburned rangelands where livestock grazing during the growing season occurred with no burning occurrence.

Three water sources were selected in one post burned, three and five years post burn in Lashgar Dar Rangelands where livestock grazing during the growing season occurred.

Vegetation samplings were conducted based on the randomized systematic method across 500 m length transects which were placed at 10, 100, 500, 1000, and 2000 m, running perpendicular to each water source in late May 2014.

Fifty randomly chosen quadrats (50 cm × 50 cm) were sampled at the phenological maturity (peak biomass) during the May 2014 in each transect for the above-ground biomass production and vegetation diversity in the study area.

In each quadrat, the plant species were identified and canopy cover of each species was determined in terms of the covered surface to the nearest 5%.

Species diversity in various fires and grazing intensity were calculated and compared using Shannon's index (H) based on Ludwig and Reynolds (1988) method.

Biomass production was determined by cut and weight method. For that, the whole vegetation within each quadrat was cut at the soil surface and placed into paper bags. The aboveground green parts (stem and leaves) were brought to the lab, oven dried at 70 °C for 24 hours and weighed.

2.1 Soil sampling and Analyses

Soil samples were systematically taken by auger in late May 2013 from 0-15 cm depth every 5 m along each transect (100 soil samples per each transect).

Soil bulk density was determined by the core method for undisturbed soil described by Blake and Hartge (1986). The rock fragments greater than 2 mm were separated and discarded from the soil samples to achieve a correct bulk density value (Vincent and Chadwick, 1994).

$$\text{Soil bulk density} = \frac{\text{mass of oven dry soil (g)}}{\text{total volume of soil (cm}^3\text{)}} \quad (1)$$

Soil porosity was measured based on bulk density values assuming a particle density of 2.65 g cm^{-3} (Danielson and Sutherland, 1986).

Gravimetric water content measurements were conducted on soil samples which were taken at 0 to 15 cm depth as described by Gardner (1986) method. Air dried soil samples were sieved through a 2 mm sieve to remove any undesirable plant residues and rocks.

Soil pH and EC were measured with a 1:2.5 soil to solution ratio which was described by Okalebo *et al.* (2002). Soil samples were analyzed for total organic carbon (TOC) by the Walkley and Black (1934) method.

Effects of grazing and fire on soil and vegetation properties on soil and vegetation properties were statistically analyzed by analysis of variance (ANOVA) (at $\alpha = 0.05$).

3 RESULTS

3.1 Effect of different burned treatments and distances from the water sources on the above-ground biomass production

The above-ground biomass production declined significantly along decreasing distances from the water sources in the unburned and various years of post-burned rangelands (Figure 2). There were significant differences found between the above-ground biomass productions (kg ha^{-1}) in the unburned and various years of post-burned rangelands (Figure 2). The highest and the lowest above-ground biomass production values were found in the unburned rangelands with 2000 m distance from the water source (630 kg ha^{-1}) and the one year post burned rangelands with 10 m distance from the water source (117 kg ha^{-1}), respectively (Figure 2).

3.2 Effect of different burned treatments and distances from the water sources on Shannon-Wiener diversity index

The Shannon-Wiener diversity index significantly increased with increased distance from the water sources. The Shannon-Wiener diversity index of vegetation was significantly altered in the unburned and in the one, three, and five years post burned rangelands.

The maximum value of Shannon-Wiener diversity index of vegetation was found in the unburned rangelands with 2000 m distance from the water source (2.43). The minimum value of diversity index was illustrated in the one year post-burn rangelands with 10 m distance from the water source (Figure 3).

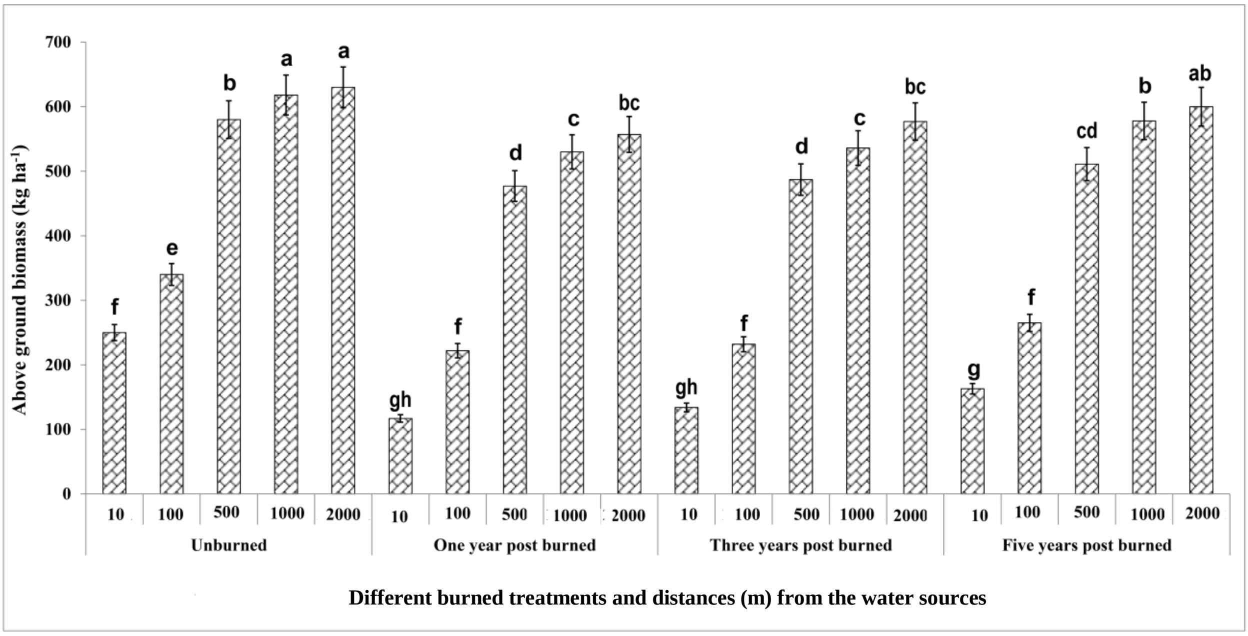

Figure 2 Results of the analysis of variance (ANOVA) of the effects of different burned treatments and distances from the water sources (m) on the above-ground biomass production. Different letters on the bar graphs represent a significant difference (P<0.05) between the above-ground biomass production values in different treatments (P< 0.05)

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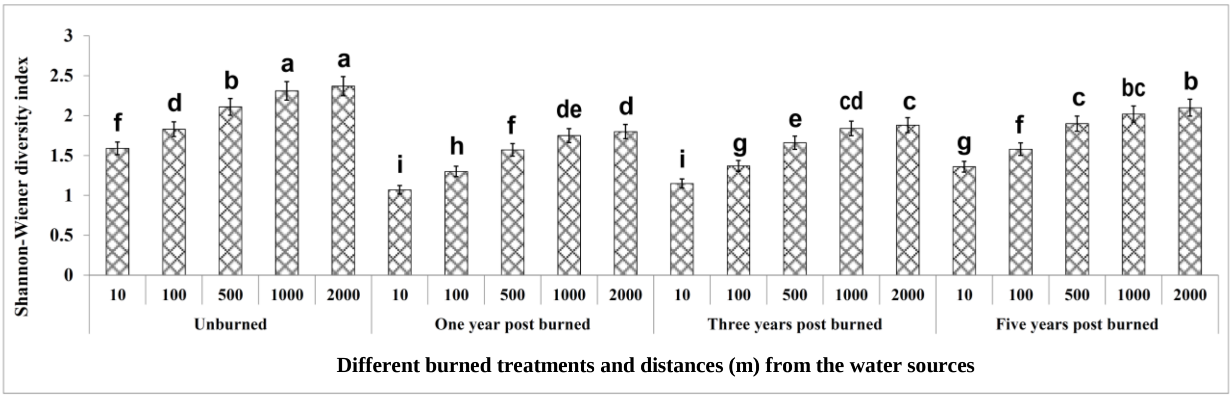

Figure 3 Results of the analysis of variance (ANOVA) of the effects of different burned treatments and distances from the water (m) sources on Shannon-Wiener diversity index. Different letters on the bar graphs represent a significant difference (P<0.05) between Shannon-Wiener diversity index values in different treatments.

3.3 Effect of different burned treatments and distances from the water source on bulk density, gravimetric water content and porosity of the soil

Bulk density of the soil differed significantly across the various burned treatments and distances from the water sources. Bulk density of the soil significantly increased with decreasing distances from the water sources. The highest bulk density values were seen in the one year post burned treatment. Compared with the one year post burned treatment, the unburned, three year, and five year post-burn treatments had lower bulk density values (Table 1). The bulk density values of the soil were the highest (1.12 g cm^{-3}) and the lowest (0.81 g cm^{-3}) in the one year post burned with 10 m distance from the water source and the unburned region with 2000 m distance from the water source treatments, respectively.

Table 1 shows the effects of different burned treatments and distances from the water source on gravimetric soil moisture content. Soil moisture (0–15 cm depth) content varied significantly between the various treatments. The unburned rangelands with 2000 m distance from the water source registered the highest (16.4 %) and the one year post burned rangelands with 10 m distance from the water source had the lowest (6%) gravimetric soil moisture content.

Soil porosity decreased significantly with decreasing distance from the water source (Table 1). The unburned rangelands with the most distance from the water source (2000 m) had the highest (69.43 %) soil porosity, while the soil porosity reduced significantly in the burned regions. The maximum (57.75 %) soil porosity value was seen in the one year post burned treatment with 10 m distance from the water source (Table 1).

3.4 Effect of different burned treatments and distances from the water sources on soil pH

Soil pH was not significantly affected by different burned treatments and distances from the water sources. There were no relationships between the soil pH change trends and different burned treatments or distances from the water sources (Figure 4).

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Table 1 Results of the analysis of variance (ANOVA) of the effects of different burned treatments and distances from the water sources on bulk density, gravimetric water content and porosity of soil

Different burned treatments and distances (m) from the water sources	Bulk density (g cm^{-3})	Gravimetric soil water content (%)	Porosity (%)
Unburned			
10	1.07 ^{ab}	7.40 ^{e}	59.62 ^{e}
100	0.99 ^{bc}	9.80 ^{d}	62.64 ^{cd}
500	0.93 ^{cd}	12.60 ^{bc}	64.91 ^{bc}
1000	0.84 ^{d}	14.50 ^{ab}	68.30 ^{ab}
2000	0.81 ^{d}	16.40 ^{a}	69.43 ^{a}
One year post burned			
10	1.12 ^{a}	6 ^{e}	57.74 ^{e}
100	1.05 ^{ab}	7.9 ^{e}	60.38 ^{de}
500	0.97 ^{c}	10.4 ^{cd}	63.40 ^{c}
1000	0.93 ^{cd}	13.1 ^{b}	64.91 ^{bc}
2000	0.84 ^{d}	14.9 ^{a}	68.30 ^{ab}
Three year post burned			
10	1.11 ^{a}	6.5 ^{e}	58.11 ^{e}
100	1.05 ^{ab}	8.3 ^{de}	60.38 ^{de}
500	0.97 ^{c}	10.9 ^{c}	63.40 ^{c}
1000	0.89 ^{cd}	13.4 ^{b}	66.42 ^{b}
2000	0.83 ^{d}	15.8 ^{a}	68.68 ^{a}
Five year post burned			
10	1.09 ^{ab}	6.8 ^{e}	58.87 ^{e}
100	1.03 ^{ab}	9.1 ^{d}	61.13 ^{d}
500	0.96 ^{c}	11.8 ^{c}	63.77 ^{c}
1000	0.89 ^{cd}	13.9 ^{b}	66.42 ^{b}
2000	0.81 ^{d}	16.1 ^{a}	69.43 ^{a}

Different letters in the same column represent a significant difference ($P<0.05$) between bulk density, gravimetric water content and porosity values of soil in different treatments

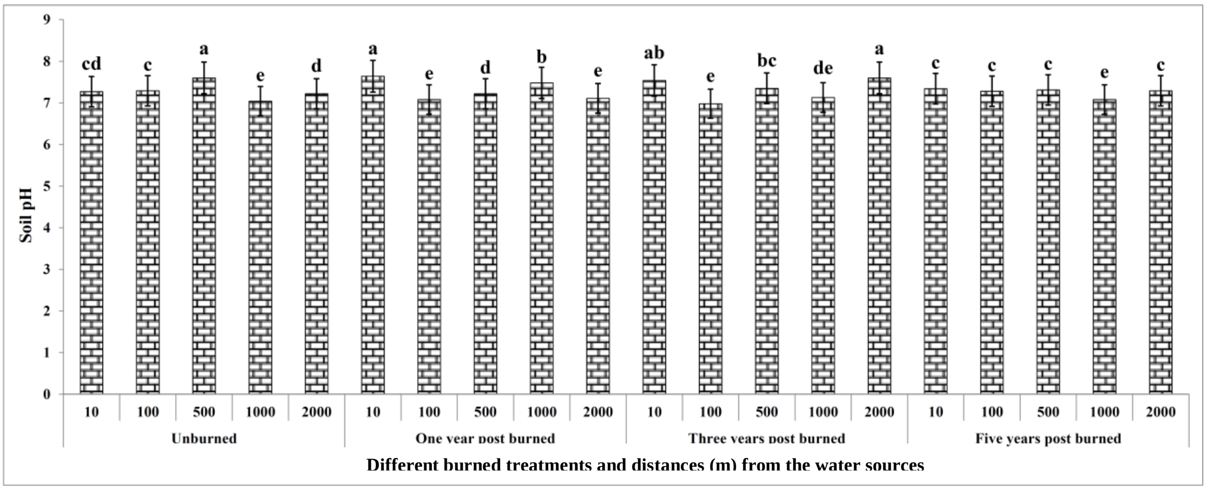

Figure 4 Results of the analysis of variance (ANOVA) of the effects of different burned treatments and distances from the water sources (m) on the soil pH. Different letters on the bar graphs represent a significant difference ($P<0.05$) between soil pH values in different treatments

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3.5 Effect of different burned treatments and distances from the water sources on soil EC

Based on the results of ANOVA (Figure 5), the soil EC increased significantly with decreasing distances from the water sources. Generally, the soil EC values were significantly higher in different years post burned treatments than those of the unburned treatment (Figure 5). The maximum soil EC values were recorded as 0.73 dS m^{-1} for the one year post burn treatment with 10 m distance from the water source. The lowest soil EC values were seen as 0.30 dS m^{-1} in the unburned treatment with 2000 m distance from the water source (Figure 5).

3.6 Effect of different burned treatments and distances from the water source on the soil TOC

The soil TOC significantly increased in the unburned treatment with 2000 m distance from the water source (18.34 g kg^{-1}) (the highest soil TOC values were seen in this treatment). There were significant differences found between the soil TOC in the unburned and all the burn treatments (Figure 6). The soil TOC values significantly increased with increasing distances from the water sources. The lowest TOC value (6.66 g kg^{-1}) was found in the one year post burned treatment with 10 m distance from the water source (Figure 6).

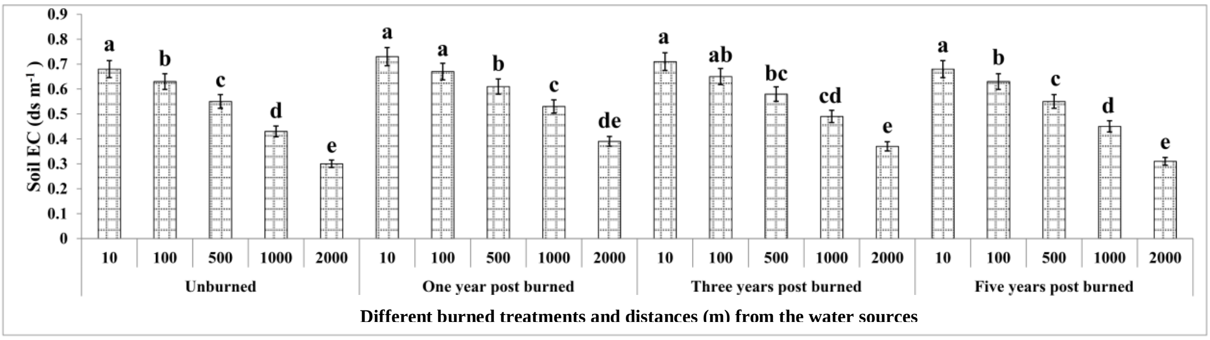

Figure 5 Results of the analysis of variance (ANOVA) of the effects of different burned treatments and distances from the water sources (m) on the soil EC. Different letters on the bar graphs represent a significant difference (P<0.05) between soil EC values in different treatments

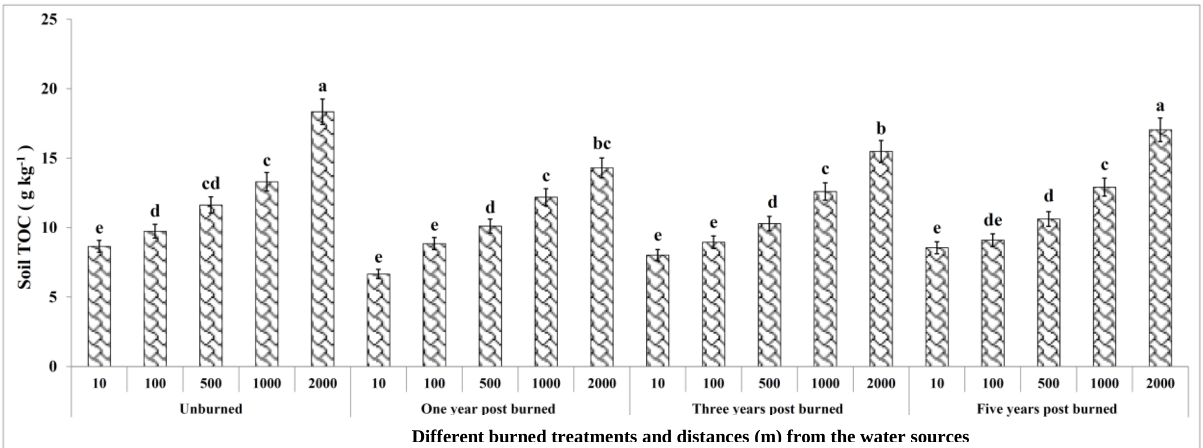

Figure 6 Results of the analysis of variance (ANOVA) of the effects of different burned treatments and distances from the water sources (m) on the soil TOC. Different letters on the bar graphs represent a significant difference (P<0.05) between soil TOC values in different treatments

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4 DISCUSSION

4.1 Effect of different burned treatments and distances from the water source on the above-ground biomass production

The above-ground biomass production values of the plants in the unburned rangelands were significantly higher than those of the burned rangelands. This agrees with the work done by Bennett *et al.* (2002), which reported decrease in the above-ground biomass production after the fire. In contrast, the inconsistent results were reported by Brys *et al.* (2005) who found fire significantly increased biomass production by the plants.

Similar results were reported by other researchers who reported fires could reduce vegetation productivity (Brockway *et al.,* 2002) in semiarid environments where water availability is low (DeBano *et al.,* 1998; Bennett *et al.,* 2002) or nutrient elements are limited (Bennett and Adams, 2001) for plant growth. Fire releases nutrients that were immobilized in the soil organic matter (DeBano *et al.,* 1998).

The above-ground biomass production declined significantly across the decreasing distances from the water sources. Similar results were reported by Milchunas *et al.* (1988) who found vegetation biomass was reduced as grazing intensity increased.

4.2 Effect of different burned treatments and distances from the water sources on Shannon-Wiener diversity index

As it were shown in Figure 3, Shannon-Wiener diversity index values were significantly higher in the unburned rangelands than those of the burned rangelands. In Lashgar Dar Rangelands, fires occur during the growing season. So, this is consistent with the study of Brockway *et al.* (2002) who stated vegetation diversity increased by dormant-season fire and decreased by growing-season fire. However, inconsistent results were reported by Safford and Harrison (2004) who found vegetation diversity increased by fire.

Shannon-Wiener diversity index values decreased significantly by decreasing distances from the water sources (Figure 3). This is in agreement with Wu *et al.* (2009) results that reported light or moderate grazing intensities may lead to increased plant diversity. The consistent results were also reported by Zhao *et al.* (2006) who stated heavy grazing reduced vegetation diversity of the rangelands.

4.3 Effect of different burned treatments and distances from the water sources on bulk density, gravimetric water content, and porosity of the soil

The results of this research indicated that the soil bulk density values were higher on the burned than on the unburned sites (Table 1). Similar results were reported by other researchers (Pierson *et al.,* 2008; Wohlgemuth and Hubbert, 2008).

In all treatments, soil bulk density numerical values were significantly increased by decreasing distances from the water sources (Table 1). These results are consistent with the study of Tollner *et al.* (1990) which found that heavy grazing caused an increase in soil bulk density. The results of the present research are also in agreement with those of Laycock and Conrad (1967) who reported soil bulk density was significantly increased by livestock grazing.

Animal grazing and trampling break down soil aggregates and due to compaction, so soil bulk density significantly increased. The lower intensity livestock grazing have higher level of soil macropores than under heavy grazing intensity treatments. Soil macropores increment due to the increase in soil porosity and decrease in soil compaction. So, soils with higher porosity and lower bulk density have higher gravimetric water content.

Based on the results of this research, the unburned rangelands with 2000 m distance from the water source registered the highest (16.4 %) and the one year post burn rangelands with 10 m distance from the water source was found the lowest (6 %) gravimetric soil moisture content (Table 1).

In agreement with this research, Litton and Santelices (2003) and Wohlgemuth and Hubbert (2008) reported that soil moisture content reduced after burning. Fire remove litter from the soil surface and then the sun can evaporate more soil moisture and soil surface water content decreased. On the other hand, litter removal from the soil surface leading to increment of runoff and decrease of water infiltration rates. The consistent results were also reported by Pierson *et al.* (2001) who found surface soil water content may be affected by fire. In contrast, the inconsistent results were reported by Soto and Diaz-Fierros (1997) and Vermeire *et al.* (2005) who stated soil moisture content may not be altered by burning.

The results of this research indicate that soil water content was enhanced significantly by increasing distances from the water sources (Table 1). These results are consistent with those of other researchers (LeCain *et al.,* 2000; Olofsson *et al.,* 2008) who stated soil moisture content was reduced by animal grazing. However, inconsistent results were reported by Li *et al.* (2011) who found soil water content was enhanced significantly by increasing livestock grazing intensity.

The unburned rangelands with the most distance from the water source had the highest (69.43 %) and the one year post burned treatment with 10 m distance from the water source had the lowest (57.75 %) soil porosity values (Table 1). The results of the present research are in agreement with those of Eldiabani *et al.* (2014) who reported soil surface porosity decreased significantly after burning. The results of the present research are also consistent with the study of Eldiabani *et al.* (2014) who stated soil porosity may be affected by fire.

Soil porosity decreased significantly with decreasing distance from the water source (Table 1). Similar results were reported by Blackburn (1984) and Azarnivand *et al.* (2011) who stated that animal grazing led to reduce soil porosity. Generally, increased soil bulk density caused decreased soil porosity percentage from 2000 m distance from the water sources to those of the 10 m distance. Reduction in soil moisture content in the near distances from the water sources may have been caused by increase in livestock numbers. Animal trampling caused decrease in porosity and water infiltration into the soil which resulted in decreasing soil humidity moisture content (Azarnivand *et al.,* 2011).

4.4 Effect of different burned treatments and distances from the water sources on soil pH

There were no relations between the soil pH change trends and the different burned treatments or distances from the water sources (Figure 4). Similar results were reported by Boerner *et al.* (2000) who found within six months, soil pH in post-fire site returned to pre-fire levels. This is consistent with the study of other researchers who stated soil pH was altered (Ulery *et al.,* 1996) ephemerally after fire (Certini, 2005).

The results of this research are in agreement with Milchunas and Lauenroth (1993) who reported that there were no relationships between grazing and soil pH. However, inconsistent results were reported by Yates *et al.* (2000) who stated soil pH was higher in the low grazing intensity than that in the high grazing intensity site.

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4.5 Effect of different burned treatments and distances from the water sources on soil EC

Based on the present research results, soil EC values were significantly higher in the different years post burn treatments than those of the unburned treatment (Figure 5). Similar results were found by other researchers (Alauzis *et al.*, 2004) who reported EC values of the burnt regions were higher than that of the unburned ones. In contrast, the inconsistent results were reported by Dennis *et al.* (2013) who found burning caused a significant decrease in the EC of the rangelands soils. The results of the present research indicated that soil EC increased significantly with decreasing distances from the water sources (Figure 5).

4.6 Effect of different burned treatments and distances from the water sources on the soil TOC

The significant differences were seen between the soil TOC in the unburned and all burned treatments. The results of this research showed the soil TOC significantly increased in the unburned treatment with 2000 m distance from the water sources (18.34 g kg^{-1}) (Figure 6). These results are in agreement with those of Medvedeff *et al.* (2013) who reported that amount of the soil TOC was altered by burning. In contrast, the inconsistent results were reported by Dai *et al.* (2006) who found concentrations of the soil TOC were not affected by fire.

The results of this research also agree with the work done by Ekinci (2006) who reported that the mean soil organic carbon values were reduced by burning. In contrast, the inconsistent results were reported by Scharenbroch *et al.* (2012) who stated that soil organic carbon concentrations were reduced by fire.

Based on the results of the present research, the soil TOC values were significantly altered across distances from the water sources. The minimum value of the soil TOC (6.66 g kg^{-1}) was found in the one year post burned treatment with 10 m distance from the water sources (Figure 6). These results are in agreement with the results of other researchers (Wang *et al.*, 2008) who stated animal grazing altered the organic C supply of the soil in rangelands ecosystem. The consistent results were also reported by Ingram *et al.* (2008) who found the soil organic C decreased by livestock grazing. In contrast, the inconsistent results were reported by Reeder and Schuman (2002) who found the soil organic C increased by livestock grazing. The inconsistent results were also reported by Wang *et al.* (1998) who reported that soil organic C may not be affected by animal grazing.

5 CONCLUSION

The results of this study have demonstrated that soil and vegetation properties of unburned rangelands with the maximum distance from the water sources is better than other burned and distances from the water sources treatments. Compared with other burned treatments, the worst and best condition of soil and vegetation properties were seen in the one year post burned and unburned rangelands, respectively.

6 REFERENCES

Alauzis, M.V., Mazzarino, E., Raffaele, R.E. and Roselli, L. Wildfirest in NW Patagonia: Long-term Effects on a Nothofagus Forest Soil. Forest Ecol. Manag., 2004; 192: 131-142.

Andrew, M.H. Grazing Impact in Relation to Livestock Watering Points. Trends Ecol. Evol., 1988; 3(12): 336-339.

Azarnivand, H., Farajollahi, A., Bandak, E. and Pouzesh, H. Assessment of the effects of overgrazing on the soil physical characteristic and vegetation cover changes in rangelands of Hosainabad in Kurdistan Province, Iran. J. Rangeland Sci., 2011; 1(2): 95-102.

Bardgett, R.D. and Wardle, D.A. Herbivore mediated linkages between aboveground and belowground communities. Ecology, 2003; 84: 2258-2268.

Bennett, L.T. and Adams, M.A. Response of a perennial grassland to nitrogen and phosphorus additions in sub-tropical, semi-arid Australia. J. Arid Environ., 2001; 48: 289-308.

Bennett, L.T., Judd, T.S. and Adams, M.A. Growth and nutrient content of perennial grasslands following burning in semi-arid, sub-tropical Australia. Plant Ecol., 2002; 164: 185-199.

Blackburn, W.H. Impacts of grazing intensity and specialized grazing systems on watershed characteristics and responses. In: Developing strategies for rangeland management. NRC/National Academy of Science; 1984; 927-1000.

Blake, G.R. and Hartge, K.H. Bulk density. In: Klute, A., ed. Methods of soil analysis, part 1, physical and mineralogical properties. 2nd ed. Madison, WI: American Society of Agronomy; 1986; 363-375.

Boerner, R.E.J., Sutherland, E.K., Morris, S.J. and Hutchinson, T.F. Spatial variations in the impact of prescribed fire on soil nitrogen dynamics in a forested landscape. Landscape Ecol., 2000; 15(5): 425-439.

Brockway, D.G., Gatewood, R.G. and Paris, R.B. Restoring fire as an ecological process in shortgrass prairie ecosystems: initial effects of prescribed burning during the dormant and growing seasons. J. Environ. Manag., 2002; 65: 135-152.

Brys, R., Jacquemyn, H. and Blust, De.G. Fire increases aboveground biomass, seed production and recruitment success of Molinia caerulea in dry heathland. Acta Oecologica, 2005; 28: 299-305.

Certini, G. Effects of fire on properties of forest soils: a review. Oecologia, 2005; 143:1-10.

Dai, X., Boutton, T.W., Hailemichael, M. and Jessup, KE. Soil carbon and nitrogen storage in response to fire in a temperate mixed-grass savanna. J. Environ. Qual., 2006; 35: 1620-1628.

Danielson, R.E. and Sutherland, P.L. Porosity. In: Klute, A., ed. Methods of soil analysis, part 1, physical and mineralogical properties. 2nd ed. Madison, WI: Am. Soc. Agron., 1986; 443-461.

DeBano, L.F., Neary, D.G. and Ffolliott, P.F. Fire's Effects on Ecosystems. John Wiley and Sons, New York, 1998; 333 P.

Dennis, P.G., Newsham, K.K., Rushton, S.P., Ord, V. J., O'Donnell, A.G. and Hopkins, D.W. Warming constrains bacterial community responses to nutrient inputs in a southern, but not northern, maritime Antarctic soil. Soil Biol. Biochem., 2013; 57: 248-255.

Duncan, A. Farm Animals and Biodiversity. Anim. Sci., 2005; 81: 187-188.

Ekinci, H. Effect of forest fire on some physical, chemical and biological properties of soil in Çanakkale, Turkey. Int. J. Agr. Biol., 2006; 8(1): 102-106.

Eldiabani, G.S., Hale, W.H.G. and Heron, C.P. The effect of forest fires on physical properties and magnetic susceptibility of semi-arid soils in northeastern, Libya. Int. J. Environ. Chem., 2014; 8(1): 54-60.

Firestone, M.K. Nutrient cycling in a managed oak woodland-grass ecosystems. Final report to Integrated Hardwood Range Management Program. University of California. 1995; 56 P.

Frank, A.B., Tanaka, D.L. Hofmann, L. and Follett, R.F. Soil carbon and nitrogen of northern Great-Plains grasslands as influenced by long-term grazing. J. Range Manage., 1995; 48: 470-474.

Frank, D.A., Gehring, C.A., Machut, L. and Phillips, M. Soil community composition and the regulation of grazed temperate grassland. Oecologia, 2003; 137: 603-609.

Gardner, W.H. Water content. In: Klute, A., ed. Methods of soil analysis, part 1, physical and mineralogical properties. 2d ed. Madison, WI: Am. Soc. Agron., 1986; 493-544.

Ingram, L.I., Stahl, P.D., Schuman, G.E., Buyer, J.S., Vance, G.F., Ganjegunte, G.K., Welker, J.M. and Derner, J.D. Grazing impacts on soil carbon and microbial communities in a mixed-grass ecosystem. Soil Sci. Soc. Am. J., 2008; 72(4): 939-948.

Laycock, W.A. and Conrad, P.W. Effect of grazing on soil compaction as measured by bulk density on a high elevation cattle range. J. Range Manage., 1967; 20(3): 136-140.

LeCain, R., Morgan, J.A., Schuman, G.E., Reeder, J.D. and Hart, R.H. Carbon exchange rates in grazed and ungrazed pastures of Wyoming. J. Range Manage., 2000; 53: 199-206.

Li, B. 1997. The rangeland degradation in north China and its preventive strategy. Scientia Agriculturae Sinica. 30: 1-9.

Li, W.H. Z., Huang, Z.N. and Wu, G.L. Effects of grazing on the soil properties and C and N storage in relation to biomass allocation in an alpine meadow. J. Soil Sci. Plant Nutr., 2011; 11 (4): 27-39.

Litton, C.M. and Santelices, R. Effect of wildfire on soil physical and chemical properties in a Nothofagus glauca forest, Chile. Rev Chil Hist Nat., 2003; 76: 529-542.

Ludwig, J.A., and J.F. Reynolds. Statistical Ecology: A Primer on Methods and Computing. John Wiley and Sons, New York. 1988; 337 P.

McNaughton, S.J. Compensatory plant growth as a response to herbivory. Oikos 1983; 40: 329-336.

Medvedeff, C.A., Inglett, K.S., Kobziar, L. and Inglett, P.W. Impacts of fire on microbial carbon cycling in subtropical wetlands. Fire Ecol., 2013; 9: 21-37.

Milchunas, D.G. and Lauenroth, W.K. Quantitative effects of grazing on vegetation and soils over a global range of environment. Ecol. Monogr., 1993; 63: 327-366.

Milchunas, D.G., Sala, O.E. and Lauenroth, W.K. A generalized model of the effects of grazing by large herbivores on grassland community structure. The Am. Nat., 1988; 132: 87-106.

Okalebo, J.R., Gathua, K.W. and Woomer, P.L. Laboratory Methods of Soil and Plant Analysis: A Working Manual. TSBF Program UNESCO – ROSTA Soil Science Society of East Africa technical Publication No. 1. Marvel EPZ Ltd.; Nairobi, Kenya, 2002; 127 P.

Olff, H. and Ritchie, M.E. Effects of herbivores on grassland plant diversity. Trends Ecol. Evol., 1998; 13: 261-265.

Olofsson, J., de., Mazancourt, C. and Crawley, M.J. Spatial heterogeneity and plant species richness at different spatial scales under rabbit grazing. Oecologia, 2008; 156: 825-834.

Pierson, F.B., Robichaud, P.R. and Spaeth, K.E. Spatial and temporal effects of wildfire on the hydrology of a steep rangeland watershed. Hydrol. Process, 2001; 15: 2905-2916.

Pierson, F.B., Robichaud, P.R., Moffet, C.A., Spaeth, K.E., Hardegree, S.P. Clark, P.E. and Williams, C.J. Fire effects on rangeland hydrology and erosion in a steep sagebrush-dominated landscape. Hydrol. Processes, 2008; 22: 2916-2929.

Proulx, M. and Mazumder, A. Reversal of grazing impact on plant species richness in nutrient-poor vs. nutrient-rich ecosystems. Ecology, 1998; 79: 2581-2592.

Ratliff, R.D. Meadows in the Sierra Nevada of California: state of knowledge. General Technical Report PSW-84.United States Department of Agriculture. Forest Service. Pacific Southwest Forest and Range Experiment Station, Albany, CA. 1985; 52 P.

Reeder, J.D. and Schuman, G.E. Schuman. Influence of livestock grazing on C sequestration in semi-arid mixed-grass and short-grass rangelands. Environ. Pollut., 2002; 116: 457-463.

Safford, H.D. and Harrison, S. Fire effects on plant diversity in serpentine vs. sandstone chaparral. Ecology, 2004; 85: 539-548.

Sasaki, T., Ohkuro, T. Jamsran, U. and Takeuchi, K. Changes in the herbage nutritive value and yield associated with threshold responses of vegetation to grazing in Mongolian rangelands. Grass Forage Sci., 2012; 67: 446-455.

Satterthwaite, W.H., Menges, E.S. and Quintana-Ascencio, P.F. Assessing scrub buckwheat population viability in relation to fire using multiple modeling techniques. Ecol. Appl., 2002; 12: 1672-1687.

Scharenbroch, B.C., Nix, K.A.B. and Bowles, M.L. Two decades of low-severity prescribed fire increases soil nutrient availability in a Midwestern, USA oak (quercus) forest. Geoderma 2012; 183:80-91.

Shahriary, E., Palmer, M.W., Tongway, D.J., Azarnivand, H., Jafari, M. and Mohseni Saravi. M. Plant species composition and soil characteristics around Iranian piospheres. J. Arid Environ., 2012; 82: 106-114.

Soto, B. and Diaz-Fierros, F. Soil water balance as affected by throughfall in gorse (Ulex europaeus L.) shrubland after burning. J. Hydrol., 1997; 195: 218-231.

Stowe, K.A., Marquis, R.J., Hochwender, C.G. and L. Simms, E. The evolutionary ecology of tolerance to consumer damage. Annu. Rev. Ecol. Syst., 2000; 31: 565-595.

Todd, S.W. Gradients in vegetation cover, structure and species richness of Nama-Karoo shrublands in relation to distance from livestock watering points. J. Appl. Ecol., 2006; 43: 293-304.

Tollner, E.W., Calvert, G.V. and Langdale, G. Animal trampling effects on soil physical properties of two Southeastern U.S. ultisols. Agr. Ecosyst. Environ., 1990; 33: 75-87.

Ulery, AL., Graham, R.C. and H. Bowen, L. Forest fire effects on soil phyllosilicates in California. Soil Sci. Soc. Am. J., 1996; 60: 309-315.

Vermeire, L.T. Wester, D.B., Mitchell, R.B. and Fuhlendorf, S.D. Fire and Grazing Effects on Wind Erosion, Soil Water Content, and Soil Temperature. J. Environ. Qual., 2005; 34(5): 1559-1565.

Vincent, K.R. and Chadwick, O.A. Synthesizing bulk density for soils with abundant rock fragments. Soil Sci. Soc. Am. J., 1994; 58: 455-464.

Walkley, A. and Black, I.A. An examination of the Degtjareff method for determining organic carbon in soils: Effect of variations in digestion conditions and of inorganic soil constituents. Soil Sci., 1934; 63: 251-263.

Wang, Y.F., Chen, Z.Z. and Tieszen, L.T. Distribution of soil organic carbon in the major grasslands of Xilingole, Inner Mongolia. China Acta Phytoecologica Sinica 1998; 22(6): 545-551.

Wang, J., Sha, L.Q., Li, J.Z. and Feng, Z.L. CO2 efflux in subalpine meadows under different grazing managements in Shangrila, Yunnan. Acta. Geol. Sin-Engl., 2008; 28(8): 3574-3583.

Weber, K.T. and Gokhale, B. Effect of grazing on soil-water content in semiarid rangelands of Southeast Idaho. J. Arid Environ., 2011; 75: 464-470.

Wells, C.G., Campbell, J. and DeBano, L.F. Effects of fire on soil: a state-of-knowledge review. US Department of Agriculture, Forest service. Washington, DC., USA, 1979; 34 P.

Whelan, R.J. The Ecology of Fire. Cambridge University Press, Cambridge, 1995; 364 P.

Wohlgemuth, P.M. and Hubbert, K.R. The Effects of Fire on Soil Hydrologic Properties and Sediment Fluxes in Chaparral Steeplands, Southern California. USDA Forest Service Gen. Tech. Rep. PSW-GTR-189. 2008; 115-122.

Wu, G.L., Du, G.Z., Liu, Z.H. and Thirgood, S. Effect of fencing and grazing on a Kobresia-dominated meadow in the Qinghai-Tibetan Plateau. Plant and Soil, 2009; 319: 115-126.

Yates, C.J., Norton, D.A. and Hobbs, R.J. Grazing effects on plant cover, soil and microclimate in fragmented woodlands in south-western Australia: implications for restoration. Austral Ecol., 2000; 25: 36-47.

Zhao, W.Y., Li, J.L. and Qi, J.G. Changes in vegetation diversity and structure in response to heavy grazing pressure in the Northern Tianshan Mountains. China J. Arid Environ., 2006; 68: 337-508.

[DOR: 20.1001.1.23222700.2015.3.1.3.7]

اثر چرای دام و آتش سوزی بر خصوصیات خاک و پوشش گیاهی در مراتع نیمه خشک

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تاریخ دریافت: ۲۵ بهمن ۱۳۹۳ / تاریخ پذیرش: ۲۹ فرورین ۱۳۹۴ / تاریخ چاپ: ۲۴ تیر ۱۳۹۴

چکیده چرای دام و آتش‌سوزی از مهم‌ترین آشفتگی‌های اکولوژیکی هستند که سبب تغییر خصوصیات پوشش گیاهی و خاک مراتع می‌گردند. این تحقیق به‌منظور بررسی اثر تیمارهای مختلف آتش‌سوزی و فاصله از آبش‌خور بر خصوصیات خاک و پوشش گیاهی مراتع نیمه خشک انجام شد. تحقیق حاضر در مراتع "لشگردر" در استان همدان به مرحله اجرا رسید. نمونه‌برداری از پوشش گیاهی بر پایه روش سیستماتیک- تصادفی در طول ترانسکت انجام گرفت. تعداد۵۰ پلات به صورت تصادفی در طول هر ترانسکت استقرار یافتند. با استفاده از استوانه نمونه‌برداری خاک و در طول هر ترانسکت، ۱۰۰ نمونه از خاک منطقه به‌صورت سیستماتیک تهیه شد. تجزیه واریانس و آزمون دانکن به‌منظور تحلیل آماری داده‌ها در سطح احتمال ۰/۰۵ انجام گرفت. نتایج نشان دادند که بیش‌ترین و کم‌ترین میزان تولید سرپا (۶۳۰ و ۱۱۷ کیلوگرم در هکتار)، شاخص تنوع شانون (۲/۳۷ و ۱/۰۷)، کل کربن آلی (۱۸/۳۴ و ۶/۶۶ گرم در کیلوگرم)، ظرفیت آب ثقلی خاک (۱۶/۴ و ۶ درصد) و تخلخل خاک (۶۹/۴۳ و ۵۷/۷۴ درصد) به‌ترتیب در فاصله ۲۰۰۰ متری از آبش‌خور در مراتع بدون آتش‌سوزی و ۱۰ متری آبش‌خور و در مراتع با گذشت یک سال از آتش‌سوزی دیده می‌شوند. در حالی که بیش‌ترین و کمترین مقدار عددی جرم مخصوص ظاهری و هدایت الکتریکی خاک در ۱۰ متری از آبش‌خور (در مراتع با گذشت یک سال از آتش‌سوزی) و در فاصله ۲۰۰۰ متری از آبش‌خور (در مراتع بدون آتش‌سوزی) گزارش شده است. نتایج این تحقیق نشان‌دهنده آن است که هیچ رابطه‌ای میان روند تغییرات pH خاک با آتش‌سوزی و فاصله از آبش‌خوار وجود ندارد.

کلمات کلیدی: آشفتگی‌های اکولوژیکی، تنوع مراتع تحت تأثیر آتش‌سوزی، مدیریت خاک، منابع آب

[DOR: 20.1001.1.23222700.2015.3.1.3.7]