International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 4, No. 2, p. 62-70, 2014

INNSPUB

RESEARCH PAPER

OPEN ACCESS

Effects of grazed exclosure on some of nutrient elements of aerial and underground organs of *Artemisia sieberi*, *Stipa hohenacheriana* and *Salsola rigida*

Maryam Saffariha[1*], Hossein Azarnivand[1], Ali Tavili[1]

Range management, Faculty of Natural Resource, University of Tehran, Iran

Article published on February 25, 2014

Key words: Exclosure, nutrient elements, summer, autumn, herbage, roots.

Abstract

Grazing management is increasingly aimed at the restoration of rangelands ecosystems. Animal grazing is a global, dominant land use covering more than 25% of the terrestrial surface of the globe and a larger geographic area than any other land use. Overgrazing reduces the usefulness, productivity, and biodiversity of the land and is one cause of rangelands degradation, desertification and erosion. One of the methods of rangelands management and improvement is Exclosure. Exclosure is one of the simplest methods of rangelands improvement. It is considered as an alternative to restore vegetation in degraded rangelands in this region. We studied the effects of 20 years of rangeland exclosure on some of nutrient elements of *Artemisia sieberi*, *Stipa hohenacheriana* and *Salsola rigida* in Roodshoor region, Saveh, Iran. Sampling in exclosure and control treatments was conducted using a systematic randomized method. Four 300-m long transects were randomly located in each area. Plant organs sampling was conducted in first, middle and end of each transect. In both grazing exclusion and control sites two, plant organs samples were taken from aerial (herbage) and underground (roots) organs. Samples in the laboratory were placed in the oven for 24 hours. Then the samples were milled. The plants samples for each organ per site were analyzed in the laboratory of the department of Natural Resources, Tehran University, Iran. In general, results of this study were showed livestock grazing exclosure had no significantly effects on nutrients of NPK and C in plants Salsola, Stipa and Artemisia. Grazed exclosure increase amounts of Na, Ca and Mg on organs of these plants.

* **Corresponding Author:** Maryam Saffariha ✉ m.saffariha@gmail.com

Introduction

Land degradation processes such as desertification in arid and semiarid areas result from various factors, including climatic variation and unsustainable human activities (Gad and Abdel, 2000). Livestock grazing is a dominant human activity in many semi-natural and managed rangelands (Soderstrom *et al.*, 2001). Grazing management is increasingly aimed at the restoration of grassland ecosystems and desertification control (Parfitta *et al.*, 2010). Animal grazing is a global, dominant land use covering more than 25% of the terrestrial surface of the globe and a larger geographic area than any other land use (Asner *et al.*, 2004). Based on studies on rangeland, an important and obvious effect of grazing is the removal of above-ground biomass by livestock and subsequently, a significant impact on the rotation of the nutrients and their absorption (Shariff *et al.*, 1994). In addition to general effects of grazing on plants, livestock have also other effects on rangeland that subsequently effect on forage production. Generally, nutrients in livestock's feces and urine are useful for obvious effect of grazing is the removal of above-ground (Nicol, 1987).

Grazing affects plant communities and associated fauna, with implications for biodiversity and ecosystem processes (Rooney and Waller, 2003). It can lead to changes on plant species composition (Putman *et al.*, 1991), community nutrient pools (Binkley *et al.*, 2003; Pineiro *et al.*, 2009), plant productivity (Frank *et al.*, 2002) or the structure of plant communities (Putman *et al.*, 1991). Grazing can also affect plant-associated animal communities, particularly those of invertebrates (Gonzalez-Megias *et al.*, 2004; Lindsay and Cunningham, 2009) and consequently mediate ecosystem functions where invertebrates have a key role such as decomposition, plant seed dispersal and pollination, or regulation of other invertebrate populations through predation and parasitism (Coleman *et al.*, 2004; Samways, 2005). But, overgrazing reduces the usefulness, productivity, and biodiversity of the land and is one cause of rangelands degradation, desertification and erosion. Overgrazing is also seen as a cause of the spread of invasive species of non-native plants and of weeds. Sustainable rangelands production is based on plants and rangelands management, land management, animal management.

One of the methods of rangelands management and improvement is Exclosure. Exclosure is one of the simplest methods of rangelands improvement. Livestock grazing excluding is considered as an alternative to restore vegetation in degraded rangelands in rangelands region. However, few data are available concerning the impacts of animal exclusion on rangelands. Bugalho *et al.*, (2011) reported that controlled grazing can be beneficial to biomass accumulation and seed production, and may therefore mitigate desertification of rangeland (Zhao *et al.*, 2005). Grazing exclusion can lead to the restoration of soil fertility, vegetation biomass and composition, soil fauna, and water storage (Parfitta *et al.*, 2010). Heavy grazing is a primary contributor to rangeland desertification. Livestock grazing exclusion therefore has a high potential to restore vegetation and soil and is an important alternative to stop further degradation and combat desertification in arid and semiarid regions (Jeddi and Chaieb, 2010).

Over the past decades excluding livestock has become a common management tool for conservation and restoration of remnant native vegetation (Spooner *et al.*, 2002). Sites where livestock have been recently excluded have been found to have higher native plant species richness and cover than those with moderate to heavy grazing pressure (Briggs *et al.*, 2008). Others, however, have found that light levels of grazing are required to maintain plant richness (Tallowin *et al.*, 2005). This grazing might be achieved by native and feral herbivores, or might require managed livestock. So, excluding livestock from woodlands has benefits for components of the invertebrate community, vegetation condition and the important process of litter decomposition. Strategic grazing which includes substantial periods of rest could play a role in balancing the production and conservation needs of privately owned woodlands. (Lindsay and Cunningham, 2009).

Maintaining nutrient and organic matter levels in grazed rangelands is essential if the rangelands, and grazing, are to be sustainable. Mineral elements of plants are one of the factors that are affected by grazing exclosure. Sadeghi Sangdehi (2008) was related percentage of crude protein in both exclosure and grazed areas than in the first season is more than the season finale. Sharifi (2001) was expressed after four years of grazing exclosure, palatability of plants increased. Nobakht (2008) nitrogen release and mineralization in *Carex heliophila* and *Stipa commata* in three conditions of grazing exclosure, moderate grazing and heavy grazing was studied. He was reported that mineralization rate in moderate grazing was higher than grazing exclosure and heavy grazing. Pei *et al.* (2008) found a significant increase in soil organic C, total N, total P, and volumetric soil water content after 2 years of grazing exclusion in a desert steppe of northern China. However, Nosetto *et al.* (2006) reported no significant change in total ecosystem C storage after approximately 15 years of grazing exclusion in a semiarid degraded ecosystem in Argentina. Chen *et al.* (2012) were found significant positive effects on soil properties and on C and N storage after 12 years of grazing exclusion in desertified rangeland. Grazing exclusion is particularly likely to increase C uptake where overgrazing has decreased biomass productivity, thereby decreasing the quantity and quality of the biomass that is returned to the soil (Pei *et al.*, 2008).

So far, many studies have been conducted about the effects of grazing exclosure on soil properties. But, few studies have been conducted about effects of grazing exclosure on nutrient elements of plants. So, our aim was to assess the effects of grazing exclosure on some of nutrient elements aerial (herbage) and underground (root) organs of three species *Artemisia sieberi*, *Salsola rigida* and *Stipa hohenacheriana*. The three plants are the main source of forage that provides food for livestock in the region. Dominant grazing livestock in the region is sheep.

Material and Methods

Site

The study site is on Saveh province, Iran. This study was conducted in Roodshoor rangelands of Saveh. The Roodshoor rangelands (50º 53' -51º 03' N latitude; 35º 25'- 36º 43' E longitude) are one of the steppe regions of Iran. Based on Demartonn method the region climate is cold-dry desert with mean long-term rainfall of 201.9 mm. This region has an average altitude of 1125 m. The regional soil type is brown eroded and its ingredients are old alluvial deposits. The soil depth is more than one meter. The area has been grazed by sheep at variable intensities for many years.

Methods

The Roodshoor grazing exclosure was established in 1986 for 20 years. In order to evaluate the effect of grazing exclusion on mineral elements of dominant plants after 20 years of grazing enclosure, and a grazed control site was selected in the region in 2009. Sampling for the present study was done in late summer and late autumn on 2009. The exclosure and control sites were in close proximity and were located in the same homogeneous ecological units. Dominant grazing animal in the region is sheep. The dominant vegetation types in the region are *Artemisia sieberi*, *Stipa hohenacheriana* and *Salsola rigida*. During the summer sampling, all three plants were in the vegetative stage. While during the autumn sampling, all three plants have generally reached maximum vegetative stature. In autumn the plants had the maximum forage production.

Initially appropriate areas were selected for sampling. Sampling in each area was conducted using a systematic randomized method. Four 300-m long transects were randomly located in each area (within exclosure and outside the enclosure).

Plant organs sampling was conducted in first, middle and end of each transect. In both grazing exclusion and control sites two, plant organs samples were taken from aerial (herbage) and underground (roots) organs. Samples in the laboratory were placed in the oven for 24 hours. Then the samples were milled. The plants samples for each organ per site were analyzed in the laboratory of the department of Natural Resources, Tehran University, Iran.

The samples were passed through a two millimeter sieve before analyzing for organic matter (Walkley & Black, 1934), nitrogen (N) content using Kjeldal (Bremmer and Mulvaney, 1982), the amount of available phosphorus (P) by P-Olsen (Olsen and Sommers, 1982), potassium (K) (Boltz and Howel, 1978). Ca and Mg were examined by titration with EDTA; Na was examined by flam photometer and C was examined by burning in furnace (Jafari Haghighi, 2003).

Data were tested for normality before statistical analysis using the Kolmogorov Smirnove test. For comparison of the soil properties in the grazing exclosure treatment and control was used from Duncan's test with $SPSS_{ver.17}$ software. Significance was assessed at 5% probability level unless otherwise noted.

Results

Table 1, 2 and 3 Changes in nutrient elements on root and herbage of three plants *Salsola rigida, Stipa hohenacheriana* and *Artemisia sieberi* show in summer and autumn.

Effects of the grazed exclosure on Nitrogen

In *Salsola rigida*, the highest amount of N (Nitrogen) was occurred in the root, at the fall season and in control treatment. But, was no significant difference between the exclosure and control treatments ($p<0.05$). In *Stipa hohenacheriana*, the highest content N was observed in the root, at the autumn season and in grazed control. The difference between this group and other groups were significant ($p<0.05$). In *Artemisia sieberi* the highest content of N was observed in the root at the autumn season and at grazed control.

Effects of the grazed exclosure on Phosphorus

The maximum value of P (Phosphorus) was occurred out of the exclosure, in the summer and at roots of Salsola. Mean measures of P in root of Salsola at the control treatment and in summer had significantly different ($p<0.05$). In other cases different was no significant ($p<0.05$). Stipa was showed the highest amount of P in herbage, at the summer and out of the enclosure. This had no significantly different with content P in root and at summer but had significant different with other items (including amount P in autumn, content P in exclosur treatment at summer and autumn). Artemisia was showed most value of P in herbage at the summer and on grazed exclosure. This had significantly different with other items ($p<0.05$).

Effects of the grazed exclosure on Potassium

The K (Potassium) amount in root and herbage of Salsola in fall was more than summer and between grazed control and grazed exclosure was no significantly different ($p<0.05$). But these values had significantly different with the K amount in root and herbage of Salsola in summer and at control and exclosure treatments. The maximum content K was occurred at herbage of Stipa in control treatment and in autumn. But it had no significant different with others items ($p<0.05$). In Artemisia, the amount of K in herbage was more than root and in autumn was more than summer. It there was no significant difference between grazed exclosure and grazed control ($p<0.05$).

Table 1. Nutrients in herbage and root of *Salsola rigida*

Elements	Plant organs	Treatment means			
		Grazed control		*Grazed exclusion*	
		summer	autumn	summer	autumn
N (%)	Herbage	0.77 ± 0.31c	1.17 ± 0.91 ab	0.68 ± 0.21 c	1.1 ± 0.8 ab
	Root	1.24 ± 0.42 ab	1.33 ± 0.43 ab	1.27 ± 0.65 ab	1.2 ± 0.6 ab
P (ppm)	Herbage	1.3 ± 0. 2 bcd	1.55 ± 0. 29 bcd	1.49 ± 0.18 bcd	1.23 ± 0.15 bcd
	Root	2.1 ± 0.15 ab	0.72 ± 0. 28 e	1.33 ± 0.16 bcd	0.79 ± 0.89 e
K (ppm)	Herbage	61.8 ± 14.5 b	143.38 ± 15.38 a	14.49 ± 6.61 c	118.58 ± 42.5 a
	Root	30.17 ± 3.13 bc	113.37 ± 25 a	46.02 ± 12.37 bc	134.16 ± 62.8 a
C (%)	Herbage	15.2 ± 5.4 c	61.7 ± 2.39 ab	8.9 ± 2.4 c	63.6 ± 13.1 ab
	Root	9.9 ± 1.4 c	64.1 ± 5.5 ab	6.7 ± 1.89 c	66.1 ± 13.6 ab
Na (meq/lit)	Herbage	221.8 ± 87.3 a	16.46 ± 4.06	231.6 ± 62.49 a	22.06 ± 4.99 c
	Root	40 ± 17.9 b	36.09 ± 15.07 b	81.6 ± 22.1 b	15.39 ± 2.39 c
Ca (meq/lit)	Herbage	2.42 ± 0.32 ab	2.06 ± 0.18 b	2.92 ± 0.38 ab	3.44 ± 0.47 a
	Root	2.62 ± 0.13 ab	2.14 ± 0.27 b	2.15 ± 0.67 b	3.18 ± 0.45 ab
Mg (meq/lit)	Herbage	1.9 ± 0.48 ab	2.08 ± 0.82 a	0.94 ± 0.18 c	2.94 ± 0.45 a
	Root	0.45 ± 0.21 d	2.63 ± 0.28 a	1.7 ± 0.41 ab	2.88 ± 0.84 a

Table 2. Nutrients in herbage and root of *Stipa hohenacheriana*

Elements	Plant organs	Treatment means			
		Grazed control		*Grazed exclusion*	
		summer	autumn	summer	autumn
N (%)	Herbage	0.8 ± 0.15 bc	0.69 ± 0.2 cd	0.91 ± 0.24 bc	0.87 ± 0.32 bc
	Root	0.79 ± 0.12 bc	1.08 ± 0.3 ab	0.5 ± 0.1 cd	0.65 ± 0.12 cd
P (ppm)	Herbage	1.83 ± 0.19 abc	1.17 ± 0.12 bc	1.5 ± 0.16 bc	0.85 ± 0.2 cd
	Root	1.55 ± 0.11 abc	1.18 ± 0.4 bc	1.02 ± 0.6 bc	1.04 ± 0.14 bc
K (ppm)	Herbage	48 ± 12.1 b	86.46 ± 14.1 a	38.11 ± 5.95 bc	78.69 ± 18.06 a
	Root	26.2 ± 6.72 c	81.53 ± 27.3 a	36.11 ± 8.12 bc	72.79 ± 17.8 a
C (%)	Herbage	11.6 ± 4.1 d	78.6 ± 0.94 ab	10.9 ± 2.3 d	82.5 ± 1.58 a
	Root	5.4 ± 1.59 d	71.4 ± 12.6 ab	13.2 ± 2.7 d	86.5 ± 7.6 a
Na (meq/lit)	Herbage	5.7 ± 0.47 b	23.53 ± 4.84 ab	5.6 ± 0.24 b	37.29 ± 10.9 a
	Root	6.2 ± 0.58 b	30.18 ± 8.12 ab	10.2 ± 2.7 b	36.39 ± 12.1 a
Ca (meq/lit)	Herbage	1.68 ± 0.18 b	1.34 ± 0.65 b	1.64 ± 0.27 b	2.46 ± 0.57 a
	Root	1.26 ± 0.3 b	0.88 ± 0.16 c	0.97 ± 0.27 c	1.28 ± 0.51 b
Mg (meq/lit)	Herbage	0.48 ± 0.16 d	3.0 ± 0.45 a	0.86 ± 0.1 c	3.1 ± 0.19 a
	Root	0.46 ± 0.14 d	1.17 ± 0.44 ab	1.02 ± 0.21 c	1.98 ± 0.14 b

Table 3. Nutrients in herbage and root of *Artemisia sieberi*

Elements	Plant organs	Treatment means			
		Grazed control		*Grazed exclusion*	
		summer	autumn	summer	autumn
N (%)	Herbage	1.03 ± 0.5 bc	0.61 ± 0.1 d	1.02 ± 0.1 bc	0.68 ± 0.2 d
	Root	0.73 ± 0.6 d	1.27 ± 0.17 ab	0.99 ± 0.2 bc	0.73 ± 0.1 d
P (ppm)	Herbage	1.66 ± 0.31 bc	1.18 ± 0.28 bc	2.5 ± 0.8 a	1.43 ± 0.24 bc
	Root	1.19 ± 0.29 bc	1.05 ± 0.1 bc	1.22 ± 0.24 bc	1.27 ± 0.18 bc
K (ppm)	Herbage	52.46 ± 9.06 bc	169.19 ± 43.4 ab	37.6 ± 7.91 cd	146.98 ± 25.6 ab
	Root	22.24 ± 3.7 d	53.78 ± 6.65 bcd	28.18 ± 1.98 d	80.11 ± 14.23 bc
C (%)	Herbage	4.9 ± 0.72 d	68.3 ± 1.1 abc	3.0 ± 0.31 d	69.1 ± 1.43 abc
	Root	5.9 ± 1.47 d	70.1 ± 7.9 abc	3.9 ± 1.01 d	71.5 ± 1.5 abc
Na (meq/lit)	Herbage	18.6 ± 3.55 b	17.89 ± 3.17 b	10.39 ± 2.9 bc	37.22 ± 8.6 a
	Root	18.0 ± 4.11 b	18.0 ± 9.15 b	11.4 ± 0.15 bc	32.9 ± 7.6 a
Ca (meq/lit)	Herbage	1.18 ± 0.19 cd	2.1 ± 0.36 b	0.88 ± 0.16 e	3.4 ± 0.56 a
	Root	1.0 ± 0.17 cd	2.36 ± 0.45 b	1.07 ± 0.73 cd	2.82 ± 0.55 a
Mg (meq/lit)	Herbage	1.86 ± 0.34 cd	2.6 ± 0.81 ab	0.48 ± 0.22 e	3.8 ± 0.89 a
	Root	0.77 ± 0.18 d	2.88 ± 0.89 ab	0.7 ± 0.22 d	3.5 ± 0.18 a

Effects of the grazed exclosure on Carbon

In Salsola, the C (Carbon) amount in autumn (within exclosure and out of the enclosure) was more than summer. But it between control and exclosure treatments was no significant difference ($p<0.05$). The C amount in root and herbage of Stipa in grazed exclosure was more than out of the enclosure and it had significant difference ($p<0.05$). But the content C in herbage and root had no significant difference ($p<0.05$). Moreover, the C value in autumn was more than summer and had significant difference. In root and herbage of Artemisia was no significant difference between the C content. The C value on autumn was more than summer and had significant different ($p<0.05$). Also, between the C amount in grazed exclosure and grazed control was no significant difference ($p<0.05$).

Effects of the grazed exclosure on Sodium

The maximum amount of Na (Sodium) was occurred in herbage of Salsola, in grazed exclosure and at summer. But it had no significant different with content Na in summer at grazed control ($p<0.05$). The highest of Na was observed in herbage of Stipa, at grazed exclosure and in autumn. But it had no significant different with content Na in autumn and at grazed exclosure ($p<0.05$). In addition, in Artemisia the highest of Na was observed in herbage, at grazed exclosure and in autumn. Moreover, it had significantly difference with other items ($p<0.05$).

The maximum amount of Ca (Calcium) in herbage of Salsola at grazed exclosure and in autumn was occurred and it had significantly difference with other items ($p<0.05$). The Ca at exclosure and control treatments, in herbage of Stipa and at autumn was more than root and summer. In Artemisia, the Ca amount of herbage within exclosure sites and in autumn was more and had significant difference with other items ($p<0.05$).

Effects of the grazed exclosure on Magnesium

The Mg (Magnesium) in herbage of Salsola and in autumn was more than root in grazed exclosure treatment. It there was no significantly difference between exclosure and control sites but there was significantly difference between content Mg in summer and autumn. The maximum amount of Mg was occurred in herbage of Stipa, in autumn and at exclosure sites. In Artemisia, the maximum content Mg was observed in herbage, at exclosure sites and at autumn and it had significantly difference ($p<0.05$).

Discussion

In all three plants Salsola, Stipa and Artemisia the highest amount of N (Nitrogen) was occurred in the root, at the fall season and in grazed control. But, was no significant difference between grazed exclosure and control treatments ($p<0.05$). May be this is due to grazing in control sites enhance rate of N recycling between soil and plants. Moreover, in autumn growing of these plants is maximized and large amount of nitrogen accumulate in the root. Sangdehi (2008) found that in out of the exclosure due to the return of livestock urine and feces to soil, the content of N within soil will enhance and consequence it will increase at plants organs. On the other solution nitrogen enter into soil and more easily absorbed by plants as well. Pineiro *et al.* (2009) related livestock excreta may increase N cycling but reduce nitrogen inputs to soil through evaporation of nitrogen and leaching of urine and feces. Tessema *et al.* (2011) in a semi-arid savanna of Ethiopia concluded that the concentration of total nitrogen was higher in sites with light grazing compared with sites exposed to heavy grazing.

The maximum value of P (Phosphorus) was occurred out of the exclosure, in the summer and at roots of Salsola. Stipa was showed the highest amount of P in herbage, at the summer and out of the enclosure. May be this is due to livestock grazing in control sites add urine and feces to soil that consequent solution P will add to soil. This solution P rapidly enters to plants. Because of most of growth activities Salsola and Stipa occur during summer, so higher P absorb from soil.

Zarekia *et al.* (2012) expressed that heavy grazing intensity increased soil phosphorus levels. Increasing of the soil phosphorus level in might be related to excreta, litter deposition and more mobility of phosphorus on the surface of the soil due to livestock trampling. Haynes and Williams (1993) stated that more than 65% of the phosphorus in the diet consumed by cows is returned as feces to pastures. Soil phosphorus increase has been reported under manure. Artemisia was showed most value of P in herbage, at the summer and on grazed exclosure. Because of plants associated Artemisia (including Salsola and Stipa) have been more palatable, so grazing around Artemisia has reduce and consequence the amount of animal feces and urine around it has fallen. This has led to available phosphorus in the soil at control sites is reduced. As a result out of the exclosure P is lower than grazed exclosure. Reason of increase content P within grazed exclosure is that rangelands vegetation exploits phosphorous from lower depths so when vegetation cover and biomass are restored with grazing exclusion phosphorous accessed at deeper soil depths is brought to the surface and accumulates at the soil surface (Azarnivand and Zare Chahoki, 2011). Hosseinzadeh *et al.* (2010) said high amount of soil phosphorus in reference area may be due to the dominant positive effects of vegetation remains and high volumes of plant's organs.

The K (Potassium) amount in root and herbage of Salsola in autumn and at both treatment was more than summer. Salsola increasing growth phases (especially in autumn) large amounts of K accumulate in own organs. This agrees with results of Zehtabian (2000) and Kochaki (1995). They reported the amount of K fixation by *Salsola rigida* in the surrounding soil is remarkable. As a result, the amount of potassium in the plant increases as well. In addition, it leads to increase of protein on plant organs. The maximum content K was occurred at herbage of Stipa in control treatment and in autumn. It had no significant different with exclusion treatment ($p<0.05$). Probably this is due to grazing in out of exclosure; caused tramping soil particles and consequently potassium is easily available for plants. Zarekia *et al.* (2012) were relating the increase of K at grazed treatments may have been related to livestock's positive effect on accumulation of K via trampling and their excreta. The results contrast with Garcia *et al.* (2011) who estimated that the average content of K was higher in the areas with continuous grazing than in areas with other systems (control and rotational). In Artemisia, the K amount in herbage was more than root and in autumn was more than summer. It had no significant difference between grazed exclosure and grazed control. Because of K is dynamic element within plants, so it move contrary to electromagnetic gradient and enter to plants cells. Ghozlsfolo *et al.* (2012) and Rahmonov (2009) reported the content K on aerial organs of Artemisia sieberi and Salsola dendroides was more than root.

The C (Carbon) amount in autumn, at root and herbage (within exclosure and out of the enclosure) and in all three plants Salsola, Stipa and Artemisia was more than summer. The content C between control and exclosure treatments had no significant difference ($p<0.05$). But, the content C in within exclosure was higher. Plant productions with increasing stages of plant growth are increased in autumn. Therefore, the amount of carbon in plant organs increases. Pineiro *et al.* (2009) reported the C content was higher in the exclosures than in the grazed stands in upland soils. Whatever the amount of carbon in the soil is greater, it will increase on plants organs as well. The C amount in root and herbage of Stipa in grazed exclosure was more than out of the enclosure and it had significant difference ($p<0.05$). The grazed exclosure increase plants production. So, whatever biomass of the plant organs is more and the carbon content increases. Pineiro *et al.* (2009) found after grazing exclusion, belowground biomass C reached a relatively uniform value of 1000 kg of C ha^{-1}. However, biomass C (and N) stocks in the exclosures at the three lowland sites (Chc, Chb and Bl) arrived at a higher value under grazing conditions. Dormmar *et al.* (1989) in southwestern Alberta, after 44 years of grazing, demonstrated that by increasing the grazing intensity, the organic matter, phosphorus and total carbon were reduced.

The maximum amount of Na, Ca and Mg was occurred in herbage of all three Salsola, Stipa and Artemisia in grazed exclosure and at autumn. Only Salsola in the summer had the highest amount of Na. Livestock grazing exclosure increase biomass of plant. These plants duration growth stages absorb mineral elements such as Na and accumulate on own organs especially at herbage. Tessema *et al.* (2011) in a semi-arid savanna of Ethiopia concluded that the concentration of total Na and Ca were higher in sites with light grazing compared with sites exposed to heavy grazing. Results this study was showed maximum content Na on Salsola organs was occurred at summer but in Stipa and Artemisia was occurred at autumn. Main reason of the high sodium on organs of Salsola in the summer it is that this plant duration vegetative growth, at summer nutrient elements absorb from soil and in own organs accumulate. Then in autumn season different elements such as Na through the loss of organs will return to soil. This is agree with results Ghorbanian and Jafari (2007) that concluded *Salsola rigida* after the establishment, some elements such as N, P and Na added to the soil.

In general, results of this study were showed livestock grazing exclosure had no significantly effects on nutrients of NPK in plants Salsola, Stipa and Artemisia. May be this is due to that livestock grazing capacity on these rangelands is balanced. So, the grazing is balanced and is also useful for plants. Because livestock grazing will adds nutrients including P and urea to soil. In addition, by tramping of soil, elements such as K release at soil. As a result, these nutrients will entre to plants organs. Moreover, followed by moderate grazing biomass of plants and the content C will increase as well. Nicol (1987) reported livestock feces and urine are potential sources of nitrogen, phosphorus, potassium, sulfur, magnesium and calcium for plants. Grazed exclosure increase amounts of Na, Ca and Mg on organs of these plants.

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