

Contents available at ISC and SID

Journal homepage: www.rangeland.ir



Full Length Article:

Determination of Sodium Chloride in the Plant Species of *Frankenia hirsuta* L. in the Saline and Alkaline Rangelands of Golestan Province (A Case Study of Inche-Shorezar Rangeland)

Ghasem Ali Abarsaji^A, Mohammad Mahdavi^B, Mohammad Hassan Jouri^B

^AM.Sc. Student the Natural Resources Department, the Islamic Azad University, Noor Branch, Iran

^BAssistant Professor. The Natural Resources Department, the Islamic Azad University, Noor Branch, Iran

Email: mjouri@gmail.com. (Corresponding author)

Manuscript Received: 26/12/2012

Manuscript Accepted: 16/06/2012

Abstract. The study of the relationships of the plant species with the soil in a salty ecosystem would play a significant role in the ecologic programming and management of these inhabitants. The saline and alkaline rangelands of the Golestan province are areas that contain salty soil with high underground crusts. The areas are covered by halophyte plants such as *Frankenia hirsuta*. This species is a perennial plant from the Frankeniaceae family. They could absorb salt from soil and store it in their organs in order to reduce soil saltiness and restore salt of lands. Thus, in order to determine the percentage of sodium chloride of such species, sampling was taken in the flowering stage from two enclosure and grazing areas by six replications. Then, the percentage of Sodium Chloride (NaCl) was measured in the lab using the titration method. The statistical analyses and the comparisons of the means of the collected data were made by the use of T-test. The results showed significant difference for NaCl% of the phytomass of the species ($P \leq 0.01$). The average value of NaCl was 2.13% and 1.37% for the enclosure and grazing area, respectively. In the other word, the highest and lowest values of NaCl% were obtained for enclosure and the grazing area, respectively. It was concluded that *Frankenia hirsuta* can take in the soil salt and by gathering or grazing, it could led to reduction of soil saltiness.

Key words: Golestan Province, Saline and Alkaline region, Inche-Shorezar rangeland, Sodium Chloride (NaCl).

Introduction

Million hectares of the arid lands are covered with the primary salty soil or the secondary salty soil as a result of farming malpractices such as irrigation and water extraction (McKell, 1989). Similarly, Iran is classified as a country with vast salty desert areas (Zohary, 1973), the saline and alkaline soils of which cover 12.5% of the whole areas of the country (Akhani and Ghorbanli, 1993). The realization of how the salty ecosystems change can be a significant factor in their sustained application and ecological management. There is a variety of factors that are involved in the adaptation of the halophyte species, so that the realization of the cause-and-effect relationships between them and the environment as well as the determination of the characteristics of the halophyte species in order to manage the salt-marshes are of paramount importance (Jafari *et al.*, 2001). The tension of saltiness is known to be a widespread phenomenon in the world of creatures, especially for the plants, whereas, such plants take a various reactions against saltiness (Breckle, 1992), which allow them to sustain in such a circumstance (Chen and Murata, 2002) and help to complete their life cycle in these lands (Levitt, 1972). The greatest degree of saltiness tension is formed as a result of sodium chloride, especially of NaCl type, in the natural environment (Fitter and Hay, 1987). The halophyte plants play an important role in the movement of the salt in the environment so that they can help them store salt over an area of 500 kg/h in their phytomass and cover it up over the land after death (Ghobadian, 1984). This occurs through salt secretion in the granules of the leaves and stems of the species so that these granules become an effective way of the extra salt secretion covering up the plant tissues (Metcalf and Chalk, 1950).

Jafari (1994) suggested that the halophyte species removes salt from their different organs in the form of salt granules in order to confront with saltiness; some of the plants are *Aeluropus*, *Frankenia*, *Limonium*, *Cressa* and *Spartina*. Similarly, Mirmohammadi Meibudi *et al.* (2003) concluded that the species such as *Aeluropus* and *Limonium* containing salt granules can help reduce the electrical

conductivity. Therefore, through intensive and sustained cultivation and gathering of such species, it is expected to have a reduction in the amount of salt, hence contributing to the improvement of the soil quality. On the other hand, considering the fact that certain amounts of salt, such as sodium, are found to be appropriate, the use of such rangeland species plays a significant role in supplying the livestock with the necessary forage and salt. Another study found that the plant species *Halocnemum strobilaceum* can grow in the saline lands by absorbing and storing salt into their succulent cork bodies, and it is thus possible to get involved in the reduction of the soil saltiness by providing the grazing practices and/or by systematically harvesting the phytomass obtained from such plants (Vali, 2006), or it is feasible to minimize the amount of salt in the lands through systematic application of the forage taken from such species as *Salicornia europaea* and *Atriplex heterosperma* (Vali and Ghazavi, 2003).

It has also been pointed out that few plants are capable of growing in the salty areas and can grow through such severe conditions, hence bringing those areas under their control (Breckle, 1992). Ayoub and Malcolm (1993) and Batanouny (2001) both viewed the cattle's consumption of the succulent halophyte plants as a factor contributing to the reduction of soil saltiness while they recommended using the forage with little salt along with the given species. Those species and sagebrush plants live through the salt to a great.

In order to determine any of the appropriate halophyte species to be used in different areas of land, studies and investigations must be carried out in terms of compatibility as well as the degree of compatibility of the species (McKell, 1989). Therefore, the present study was conducted to determine the amount of sodium chloride of the plant species *Frankenia hirsuta* in the saline and alkaline rangelands of Golestan Province, Iran under two enclosure and grazed areas.

Materials and Methods

The saline and alkaline rangelands of the Golestan province are of the regions that contain salty soil, with low crusts (Hosseini, 2006). The Inche-Shorezar rangelands

covering an area of 13470 ha are located in the saline and alkaline region of the province, and are one of the winter-quarter rangelands of the Golestan province and actually sited in the desert flat, and physiographically low-lying, lands (Hosseini, 2010). The study area has a rainfall of 284mm, with a semi-arid climate, and the mean annual temperature of 17.7 °C (Hosseini, 2006). It has salty and silty-loam soils, covered with halophyte species as *Halocnemum strobilaceum*, *Frankenia hirsuta*, *Aeluropus lagopoides*, *Aeluropus littoralis*, *Halostachys caspica*, *Salsola turcomanica*, etc. The *Frankenia hirsuta* is a perennial species from the Frankeniaceae family (Mozaffarian, 2005). The study area altitude is 32m above sea level (Amirabadi Zadeh, 1995); which grows thickly in this area (Akbarlo, 1994).

Sampling was conducted from two enclosure and grazing areas in flowering stage and through six replications. For each sample, five plants (full-grown plants) were randomly selected and (their re-vegetation current-annual growth) clipped. The samples on each growth stage were collected (the dead vegetations were excluded and the possibility of soil contamination was controlled), and moved to the laboratory. The percentage of sodium chloride (NaCl) was measured using the titration method (Ghazanshahi, 1997).

A t-test was used to analyze the data and compare the means, and the published data were used to determine the area condition as well as the herd composition and quantity (Hosseini, 2010; Kadkhoda'ie, 1995). Data were collected for percentage of the canopy cover. The frequency and species density were obtained using the systematic-random sampling method as well as clipping and weighing method (Mesdaghi, 1993). The herbarium samples were provided to control species identification by Botanist.

Results

Both of the enclosure and grazing areas were in the desert and flat lands as well as in the physiographical unit of lowlands. They lie 4 meters above open sea level and have a gradient of roughly 1-2% toward the west and northwest sides from the southeast side (Hosseini, 2010). Their soil is salty and their plant type is sagebrush, i.e. *Halocnemum strobilaceum*, which is representative of the halophyte rangelands in Golestan province. The entrance and existence dates of the cattle were recorded. The period of grazing was set according to the grazing licenses, which are annually set on a 120-day period, starting from October 20 until March 20. The herd composition consists of 90% of sheep with 10% of goats, totaling 5300 heads, as permitted by the grazing license (Kadkhoda'ie, 1995). The amount of dried forage production (kg/ha) and the percentage of the canopy cover, frequency, and density of the plant species are shown in (Tables 1 and 2). The results from the production estimate (Table 1) indicated the production totals 249.28 kg/ha in the enclosure area and 223.39 kg/ha in the grazing area. A large quantity of the produced forage on the grazing season (from September 20 to March 20) is consumed by livestock. Moreover, the estimate of the percentage of canopy covers (Table 2) showed that the species *Halocnemum strobilaceum* had higher values and considered as the dominant species of the Inche-Shorezar rangelands.

The results from the determination of NaCl% are shown in (Fig. 1). There were significant differences between two sites ($t = 7.58$, $df = 10$ and $P \leq 0.01$). The average values of NaCl was 2.13% and 1.37% for the enclosure and grazing area, respectively, which represents the highest and lowest values for enclosure and grazing areas, respectively (Fig. 1).

Table 1. The amount of dried forage production (kg/ha) of the plant species *Halocnemum strobilaceum*, *Frankenia hirsuta* and other growth forms in enclosure and grazing areas

Speices	Exclosure	Grazing	T- test
<i>Halocnemum strobilaceum</i>	187.50	174.36	n.s
<i>Frankenia hirsuta</i>	4.80	4.15	n.s
Perennial grass	24.10	22.68	n.s
Annual grass	21.27 a	12.80 b	**
Perennial forbs	2.50	2.30	n.s
Annual forbs	8.68	7.10	n.s
Total	249.28 a	223.39 b	**

The means of exclosure and grazing areas with the different letters were significant based on T-test method.

Table 2. The analysis of factors regarding the percentage of the canopy cover, frequency, and density of the plant species in exclosure and grazing areas of the Inche-Shorezar rangeland

Speices	Canopy Covers %		Density (No. in SM)		Frequency %	
	Exclosure	Grazing	Exclosure	Grazing	Exclosure	Grazing
<i>Halocnemum strobilaceum</i>	31.40 a	29.2 b	0.76 n.s	0.77 n.s	85 n.s	85 n.s
<i>Frankenia hirsuta</i>	0.22 a	0.19 b	0.04 n.s	0.04 n.s	4 n.s	3.5 n.s
<i>Plantago coronopus</i>	0.80 n.s	0.75 n.s	1.70 a	1.10 b	30 n.s	30 n.s
<i>Spergularia media</i>	0.27 n.s	0.25 n.s	1.50 a	1.30 b	20 n.s	20 n.s
<i>Zingieria trichopoda</i>	2.30 a	1.30 b	190 a	150 b	60 n.s	60 n.s
<i>Lophochloa phleoides</i>	0.30 n.s	0.20 n.s	1.70 a	0.90 b	30 n.s	30 n.s
<i>Parapholis incurva</i>	0.40 n.s	0.30 n.s	1.10 a	0.80 b	30 n.s	30 n.s
<i>Polypogon monspeliensis</i>	0.02 n.s	0.02 n.s	0.03 n.s	0.02 n.s	4.0 a	3.0 b
<i>Bupleurum semicompositum</i>	0.18 n.s	0.17 n.s	0.09 n.s	0.085 n.s	20 n.s	20 n.s
<i>Frankenia pulverulenta</i>	0.40 n.s	0.35 n.s	0.50 n.s	0.60 n.s	30 b	35 a
<i>Psylliostachys spicata</i>	0.01 n.s	0.01 n.s	0.005 n.s	0.005 n.s	0.5 n.s	0.5 n.s
<i>Aeluropus lagopoides</i>	0.80 n.s	0.70 n.s	0.015 n.s	0.013 n.s	3.0 n.s	3.0 n.s
<i>Aeluropus littoralis</i>	0.05 b	0.10 a	0.005 n.s	0.010 n.s	0.5 b	1.0 a
<i>Cressa cretica</i>	0.03 n.s	0.03 n.s	0.005 n.s	0.005 n.s	0.5 n.s	0.5 n.s
<i>Salicornia europaea</i>	0.02 n.s	0.03 n.s	0.010 b	0.015 a	0.5 b	1.0 a
<i>Petrosimonia brachiata</i>	0.02 n.s	0.02 n.s	0.005 n.s	0.006 n.s	0.5 b	1.0 a
<i>Salsola turcomanica</i>	0.10 a	0.08 b	0.010 n.s	0.010 n.s	1.0 n.s	1.0 n.s
<i>Halostachys caspica</i>	0.10 n.s	0.10 n.s	0.005 n.s	0.005 n.s	0.5 n.s	0.5 n.s

The means of exclosure and grazing areas with the different letters were significant based on T-test method.

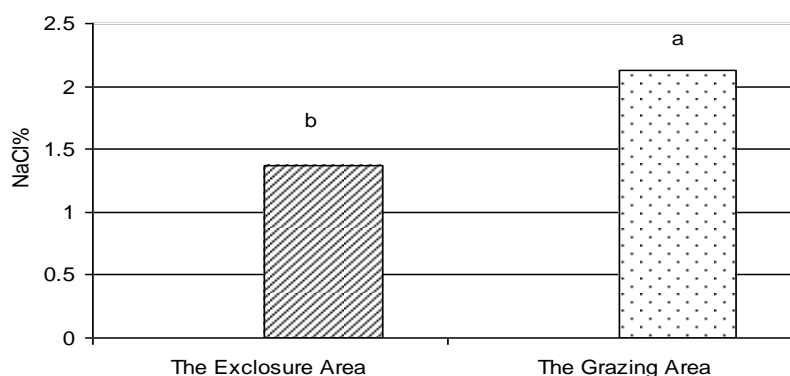


Fig. 1. The comparison of NaCl% between exclosure and grazing areas

Discussion and Conclusion

Regarding the obtained results from both enclosure and grazing areas, there was a significant difference for absorbed NaCl% by the given plant (Fig. 1) so, the mean of NaCl% was greater in the enclosure area than in the grazing area. The reason is that, in time of grazing in such a kind of forage, part of the salt in the plant is swallowed by the livestock and another part was dropped down on the earth as a result of the herd frequent trampling, and is wasted, the samples of enclosure area had higher values of NaCl% compared to those in the grazing area, as shown in (Fig. 1). The results from this study are in agreement with those obtained in Vali (2006), in which he concluded that *Halocnemum strobilaceum* take in the soil salt, and gathering or grazing of forage can reduce the saltiness in the soil (Vali, 2006) or the systematic utilization of the forage obtained from such species as *Salicornia europaea* and *Atriplex heterosperma* can decrease the land saltiness (Vali and Ghazavi, 2003). In a similar finding, Mirmohammadi Meibudi et al., (2003) concluded that those species containing salt granules, which take in the soil salt, can bring about a reduction in the electrical conductivity of the soil; through, considering intensive and sustained cultivation and harvest of the species, it can be expected from a decline in the soil salt, with this contributing to the enhancement of the soil quality. The reports from Ayoub and Malcolm (1993) and Batanouny (2001) studies also indicated that the cattle's consumption of forage from the succulent halophyte plants had led to the drop in the soil saltiness. Accordingly, since the *Frankenia hirsuta* can exude the salt taken from the soil through the salt granules (i.e. leaf or stem) in confrontation with the saltiness, it is expected, if grazed or gathered, to play an important role in cutting down on the soil saltiness in the areas in which the saltiness occurred as a result of such factors as the saltiness of irrigation water, misirrigation, etc. Although the given species is capable of taking in salt and hence diminishes the soil saltiness, the site, which is located in the lowland, close to the

Caspian Sea and contains salt water low-depth strata (Akbarlo, 1994), can cause the salt to move up the soil surface and re-increase the soil saltiness. In order to make use of this species in reducing the saltiness of the soil and enhance it biologically, we can also utilize the salt lands that develop as a result of such factors as the saltiness of irrigation water, misirrigation, etc., and use the forage produced in the lands, after cutting back on their saltiness.

References

- Akbarlo, M., 1994. The analyses of the plant cover in the saline and alkaline biota of the eastern province of Mazandaran. The MSc. Thesis in Rangeland Management, Gorgan University of Agriculture and Natural Resources. (p. 160). Gorgan, Iran. (In Persian).
- Akhani, H. and Ghorbanli, M. 1993. A contribution to the halophytic vegetation and flora of Iran, in H. Lieth and A. Al-masoom (eds.), towards the rational use of high salinity tolerant plants, Vol. 1: 35-44, Kluwer Academic Publishers, Netherlands. (In Persian).
- Amirabadi Zadeh, H., 1995. The Flora of Iran, the Frankeniaceae family. No. 11, Publication of Research Institute for Forests and Rangelands (RIFR), Tehran, Iran. (In Persian).
- Ayoub, A. T. and Malcolm, C. V. 1993. Halophytes for livestock, rehabilitation of degraded land sequestering atmospheric carbon. UNDP Pub, Nairobi, Kenya, p. 155.
- Batanouny, K. H., 2001. Halophytes and halophytic plant communities in the Arab region. Vol. 1: 136-139. Kluwer-Academic Pub., Amsterdam.
- Batanouny, K. H., 2001. Plants in the deserts of the Middle East. Springer Pub, Berlin. 171 pp.
- Breckle, S. W., 1992. Salinity-stress and salt-recreation in plants, *bielefelder okologische beitrage*, band 6: 39-52.

- Chen, T. H. H. & Murata, N. 2002. Enhancement of tolerance of abiotic stress by metabolic engineering of betaines and other compatible solutes. *Current Opinion in Plant Biology*, **5**: 250–257.
- Fitter, A. H. & Hay, R. K. M. 1987. *Environmental physiology of plants*. Academic Press, p. 423.
- Jafari, M., 1994. The feature of saltiness and halophytes. No. 113, p. 55. The Research Institute for Forests and Rangelands (RIFR) Pub. (In Persian).
- Jafari, M., Azarivand, H., Mohajeri Borazjani, S. and Heidari Sharifabad, H. 2001. Investigation of the relationship of halophytic plant covers in Boshehr with the depth of water table level surface and the factors generating saltiness. *Desert*, **6(1)**: 35-46. (In Persian).
- Hosseini, S. A., 2006. Autocological exploration of *Halocnemum strobilaceum* in Golestan province, Iran. Final research project reports of, Agriculture and Natural Resources Research Center Golestan province, Iran, p. 54. (In Persian).
- Hosseini, S. A., 2010. Investigation of the appropriate time for the entry and exit of cattle in the sample rangelands of five growing regions of Iran (Golestan–Incheboron). Final research project reports, Agriculture and Natural Resources Research Center, Golestan province, p. 52. (In Persian).
- Ghazanshahi, J., 1997. The analysis of soil and plant. International Center for Agricultural Research in the Dry Areas ICARDA), Syria, p. 311.
- Ghobadian, A., 1984. Pathology of arid and semi-arid areas. Tabriz. Amidi Press, Tabriz, Iran. (In Persian).
- Kadkhoda'ie, M., 1995. Rangeland management plan of Inche-Shorezar. The General Office of Natural Resources of Golestan province, Iran p. 67. (In Persian).
- Levitt, J., 1972. Responses of plants to environmental stresses. Academic Press, London, p. 697.
- McKell, C. M., 1989. The biology and utilization of shrubs. New-York: Academic Press, San Diego, p. 656.
- Mesdaghi, M., 1993. Rangeland management in Iran. p. 215. Astan Ghods Razavi Press, Iran. (In Persian).
- Metcalf, C. R. & Chalk, L., 1950. *Anatomy of the dicotyledons*. Vol. I, Clarendon Press, Oxford p. 1500.
- Mozaffarian, V., 2005. Dictionary of the Iranian plant names. p. 671. Farhang Mo'aser Press, Iran. (In Persian).
- Mirmohammadi Meibudi, S., Amini, A. & Khajaddin, S. J. 2003. Evaluation of two species of *Aeluropus* in reduction of soil saltiness and restoration of salt lands. *Uloum va Fonoun Keshavarzi va Manabe' e Tabiei (Agricultural and Natural Resources Techniques)*, **7(2)**: 241-250. (In Persian).
- Vali, A. A. & Ghazavi, Gh. R. 2003. Study of the relationship between the accumulation of plant species and the amount of saltiness and the soil texture in the Karsia salt-marsh, Darab. *Desert* **2**: 236-248. (In Persian).
- Vali, A. A., 2006. The effect of the species *Juncus gerardi* and *Halocnemum strobilaceum* on the characteristics of soil in the root area: A case study of the Karsia salt-marsh, Darab. *Agricultural and Natural Resources Techniques*, **1**: 261-270. (In Persian).
- Zohary, M., 1973. *Geobotanical foundations of the Middle East*. Vol 2. p. 515. Amsterdam, Stuttgart. (In Persian).