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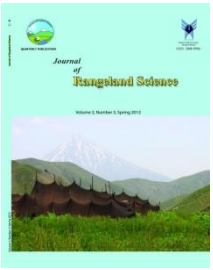

Full Length Article:

Effect of Grazing Intensity on Soil Density of Inchehbroon Rangelands (Golestan province, Iran)

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Abstract. Infiltration rate of water into the soil depends on the factors such as rock and litter cover, canopy cover, rainfall intensity, coarse material, land slope, soil texture and amount of initial soil moisture. The most important factors that are effective in the water infiltration rate of rangelands are livestock trampling and vegetation reduction due to the overgrazing. In present study, through drawing a curve of number dung distance from the fold, three areas were determined as heavy pressure grazing (A), fixed grazing (B) and without grazing (C). The soil samples were taken and soil density was determined. Results of analysis of variance showed a significant difference between soil densities in all three grazing zones ($P<0.01$). There were also significant differences between soil densities of patches and bare soil ($P<0.01$). Results showed significant differences of patches in the range of severe grazing and bare soil in the same range ($P<0.01$).

Key words: Grazing intensity, Soil density, Rangelands, Golestan Province.

Introduction

Due to sensitivity of ecological balance between environmental factors and patches and role of grazing pressure to create and change the soil factors, it's necessary to show the relationship between patches and interpatches, present some solutions to improve the rangelands, recognize the grazing and inclosure while changing the pattern in the patches and identify its relationships with soil factors such as permeability. In an arid ecosystem, water is the most important source of limitation. Therefore, in addition to hard conditions of environment and plant competitions for survival, limiting water is an obstacle for advancing the vegetation (Aguiar and Sala, 1999).

For studying patches dynamism, the study of affecting factors is important to create and change the patches (Jackson *et al.,* 1996). Grazing pressure disturbed the relationship between soil and plant (Van Bremen, 1993). Animal trampling leads to non-uniform relationship between soil and plant in arid areas. Studies showed that patches were created to influence the nutrient cycle and water permeability in the soil (Vinton & Burke, 1995). Water permeability of patches into the soil is increased by the flows of stem and leaves (Van Elewijck, 1989). Leaves and stems trapped and sustained the particles of water. Permeability of water into the soil in patches is more than interpatches because in patches, the soil is less exposed to rain drops and the hydraulic conductivity is higher due to the roots of plants (Walker *et al*., 1981).

Stoddert *et al.,* (1975) stated that the most important effect of grazing on permeability of water into the soil is the soil compaction and vegetation reduction. Dadkhah and Gifford (1980) in investigating the effects of vegetation, stone and trampling on penetration rate found that the livestock trampling and vegetation cover were the most important factors that influenced the infiltration rate and sediment production.

Eskandari (1996) studied the effect of uncontrolled livestock grazing on soil properties of summer rangelands of Isfahan and concluded that uncontrolled grazing has harmful effects on soil physical properties. Vahabi (1990) showed that the higher penetration rate in inclosure areas is due to lack of trampling livestock, lack of soil compaction and the increases of density and canopy cover in plant species, growth and development of plant roots, increase of organic matter and improvement of soil structure.

Pietola *et al.,* (2005) investigated the effect of livestock grazing on soil infiltration in southern Finland and found a significant difference for water permeability between trampling and not trampling the soils. Also, water permeability into the soils of clay, sand and loam is limited by livestock trampling. In overall, physical conditions of soil surface are important factors in germination and establishment of vegetation (Valentine and Bresson, 1992).

Mwendera *et al.,* (1997) studied the infiltration rate, surface runoff and soil erosion under the grazing pressures in rangelands of Ethiopia. Their results showed that pressure of heavy grazing reduced the vegetation and infiltration rate and increased the soil erosion and surface runoff as compared to extra heavy grazing.

Wood *et al.,* (1998) examined the changes of soil physical properties in rangelands of Armydal Australia and found a higher infiltration rate in the soil of rangelands that were inclosure about 27 years compared to the rangelands that were under grazing about 2 years. These differences were due to the regeneration of physical properties in soils because of biological activity and dry and wet phenomenon of soils in a rangeland without grazing.

The main goal of this study was to investigate the soil density between patches and interpatches at different levels of grazing severity. This study considers a relationship among soil density, vegetation and grazing intensity.

Materials and Methods

Study area is winter rangelands in north of Golestan province located in 30 km of northern AqQala. This area coordinates are 37° 14' latitude and 54º 29' longitude. Inchehbroon presented halophyte rangelands in Golestan province, Iran. This area altitude is -4 m. Climate of area according to

meteorological stations of Voshmgir dams and inchehbroon is warm and dry and view of climatic division by Ambergeh method is dry, mild and semi desert. Average annual rainfall is 304 mm in fall from October to May. Land soils of study area were specified as medium texture, more salinity and alkali situate at land units of physiography and it seems that they were mainly created from alluvial deposits Gorgan-rood River.

Land slope is toward the southeast and northwest, lands are flat and height is mild (Naseri, 1996). *Halocnemum strobilaceum* species that make up the dominant vegetation with appropriate cover production which was more than 40% of total production played an important role in producing the forage in these rangelands. Its growth stage starts from February and ends in October. Other species in this area can be cited as follows: *Halostachys caspica, Aeluropus lagopoides* and *Aeluropus littoralis* (Hoseini, 2008).

In order to measure the soil density, some areas with different grazing intensities were determined. Considering the research background, it has been indicated that grazing pressure is at maximum level near the water spot and wherever away from this area, there is a decline in the grazing pressure and then, grazing pressure is constant. For determining the zones of grazing pressure, an enclosure was selected in Inchehbroon station of Golestan province where is the nearest fold to zones. Transects were established in four directions around the fold. Transects at intervals of 10 m were established in plots of 2x2 m^2. Through drawing a curve of number dung distance from the fold, three areas were determined as heavy pressure grazing (A), fixed grazing (B) and without grazing (C).

Soil density (g/cm^2) was determined using a cylinder in four replications with the distance of 10 m from each other on patches and four replications on bare soil (the space between patches) in each grazing area (total number of 24 plots) using standard cylinders. Soil samples were moved to the laboratory and dried in an oven at temperature of 105ºC for 24 hours. The dried weight and volume of soil samples were measured. The collected data were analyzed using ANOVA and comparisons were made between the main treatments of different grazing intensities and sub treatments of patches and bare soil.

Results and Discussion

This study was conducted with three main treatments of without grazing (17 year enclosure), heavy grazing and fixed grazing and two vegetation treatments as patches and bare soil in four replications in saline and alkaline rangelands of Golestan province.

The results of analysis of variance showed significant differences between three grazing systems for soil density ($P<0.01$). However, there was no difference between enclosure and fixed grazing. There were also significant differences for soil density between patches and bare soil ($P<0.01$) (Table 1). Two separate analyses of variance were made for different levels of grazing for patches and inter patch area (Table 2). The results showed a significant difference between three treatments for both patch and bare soil ($P<0.01$).

According to results, the soil texture in all three regions was silt loam and no change was observed in soil texture. There were significant differences between enclosure and heavy grazing ($P<0.01$), but there was no significant difference between enclosure and fixed grazing. For bare soil, the soil densities of heavy grazing and fixed grazing with average values of 1.5 and 1.4 g/cm^2 were higher than that for enclosure with average value of 1.37 g/cm^2. The results indicated 13% and 30% increases in soil density for heavy grazing and fixed grazing compared to enclosure. Wood *et al.*, (1998) in investigation of soil properties in Australia showed that soil penetration ratio in rangelands without grazing for 27 years remained much more than no grazing rangelands for 25 years. Eskandari (1996) investigated the effect of livestock grazing on soil properties in spring rangelands of Zagros (Isfahan province) and concluded that an excessive livestock grazing had a critical effect on soil physical properties. He argued that the improper effects were excessive for the compaction of soil surface, reduced water permeability in the soil and created improper conditions for plant growth. The results of mentioned studies indicated that reduction of

water penetration in soil surface is due to soil compaction by livestock trampling that confirms the results of our study showing that change of soil density (bulk density) leads to a decrease in soil pores because of grazing.

The soil densities in patches for heavy grazing, fixed grazing and enclosure were 1.45, 1.39 and 1.33 g/cm^2, respectively. The results showed no significant differences between them (Fig. 2). Forage production in not-grazed patches was high in the growing season. So, plants had a full growth and their root biomass in the three sites was similar. Plant vegetation of shrubs in patches of studied sites was prevented from trampling so that patches had less trampling and soil density had no significant differences with enclosure site. Also, in patches, the leaves, stems and soil particles were trapped and kept up and with created micro-topography sometimes reaching about 20 cm, it caused an increase in water permeability and lack of soil density in sever grazing and constant grazing areas. So, for patches, there was a significant difference among heavy grazing, fixed grazing and enclosure (Fig. 2). Rietkerk *et al.*, (2000) stated that two factors for creating patch and interpatch patterns of plants in arid regions are the positive effect of water permeability within the mosaic of plants and negative effect of runoff on bare soil between patch and interpatch areas. This task caused an increase in coverage in some parts of plants, leaching of soil accumulation in interval foot plants, increase of humidity in these areas and an increase in the richness of coverage and erosion between them to create micro topography. Van Elewijek (1989) stated that patches caused an increasing permeability by the flows of leaves and stems and leaves and stems trap and hold the soil particles. Results of these studies are in conformity with the results of other researchers.

Soil density between heavy grazing and two other grazing methods was significant ($P<0.01$). While soil density differences between enclosure and fixed grazing were not significant. Soil densities in bare soil of enclosure and fixed grazing with average values of 1.42 and 1.40 g/cm^2 were higher than heavy grazing with value of 1.54 g/cm^2. It was up to 12% and 10% reduction compared to heavy grazing. Wherever near the fold, livestock density was increased by unit area, and also animal spends more time around and in front of fold. For soil density, there were no significant differences for bare soil of fixed grazing area and enclosure area. Pietola *et al.*, (2005) in the study of grazing effect on soil permeability in Finland found a significant difference between soil trampling and not trampling for water permeability. Results of their research are similar with the present research.

Soil density differences between patches and bare soil were significant for all three grazing intensities ($P<0.01$). Soil density for bare soil with average value of 1.46 g/cm^2 was higher than patches with average of 1.37 g/cm^2 increased from 9% (Fig. 3).

Patches which usually are shrubs make up fertile islands whose soil is less exposed to rain drops and pressure of animals. Also, in addition to lack of synchronization of grazing season with dominant plant growth, plants have full growth and patches produce more biomass than bare soil. In contrast, bare soil was compressed because of trampling of livestock, human and raindrops. Walker *et al.*, (1981) stated that water permeability into the soil covered with plants is more than bare soil because soil is less exposed to rain drops and will not be compressed. Also, high hydraulic conductivity is due to the roots of plants. Dadkhah and Gifford (1980) introduced some important factors that affect the infiltration rate and sediment production of livestock trampling and vegetation. Infiltration rate and sediment production in different grazing intensities determine the rates of trampling livestock and density of surface soil confirmed the results of our research.

Table 1. Result of analysis of variance for soil density between the main treatments

Source of variation	DF	SS	MS	F
Factor (Patches vs. Inter patches)	1	0.024	0.024	12.20**
Error	18	0.036	0.002	-

**= Significant differences at 1% level.

Table 2. Variance analysis of surface density at different levels of grazing

Sources	DF	Patches		Inter Patches	
		MS	F	MS	F
Treatment	2	0.016	7.32**	0.024	13.61**
Error	9	0.002	-	0.002	-

**= Significant differences at 1% level.

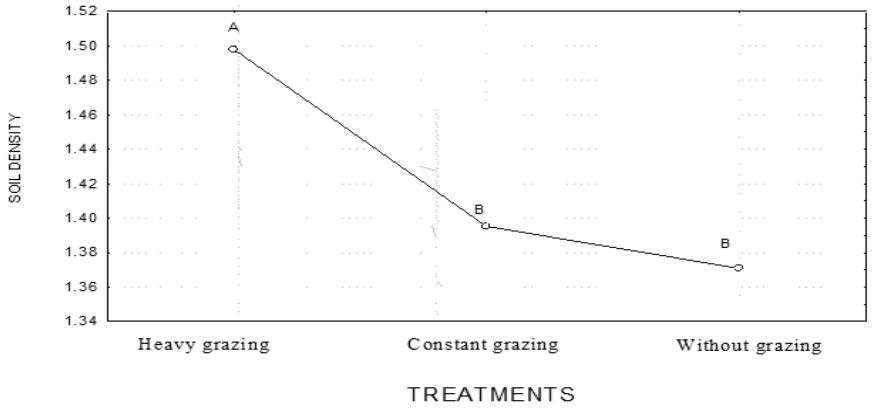

Fig. 1. Comparison of three main effects of without grazing, heavy grazing and constant grazing on soil densit

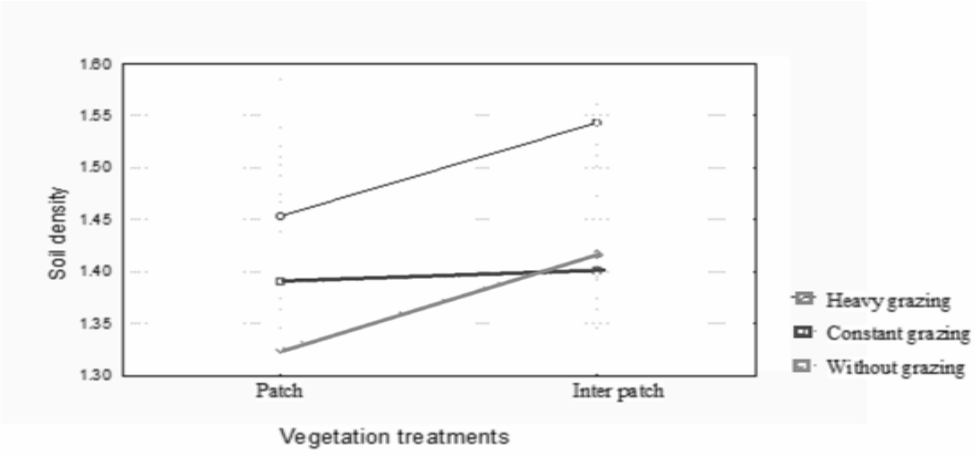

Fig. 2. Comparison of interaction effect of soil density between vegetation treatment (Patch) and bare soil (Inter patch) in three grazing intens

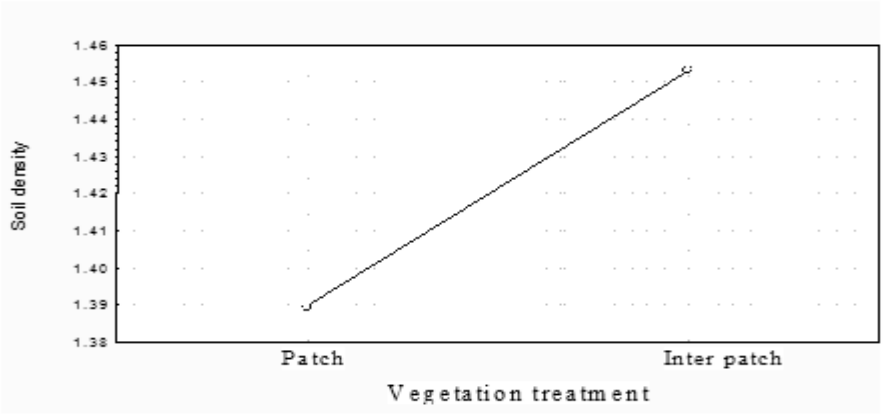

Fig. 3. Comparison of soil density between vegetation treatment (patch) and bare soil (Inter patch)

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