Relationships Among Forage and Litter Production in Three Grazing Intensities in Nodooshan Rangeland (Yazd, Iran)

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Abstract. Grazing management plays an important role in the continuous and economic utilization of pastures. Proper grazing management is a main factor for the accumulation of plant litter which reduces soil erosion and increase the soil permeability to keep more moisture in the soil. In current study, the effect of three different grazing intensities (low, moderate and high) along with the grazing gradient on the forage production rate and plant litter percentage was investigated on Nodooshan steppe pastures of Yazd, Iran. A randomized complete block with three replications was used to compare three grazing methods. Data for forage production and litter percent were collected from a $2m^2$ quadrate in each plot. The results showed significant differences among grazing systems for both traits ($P<0.05$). The results showed that low grazing had the highest forage production. The regression equation between forage production and litter percentage were logarithmic in both moderate and high grazing intensities. For low grazing intensity, the relationships between two traits showed quadratic egression and therefore, it was concluded that moderate grazing intensity was the best in terms of both forge and litter production.

Keywords: Grazing severity, Forage production, Litter, Nodooshan rangeland of Yazd.

Introduction

Areas of country natural resources in three decades are severely degraded and destruction factors were dramatic adverse effects such as soil erosion, flood, waste and water shortages and environmental pollution had to follow (Onagh 1994). In this regard, vegetation of soil surface plays an important role and increases the herbage production per unit area and leads to the reduction of erosion rate (Refahi 1999). One of the useful ways to improve pasture production is proper grazing management. Because of its relatively low cost and its high potential profitability per unit of input management, it is justified Holechek *et al.* (2004). Proper grazing management can be a key to the accumulation of plant litter which reduces soil erosionand evaporation from the surface of pastures increases permeability of the soil and water holding capacity of soil and regulates soil surface temperature. Also, when the litter converts to humus, nutrient and soil permeability rate can be increased and leads to the increase in rangeland production (Schwan 1949; Bartolome *et al.* 1978; Molinar *et al.* 2001). Rauzi (1960) in North Dakota showed that if the amount of litter increases twice, the herbage production rate increases more than twice. The other scientists showed that fodder and litter left by the effect of water infiltration have significant effects on forage production (Wikeem *et al.* 1989, Willms 1986). Mapfumo *et al.* (2005) in the study of grazing intensity effect on litter of annual and perennial plants in Alberta rangelands concluded that the rate of litter in perennial plants was higher than annual plants. Also, the amount of litter in the light grazing was 1.5 times more than heavy grazing and with increasing intensity of grazing; the litter and production rates were reduced. In Iran, rangelands play an important role in soil conservation and area vegetation. But unfortunately, in recent years, ongoing drought and over grazing the rangelands caused damage to rangeland and reduce forage production. The number of grazing animals around the places where drinking water exists in rangelands is critical in dry on steppe pastures. When other factors affecting the grazing distribution such as slope, elevation, soil-related factors, etc. do not limit the grazing distribution, ultimately the distance from watering place limits the pasture extent. Watering as one of the critical points is considered in the rangelands that grazing intensity is high and the goats and sheep graze several times a day toward the moving parts and after drinking water from distant places. Therefore, frequent review of qualitative and quantitative changes in vegetation around watering area is necessary that in case of any progressive change in the status of vegetation and soil, can be attempted to improve the rangeland management methods. The model of Chen and *et al.* (2007) showed that with increasing the grazing intensity, the rate of standing product reduces. Zhao *et al.* (2007) investigated the effecting gradient of grazing in rangeland vegetation of northern China and they concluded that the heavy grazing not only influences the diversity of palatability forage, but also can change the structure and distribution patterns of dominant species. Baghestani and Arzani (2001) studying the effects of four goat grazing intensities (low, high, moderate and no grazing) on vegetation steppe rangelands of Yazd Nayer concluded that production and cover percentage were maximum in grazing balance intensity and was minimal in High intensity grazing. Low, moderate and high grazing intensities in the short term of two years had no significant effect on the pasture production, but high grazing intensity led to the reduction of *Stipa barbata* and *Salsola rigida* frequency. In another study, Fattahi (2003) showed that by increasing the grazing intensity, the forage production and cover of litter percentage were reduced. Ajorloo (2005) investigated the effect of distance from the center of crisis on vegetation and soil properties in Abgarm pastures, Qazvin.

There were considerable changes in canopy cover litter and species diversity around the watering place and villages. He showed that vegetation and litter factors had a strong correlation with distance from the crisis center.

In dry areas of steppe pastures of Nodooshan in Yazd, the watering in these areas is criticaly important. Therefore, in present study, the effect of grazing gradient around watering area and the relationships among herbage and litter production in the steppe pastures of Nodooshan in Yazd (province livestock pole) were studied.

Material and Methods

Regional Location and Data Collection

Sadr Abad area is located in 31° 52′ to 31° 57′ northern latitude and 53° 30′ to 53° 36′ eastern longitude. The mean annual rainfall is 124 mm. The climate of this region using Emberger method is dry steppic climate. Three watering areas with the following geographical locations were used as replications:

1. Geographical location of 31° 52′ 14″ northern latitude and 53° 32′ 19″ eastern longitude

2. Geographical location of 31° 53′ 31″ northern latitude and 53° 31′ 58″ eastern longitude

3. Geographical location of 31° 54′ 44″ northern latitude and 53° 31′ 24″ eastern longitude

To conduct sampling according to the relationship between grazing intensity and distance from watering, Livestock traveling effects in recent years, vegetation changes and information gained from local farmers about grazing, three regions with different grazing intensities associated with gradient grazing were isolated using Zhao classification method (Zhao 2007). So, 3 distances from watering center were assigned as follows:

a) High grazing area from 0-200 m distant from watering center

b) Moderate grazing area from 200-800m distant from watering center

c) Low grazing area from 800-1200 m. distant from watering center.

Around each watering center, grazing intensity of three regions in terms of other conditions such as topography, slope and aspect were the same and the predominant species at all sites were *Artemisia sieberi*. Dimension plot based on species level curve was obtained. Number of plots needed for the sampling using cumulative average was determined (Muller, 1974). Systematic plots were placed randomly and in each plot, weight of dry matter of palatability forage and litter percentage was estimated.

Table 1. List of Species and their Life Period, Growth form and Palatability in Sampling Sites

Number	Species name	Family	Life period	Growth form	Palatability
1	*Allysum minus*	Cruciferae	A	Forb	I
2	*Artemisia sieberi*	Compositae	P	Shrub	II
3	*Astragalus achrochlarus*	Leguminosae	P	Shrub	III
4	*Astragalus candolleanus*	Leguminosae	P	Shrub	III
5	*Boissiera squarrosa*	Gramineae	A	Grass	I
6	*Bromus tectorum*	Gramineae	A	Grass	I
7	*Eryngium Spp*	Umbelliferae	P	Shrub	III
8	*Iris songarica*	Iridaceae	P	Forb	III
9	*Lactuca glaucifolia*	Compositae	P	Shrub	III
10	*Peganum harmala*	Zygophyllaceae	P	Shrub	III
11	*Poa sinaica*	Gramineae	P	Grass	I
12	*Salsola arbuscula*	Chenopodiaceae	P	Shrub	II
13	*Scorzonera tortuosissima*	Compositae	P	Forb	I
14	*Stachys* inflata	Labiatae	P	Forb	III

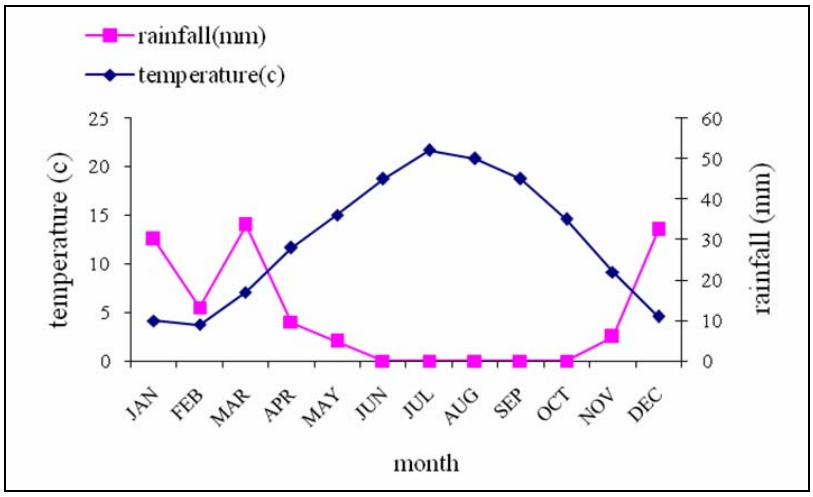


Fig. 1. Embrothermic Curve of Nodooshan Station

Statistical Design and Analysis Methods

A randomized complete block design was used for low, moderate and high grazing intensity as treatments and three watering centers as replications. One way ANOVA and GLM methods were used using SPSS software. Comparison among 3 grazing treatments was made by Duncan method. Normality of data in each group was tested using Kolmogrov Smirnov statistics and homogeneity of variances was investigated with Leven test (Talebi, 2002).The relationships between herbage and litter production were quantified using the regression analysis.

Results

Effect of Grazing on Production:

Results of variance analysis showed significant ($p<0.05$) differences among three grazing intensities. Duncan test showed that low grazing had the highest production for both *Artemisia* and total forage production (Fig. 2).

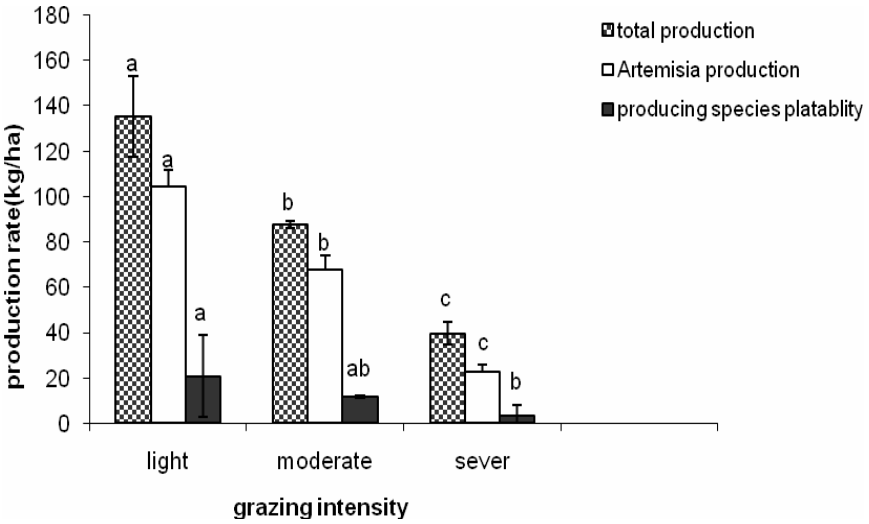


Fig. 2. Average Production of Different Grazing Intensities
Means of columns with the same color followed by different letters are significantly different ($P<0.05$).

Effect of Grazing on Litter

Results of variance analysis showed significant differences among three grazing intensities. Regarding the litter rate, the high grazing intensity had the lowest amount of litter compared to medium and

light grazing intensities. The results indicate that there is no difference between

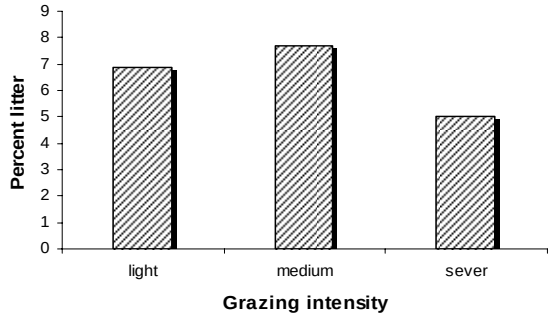
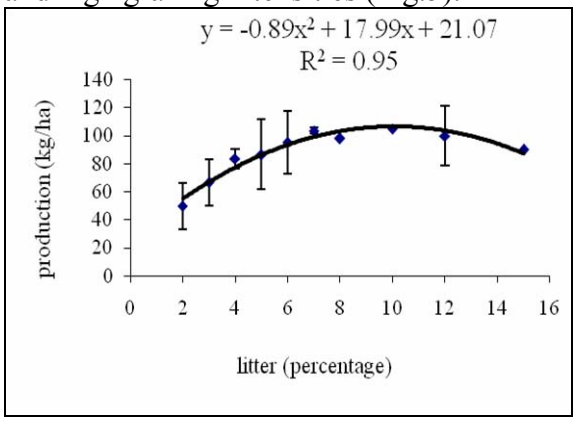


Fig. 3. Comparisons among three grazing intensities for litter percentage
Means of columns followed by the different letters are significantly different (P<0.05).

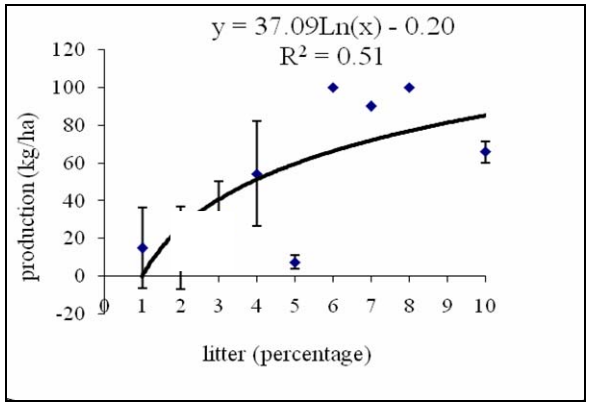
Relationship between Forage Production and Litter Percentage

The results showed that the most appropriate regression equation model to investigate the relationship between forage and litter production in the studied area was quadratic for low grazing and non-linear logarithmic model for both moderate and high grazing intensities (Fig.5).

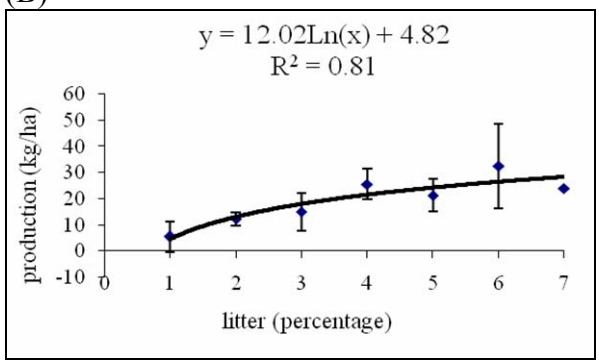


(A)

low and medium grazing intensities.



(B)



(C)

Fig. 4. Regression Equations between Forage Production and Litter Percentage at three Grazing Intensities, Low (A), Moderate (B) and High (C)

Discussion and Conclusion

Results from investigating the effects of grazing intensity on forage production indicate that three grazing intensities had a significant difference. Also, by reducing the distance from the watering center, the total production was decreased. The reason is that high production rate at a distance far from watering related to perennial plants especially is the dominant species as *Artemisia* in terms of palatability is desirable for livestock. Therefore, near the watering area, the grazing pressure and its direct effect on the grazing of leaves increase and reduced photosynthetic levels reduces the rate of production. Also, trampling the soil by livestock can affect soil structure and thus, affects the activity of microorganisms leading to diminish in the absence of oxygen supply. This leads to the reduction in forage plant availability

and finally, reduces the nutrient and plant production. In a similar study, (Fattahi 2003, Kooijman and Smith 2001) and Chen *et al.* (2007) achieved the same results. Based on the results, increasing the distance from the watering causes the increase in percentage of litter. Because direct grazing decreases the amount of biomass and reduces the survival rate and plant litter. In such a case, the forage has been consumed for wet forage. Also, due to poor vegetation near the watering area, less litter will be produced. Far from watering area, it increases the vegetation and the litter amount. Around the watering area, though the vegetation is poor, the amount of litter is also low. Perhaps, the reason is that poor vegetation and non palatabil plants cannot be used by animals but the litter of these plants has better nutritional and this causes the reduction of litter percentage around the watering area. The results of this current research are in agreement with the findings of (Fattahi 2003, Ajorloo 2005) and Rauzi *et al.* (1966).

The relationships between forage production and litter percentage at moderate and high grazing levels were logarithmic. It means that with much percentage of litter and the increase of distance, and production rate is increased. Closer examination of moderate grazing shows that the relationship between two mentioned parameters is stronger. So, the linear regression between these two parameters indicates that the average slope in the moderate grazing area (7.4) is more than the slope in the area of heavy grazing (4.3). It means that slight litter increasing leads to more plant production. The reason for this is the intense grazing of region and watering area due to the lack of good forage quality, so livestock uses more litter of poor quality. Thus, the rate of litter and forage production of ideal plants are minimal in this area. With increasing the distance and emergence of dominant and palatable plants, animals use more green fodder and more litter remains on the ground. This litter over time is decomposed and the rate of soil organic matter is increasing. Increasing the soil organic matter and microorganism activity affects the growth and thus, increases the plant production. Mapumo *et al.* (2005) achieved similar results. Also, the results show that the relationship between production and litter in light grazing level is Quadratic. This means that to a certain extent, with increasing the rate of litter, the production rate is increased and then, the forage production is reduced. This means that in light grazing level with reduced grazing intensity, the forage production rate increases. Because this area is light grazing, more forage remains. Thus, with increasing the distance of the available range of livestock, the production rate and litter are increasing. In far away distances (more than 1 km), livestock grazing was very small. Therefore, plant growth stimulant (livestock grazing) was destroyed; consequently the production rate and the nature of the litter rate were decreased.

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