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Tolerence of *Festuca ovina* to different severities of simulated grazing effects in semi-arid Rangelands, Kurdistan, Iran

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Key words: Clipping, Yield, Majidabad rangelands, final height, Generation culm number

Abstract

For assessing simulated grazing effects on *Festuca ovina* as an important species, two exclosure field established before 2007 growing season in Majidabad rangelands as representative for semi-arid rangelands in major parts of west of Iran. Inside the exclosure areas, 40 plants selected of which 10 replications allocated to each specific treatment of ocular-estimated hand clipping of the 25, 50 and 75 percent of annual growth. 10 replications were assigned as control plants. Clippings were done monthly during the months of current grazing season. Monthly-clipped plant materials were dried in shadow free air to calculate the accurate clipping intensity. Then the residues of all plants (also controls) clipped and dried simultaneously at the end of growth season for four years. Split plot in time was used as the statistical design and analysis. The results showed that the main effect of year and different clipping intensities and interactions effect of different clipping intensity and years are significant on forage production and also indicated significant difference on final height and number of generation culm. Most and least amount of production is related to 2007 and 2008 years with 508 and 169 mm of rainfall respectively and 75% treatment (heavey clipping). As the overall conclusion, regarding the environmental and management variations of this species, it is adapted with light clipping and maximum grazing allowance is about 30% of the annual yield growth.

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Introduction

Out of 165 million hectares, Iran has 90 million hectares (54.5 percent) of rangelands. Increasing demand for utilize rangeland's forage in order to supply protein's products for overpopulation in Iran render necessary management of rangelands. Rangelands management because of vast area and different conditions requires improved methodologies for classifications, descriptions, and monitoring of plant communities (zahedi., 2011).

The rangelands of Iran's Semi-Mediterranean climate region are criterion because they occur within a region where precipitation falls only during the cold part of the year, they have a strong representation of annual species in their flora and they have undergone deficiency of precipitations a large-scale of the year. Forage from these lands provides the grazing resource for range livestock production, a leading agricultural commodity in the country. One of the most factors responsible in demolition of rangelands in this region is untimely grazing that with overgrazing affected severely quality and quantity of rangelands. Other factors that potentially contributed to the decline of area and productivity of the rangelands on this region include consecutive droughts during recent decades and tillage for crop agriculture. Most part of the rural population in Iran is depending on rangelands. The populace of these people within the three decades had increased about three times but the area of rangelands because of deterioration or convert to agricultural lands and other land uses had decreased and they undergone severe pressure resulted from overgrazing and utilization(zahedi., 2011).

Rangeland management is based on the effective use and application of ecological principles and information. This requires that a diverse set of management activities be developed, including grazing management, vegetation manipulation, restoration and bioremediation, watershed management, resource inventory and monitoring, document vegetation characteristics of plant communities for a reference point in order to determine how herbivory affects vegetation composition and production, also understanding of plant characteristics (production, species composition, canopy cover, phenology, degree of utilization by grazers, and abiotic factors) and various outreach programs. Knowing about plant responses to foliage removal or clipping is one of the most requirements of grazing management on rangelands. Moghadam., M.R., (2002) Dawson,. *et al.*, (2003) examined morphological and topological responses of nodal root axes to defoliation under both a high nitrogen and a low N supply in a fast- and slow growing grass species, Lolium perenne and Festuca ovina. The results showed that The total axis root length of *F. ovina* was less when plants had been defoliated. Root axis weight, primary root axis length and primary root diameter were also less with defoliation than an undefoliated control, under high N. Under low N conditions the root axes of *F. ovina* had a more randomly branched topology without defoliation. Significant weed mortality and reduction in reproductive performance occurred when at least 60% of the above-ground phytomass had been removed on or after 23 May. Defoliation treatments (0%, 25%, 50%, and 75% of aerial phytomass removed in either early-, mid-,or late-season had little effect upon plant cover the following year; total herbage production was greater for defoliated than for undefoliated control plots, but did not vary with season of defoliation (Sharrow and Kuntz., 1999). In a factorial study, Wallace (1987) showed that the combination of clipping and compaction reduced plant growth the most and all treatment combinations significantly reduced the growth and biomass of plants relative to controls. Busso and Richards (1995) showed that repeated late and severe grazing of the species *Agropyron desertorum* and *Pseudoroegneria spicata* under long-term droughts (2 or more years) could then be expected to rapidly reduce their persistence in the community. Alhamad and Alrababa (2008) suggested that light grazing may sustain or even enhance grassland productivity. Further, optimum grazing practices to conserve biodiversity of *Avena* grassland may involve moderate stocking rate.

To evaluate responses of range grasses to defoliation, removal patterns should simulate those under grazing (Stroud *et al.* 1985). at a study about *Stipa hohenackerian Ghasriani et al.,(2013)* expressed that no significant differences were recorded for 25 and 50% harvesting intensities in terms of studied traits but a harvesting intensity of 75% negatively affected *Stipa hohenackerian*. Consequently, a harvesting intensity of 25-50% is recommended as the best allowable use for *Stipa hohenackeriana* in this vegetative region and other similar areas in Iran.

In this study, concerning lack of researches on responses of the rangeland key grass (*Festuca ovina*) to grazing and the importance of the matter, we conducted a hand-clipping experiment for the amount of 0 (control plants), 25, 50, and 75 percent of the annual aboveground biomass production monthly during three months grazing season to evaluate simulated grazing effects in the field. The study performed in 5 continuous years (2007-2011).

Materials and methods

Study area

This study was undertaken southwest of Qurve county in east Kurdistan province of Iran. The dominant pasture species are representative for vegetation cover in most parts of east region of province (Figure 1). The research site is located in a hemogen part of rangelands which called Majidabad (latitude 756730N, longitude3881705E). The annual average and precipitation for years of study were 508, 167, 350 and 430mm, respectively. The plant community at the flux measurement site is dominated by three perennial grasses were Festuca ovina, Stipa barbata and Bromus tom entellus plus Astragalus muschianus. The plants start to grow in med or lately March. The aboveground biomass reached its maximum in about early June and the end of grow in season is early September. The study area is relatively mountainous with a mean elevation of 2180 m and receives 363 mm of precipitation in long average annually. Nearly 70% of precipitation falls as snow in the winter (Desamber to February). Typical of semiarid rangelands, these pastures are considered water-limited plus temperature limited because of the cold climate.

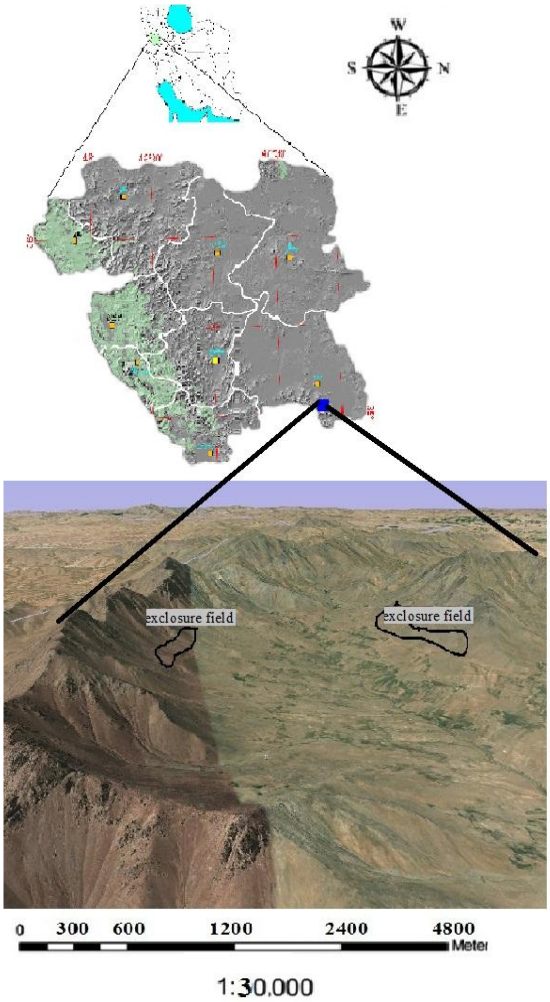

Fig. 1. study area.

Sampling

In the sites, *Festuca ovina* was evaluated as a key species. 40 similar individuals were selected at the beginning of the grazing season in the first year of study and were marked by stable wooden labels during study years. Grazing simulation was performed in 4 clipping intensities includes: control (0 percent), light (25 %), moderate (50%), and heavy (75%) to assess clipping treatments effects on this perennial grass, they were investigated as treatments with 10 replications for each treatment. Clipping was done with clippers monthly from start to the end of livestock grazing based on the growing season period. Residual forage of treatments and total forage of the controls were clipped in the end of growing season when species were completely dry. Thereby, total yield was calculated in each year.

Statistical analysis

Split plot in time was used as the statistical design and analysis of variances by means of SPSS19 software. Duncan's multiple range test used for comparing means.

For analyzing final effects of 4-year clipping regarding the years as minor factor and obtaining how the years effected measured attributes, ANOVA were conducted on the data. Each year, vigor, mortality, plant maximum height (±1 cm), aboveground annual biomass production (±0.1 gr), and reproductive shoot (flowering culm) number measured or estimated. these were done for 4 years. The reported precipitation fluctuated during 2001-2010 with an average of 330mm (Fig. 2).

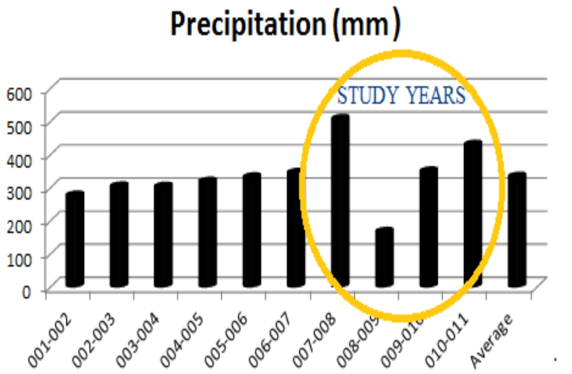

Fig. 2. Ten-year precipitation of Qurwe station (5 km southwest of the study area).

Results

The precise value of average clipped aboveground yield, average scorings of observed vigor, and mortality percent of 10 replications (plants) of each treatment entered in table 1. The values of 4-year clipped yield indicated that we over clipped the plants of simulated light grazing treatment and under clipped the plants of simulated heavy grazing treatment, but not out of the predicted range. A mortality case occurred during the study years among the 40 monitored plants (heavy treatment). In accord with table 1, the actual 4-year averaged clipped yield were 0, 29, 56, and 81 percent for control, light clipping, moderate clipping, and heavy clipping, respectively. Obviously, all of the clipping levels affected the vigor but only heavy levels affected mortality (table 1).

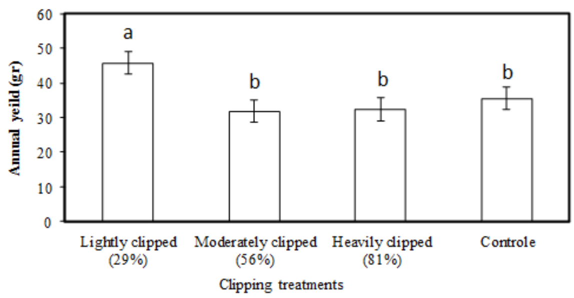

Fig. 3. Four-year clipping effect on annual aboveground yield of *Festuca Ovina* in Majidabad rangeland. Error bars = ±SE. Treatments with the same letter were not significantly different at $p > 0.01$.

Table 1. The average respected range and precise percent of clipped aboveground yield, vigor and mortality in different treatments of *Festuca Ovina* in Majidabad rangeland in 2007-2010.

Year	Respected clipping range (%)	Clipped annual yield (gr)	Annual total yield (gr)	Actual clipping treatment (%)	Observed vigor (1-10)	Mortality (%)
2007	0	-	41.56	0	10	0
	25	14.61	54.13	27	10	0
	50	35.99	57.13	63	10	0
	75	48.85	64.28	76	10	0
2008	0	-	28.339	0	7	0

	25	11.168	34.900	32	6	0
	50	11.82	22.300	53	5	0
	75	18.36	21.600	85	4	0
2009	0	-	34.871	0	7	0
	25	13.64	45.471	30	7	0
	50	13.544	24.627	55	6	0
	75	17.95	22.170	81	5	0
2010	0	-	37.417	0	7	0
	25	13.597	48.563	28	8	0
	50	12.38	22.933	54	6	0
	75	17.64	21.510	82	5	10

Analyses of variances of aboveground annual yield, plant height, and number of generative culms according to a split plot in time, design implied significant different of all variance sources except replication * year interaction at P≤0.05 or P≤0.01 (Tables 2, 3, and 4). These different responses illustrated in figures 2, 3, and 4 for the studying attributes. The light clipping treatment (29%) preceded all other treatments even control values with a significant distance in all measured attributes (P≤0.01). According to tables 2, 3, and 4, the interaction effect of treatment * year has a significant difference at $p \leq 0.01$. To clarify the manner that year (especially precipitation) effected treatments, one-way ANOVA employed without presuming years as main plots (minor factors) and all data means compared and categorized by Duncan's test (figures 6, 7, and 8).

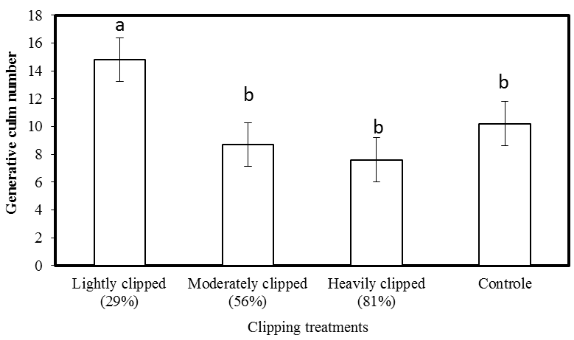

Fig. 4. Four-year clipping effect on final height of *Festuca Ovina* in Majidabad rangeland. Error bars = ±SE. Treatments with the same letter were not significantly different at p > 0.01.

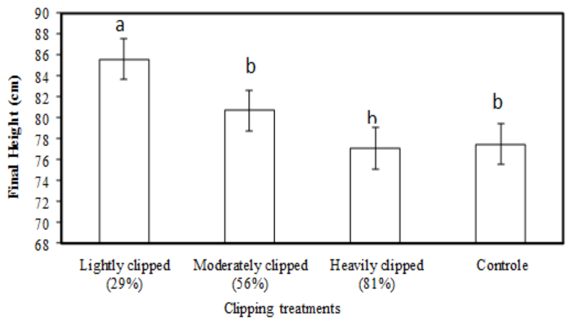

Fig. 5. Four-year clipping effect on number of generative culms of *Festuca Ovina* in Majidabad rangeland. Error bars = ±SE. Treatments with the same letter were not significantly different at p > 0.01.

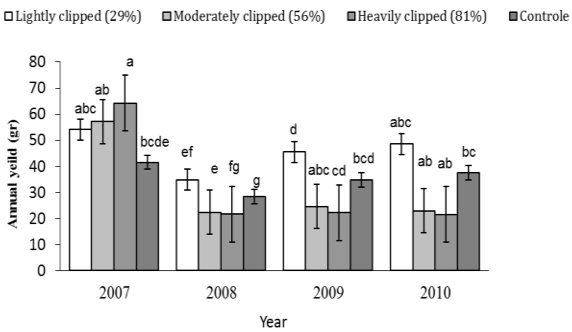

Fig. 6. Yearly effect of different clipping intensities on annual aboveground yield of *Festuca Ovina* in Majidabad rangeland. Error bars = ±SE. Bars with the same letter were not significantly different at p > 0.01.

Table 2. Variance sources and mean squares represent effects of clipping treatments and different years on aboveground yield of *Festuca Ovina* in Majidabad rangeland in 2007-2010.

Source	df	Mean squares	F
Treatment	2	192.9	14.7 ***
Treatment×replication	27	73.8	2.1 *
Year	3	160.8	21.5 ***
Treatment × year	6	21.5	5.8 ***
Year × replication	18	2.244	0.9 ^{n}
Error	53	5.84	
Total	114		

*** P≤0.001; **P≤0.01; * P≤0.05; n=not significant

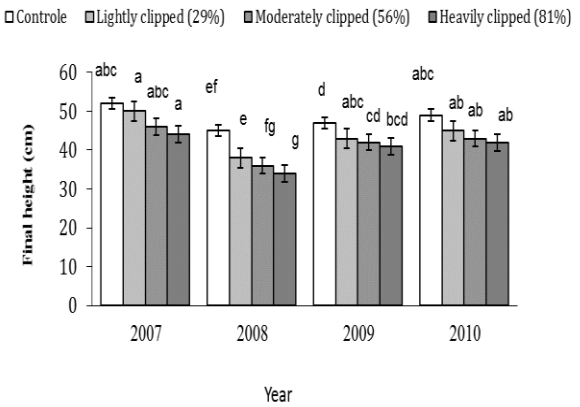

Fig. 7. Yearly effect of different clipping intensities on final height of *Festuca Ovina* in Majidabad rangeland. Error bars = ±SE. Bars with the same letter were not significantly different at p > 0.01.

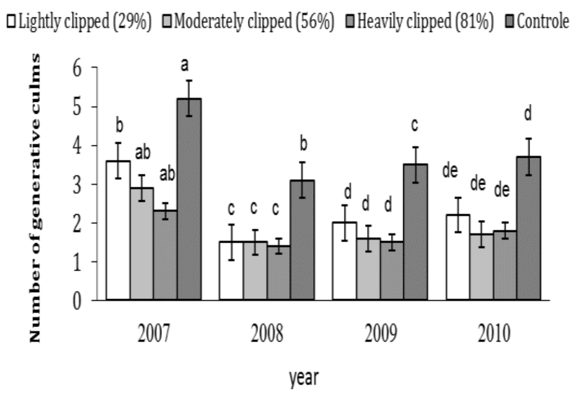

Fig. 8. Yearly effect of different clipping intensities on number of generative culms of *Festuca Ovina* in Majidabad rangeland. Error bars = ±SE. Bars with the same letter were not significantly different at p >

Table 3. Variance sources and mean squares represent effects of clipping treatments and different years on final height of *Festuca Ovina* in Majidabad rangeland in 2007-2010.

Source	df	Mean squares	F
Treatment	3	323.9	8.6 ***
Treatment×replication	18	261.3	4.3 ***
Year	3	107.34	28.8 ***
Treatment × year	6	77.8	5.1 **
Year × replication	27	137.4	1.3 ^{n}
Error	47	24.5	
Total	112		

*** P≤0.001; **P≤0.01; * P≤0.05; n=not significant

Table 4. Variance sources and mean squares represent effects of clipping treatments and different years on number of generative culms of *Festuca Ovina* in Majidabad rangeland in 2007-2010.

Source	df	Mean squares	F
Treatment	3	246.4	4.8 **
Treatment×replication	27	100.7	1.46 *
Year	2	95.2	48.7 ***
Treatment × year	6	111.6	2.62 *
Year × replication	18	55.0	1.27 ^{n}
Error	42	46.6	
Total	106		

*** P≤0.001; **P≤0.01; * P≤0.05; n=not significant

Despite drastic differences in the years' precipitations, the mean yield per plant was higher in lightly clipped treatment relative to other treatments in all years except first year which was lower than others at $p \leq 0.05$ (figure 6). In all years, controle treatment plants had a higher height more than others in all years at $p \leq 0.05$ (figure 7). and, the number of generative culms in control and lightly clipped plants were higher than those of heavy and moderately clipped plants (figure 8; $p \leq 0.05$).

Discussion

Regarding the cumulative clipping effects during the study years, figures 3, 4, and 5 illustrated that attributes aboveground yield, and final height, had a better status in compare to other treatments, even control but the number of generative culms had a better status in control. It seems that this species is adapted with light grazing and so that light grazing can protect or improve its vigor and dominance. Stimulation of the tillering process in grass plants can result in increased plant density and greater quantity and quality of aboveground herbage production (Manske 2003).

The same results occurred in a study on two-year clipping effects (0, 25, 50, and 75%) on *Festuca viridula* when none of the treatments affected the crown cover of plants and in a year total yield in all treatments preceded the control values (Sharrow and Kuntz, 1999). Also, Alhamad and Alrababa (2008) suggested that light grazing may sustain or even enhance grassland productivity. As an opposite report, Tracy *et al.* (2007) resulted that *Pseudoroegneria spicata* cannot resist light grazing for two successive years. Only one of the bunches deceased during our 4-yaer study (Table 1) similar to 0.2% Experiment-wide plant mortality resulted by Clark *et al.* (1998).

2007 crop-year precipitation was 508 mm and occurred in proper time for plant growth so that the mean annual aboveground yield was more than those of the normal 2009 crop-year in precipitation (table 1). 2008 crop-year precipitation was 167 mm, near half of that of the previous year, and mainly occurred in improper season (winter). 2009 crop-year precipitation was 350 mm and was a normal year in both amount and distribution. In 2010, despite a relatively high precipitation (430 mm), aboveground yield and number of generative culms in moderate and heavy treatments because of clipping and year effects were equal or less than those of previous year. According to tables 2, 3, and 4, treatment × year interaction is significant at $\alpha = 0.05$. To clarify the manner year effected treatments, one-way ANOVA employed without presuming years as main plots and all data means compared and categorized by Duncan's test (figures 5, 6, and 7). Despite various climatic conditions, the highest aboveground yield of lightly clipped plants in all study years except first year (figure 5) indicated that this species is in compatibility with light grazing. This level of clipping intensity confirmed as a proper use factor by some authors (Sharrow and Kuntz, 1999).

The plants were clipped to a moderate level categorized in the same group with heavy clipped plants in the last three study years and have the lowest annual yield in common with heavy treatment. Defoliation of the grasses did not reduce their aboveground biomass production in the wet year, but severely reduced it in the dry year, primarily because of a decrease in tiller density (Fanestock, and Detling, 1999).

In all years, the final height of control plants preceded all treatments (figure 6). This means light grazing may has less damage for height of generative stalks than other treatments in enclosure areas. In the last year, the height values of treatments were in the same group and lower than that of control. The comparison of treatments in 2008 and 2010 imply that despite four years of different clipping intensities, the damage of herbage removal to height of plants can be retrieved after a normal precipitation. It may also imply that the final height may not be assumed as a proper indicator to monitor effects of herbage removal after four years. The number of generative culms decreases extremely in all treatment except control plants (figure 7) and it was significantly ($p >$ 0.01) lower in moderate and heavy clipped treatments than light and control numbers. This attribute was affected more than other measured attributes both in the drought year and in the last year (figure 7). In a study, clipping 35-40% at any timing reduced the number of buds and flower heads per plant (Katie *et al.* 2009). Studies in rangelands of New Mexico, USA, showed that a grazing intensity of 31-40% did not lead to the decrease of the forage yield and seed production of key species. However, a grazing intensity of 50% caused a failure in seed production and forage yield of the key species (Fridman, 2003). Changes in leaf characteristics and plant morphology also occur in response to overgrazing (Yang *et al.* 2000). An improved distribution of key species at a grazing intensity of 25 percent, and reduction of the grasses and key species at a grazing intensity of 50 percent have been also reported in desert rangelands of South West America (Holechek *et al.* 2003). In a study at three similar region in Iran Ghasriani *et al.,* (2013) obtained a harvesting intensity of 25 to 50 percent as the best allowable use for Stipa hohenackerian.

In general, increased utilization leads to the decrease of the yield, height and generative culm number, or maybe increases the mortality. This study showed that harvesting intensity of upper than 50 percent had a negative effect on *Festuca ovina* and light clipping (up to 30%) has best adaptation with plant durability in Majidabad rangelands and other same ecosystems.

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