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Determination of allowable use for *Cymbopogon olivieri* in Khalij-O-Omani and desert rangelands of Iran

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Abstract

Current research was performed in selected sites of semi-steppe vegetative region including Choneghan (Hormozghan), Tabas (Yazd). *Cymbopogon olivieri* is a key and palatable species which has a considerable portion in rangelands production of the mentioned flora. For this purpose, 40 similar *Cymbopogon olivieri* were selected in each site. Selected species were exposed to different harvesting intensities of 25, 50 and 75% and zero as control group. Data were analyzed by SPSS and MSTATC and Duncan's Multiple Range Test was used for mean comparisons. Our findings showed that in desert region, a harvesting intensity of 25% positively affected shoot growth, forage production, vigor and vitality of *Cymbopogon olivieri* and the rate of mortality was not increased. Harvesting intensity of 50 and 75% had no significant negative impact on measured vegetative characteristics. However, due to the role of plant in water and soil conservation of the region and plant health in the long-term, a harvesting intensity of 50% was recommended as the best allowable use of *Cymbopogon olivieri* for this vegetative region and other similar areas. In the Khalij-O-Omani vegetative region, our results showed that no significant difference was found for forage production and the height of species among different treatments; however, forage production and the height of *Cymbopogon olivieri* differed significantly during the study years of research, indicating the effect of the fluctuations in rainfall amount and distribution.
Consequently, a harvesting intensity of 75% is recommended as the best allowable use of *Cymbopogon olivieri* for this site and other similar regions.

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Introduction

Rangelands are one of the most important and most valuable national resources of Iran, forming a large part of the country (over 52%). Other rangeland services including pharmaceutical, industrial, and food products, soil conservation, control and increased groundwater storage, fresh air, raise of relative humidity, regulation of the water cycle in nature, provide forage for livestock, preservation of plant and animal genetic resources as well as wildlife are important nationally (Fazilati *et al.,* 1965).

However, providing forage for grazing livestock is the main use of rangelands. The quantity and quality of forage is unsatisfactory and it could not provide forage needs of livestock (Gharedaghi *et al.*, 2000). Despite the major role of determining the allowable use of important species in improvement and restoration projects, soil erosion, calculation of available forage to livestock and calculation of grazing capacity of rangeland and sustainability of desirable species resulted in economic prosperity, unfortunately, no systematic and adequate research has been done in this regard. The main purpose of this study was to determine the allowable use of a key range species (*Cymbopogon olivieri*) in semi-steppe rangelands of the country.

The main question of the study is that to what extent of harvesting can be tolerated by this species. Smith *et al.,* (2007) introduced range condition as one of the most important criteria in determining the level of range utilization and stated that allowable use of the rangelands with poor condition would result in rangeland improvement. In addition, allowable use should be considered higher in the rangelands with good condition while it should be lesser in poor rangelands.

Arzani (2010) stated that allowable use percentage varied depending on plant species. If allowable use is calculated for desirable species, it can be used for all plant species. Reece *et al.,* (2001) have developed a theory on allowable use, which is expressed as half harvesting and half remaining and according to it, the livestock are permitted to graze a distinct percentage of available forage that its rate is typically 50%. Amiri (2008) estimated an allowable use between 20 to 40 percent in rangelands of Semirom of Isfahan. Ajdari *et al.,* (2010) determined an allowable use of 20-50% for the range species of Taleghan watershed. Also, Zhao and lin (2007) in studies of some range species, stated that a number of range species could not tolerate the pressure of forage harvesting and therefore are unable to offset declining production resulted from cutting shoots. In Iran, allowable use is usually considered as 50% of annual growth, which this value is reduced to 40% in rangelands located in catchment areas in order to provide more canopy cover and protection of the watershed (Moghaddam, 1998). Mesdaghi (2003) reported an allowable use of 35 and 50% for arid and semi-arid regions and humid regions, respectively.

Sharifi and Akbarzadeh (2010) studied the changes of vegetation under exclosure and grazing conditions in rangelands of Ardebil (Arshagh site) and reported that *Atriplex leucoclada* showed a considerable growth. Ganskcopp (1988) investigated the effect of harvesting intensities on the changes of forage production of *Stipa thurberiana* at a Range Research Station and concluded that this species was sensitive to intense harvesting in vegetative stage and only in the case of light harvestingit can be used multiple times during the growing season. Ghasriani *et al.,* (2013) determined the allowable use of *Stipa hohenackerian* in semi-steppe rangelands of Iran and concluded that a harvesting intensity of 25-50% is recommended as the best allowable use for this species in this vegetative region and other similar areas. Fulstone (2009), in his studies on grazing management of Missouri rangelands reported the allowable use of key species of Stipa californica and Stipa nevadensis, as 50 and 55%, respectively. As was mentioned, determination of allowable use is dependent on the studies in place and its percentage will vary depending on the species.

For this purpose, the project entitled determination of allowable use of Cymbopogon olivieri in reference

sites of the Khalij-O-Omani and desert regions was carried out for four years.

Material and methods

Sampling

Characteristics of the selected sites of semi-steppe region are summarized in Table 1. In each of the selected sites, *Cymbopogon olivieri* was evaluated as a key species. Therefore, 40 similar stands were selected at the beginning of the grazing season in each region and were marked by wooden labels. These labels remained stable and were protected from livestock grazing during four years. In this research, grazing simulation was performed in which different harvesting intensities of 25, 50, 75% and 0 (as control) were investigated as treatments with 10 replications for each treatment. Harvesting was done with clippers. Since forage harvesting was commenced from the beginning to the end of livestock grazing, therefore, the number of days that species were normally grazed by livestock was calculated in each region and then it was divided by 30 to get the number of harvesting. Residual forage and total forage of the control treatment were harvested when species were completely dry. Thereby, total yield was calculated in each year.

Statistical analysis

A split plot design in time with 10 replications was used, and data analysis was performed with SAS software. Mean comparisons were done by Duncan's Multiple Range Test. Interactions between treatments were tested by AMMI model, using IRRISTAT software. Other items, investigated in this study, included assessment of plant mortality, height, seed production and meteorological data.

Results

According to the results of analysis of variance during 2008-2011 (table 2), the effects of year, harvesting intensities and location and also their interaction effects on forage production of *Artemisia sieberi* were significant at 1% level of probability.

Table 1. Characteristics of the selected sites of semi-steppe region.

Row	Site	Altitude (a.s.l) (m)	Average annual precipitation (mm)
1	Choneghan	240.3	265
2	Tabas	84	725

Mean comparisons of forage production of *Cymbopogon olivieri* in years, locations and different harvesting intensities are presented in Table 3. According to the results, there was significant difference in terms of the mean comparison of the effects of year, harvesting intensities and location on forage production of *Cymbopogon olivieri*, so that the maximum and minimum forage production were obtained in 2009 and 2008, respectively. Maximum forage production was obtained at 25% harvesting intensity.

Table 2. Analysis of variance of harvesting intensity, year and location on forage production of *Cymbopogon olivieri*

Source of variations	Degrees of freedom	Mean squares
Location	1	80303.17 **
Year	3	6837.38 **
Location * Year	3	5096.64 **
Error(1)	72	143.2
Harvesting Intensities	3	256.1 **
Location * Harvesting Intensities	3	2498.23 **
Year * Harveingst Intensities	9	297.9 **
Harvesting Intensities * Site * Year	9	480.6 **
Error(2)	216	68.77
cv		29.75

Mean comparisons of interaction effects of location and different harvesting intensities performed by Duncan test are presented in Table 4.

In addition, a significant difference was found among the study sites so that the maximum and minimum forage production were recorded for Tabas (62.08 g) and Choneghan (3.04 g), respectively.

Table 3. mean comparisons of forage production of *Cymbopogon olivieri* in years, locations and different harvesting intensities.

Treatments	Forage Yield (g)
2008	38.22 a
2009	15.89 d
2010	27.17 c
2011	30.18 b
Control	28.23 a
25 %	29.82 a
50 %	27.92 ab
75 %	25.4 b
Tabas	21.31 b
Choneghan	61.6 a

Table 4. Mean comparison of interaction effects of location, different harvesting intensities and year on forage production of *Cymbopogon olivieri.*

Site	Harvesting Intensities	Forage Yield (g)	Duncan Grouping
Tabas	Control	62.08	*a*
Tabas	25 %	59.93	*ab*
Tabas	Control	56.2	*abc*
Tabas	25 %	55.8	*abc*
Tabas	25 %	55.7	*abc*
Tabas	Control	55.06	*abc*
Tabas	50 %	50.84	*abc*
Tabas	50 %	47.7	*edc*
Choneghan	75 %	45.7	*ed*
Tabas	50 %	45.1	*ed*
Tabas	75 %	42.6	*ed*
Tabas	75 %	41.25	*e*
Tabas	75 %	40.98	*e*
Tabas	Control	28.02	*f*
Choneghan	50 %	26.07	*f*
Tabas	25 %	22.2	*gfh*
Tabas	50 %	20	*gfh*
Choneghan	25 %	19.06	*gifh*
Tabas	75 %	15.64	*gifh*
Choneghan	50 %	15.55	*gifh*
Choneghan	50 %	11.72	*kijh*
Choneghan	75 %	10.25	*kij*
Choneghan	25 %	10.09	*kij*
Choneghan	25 %	9.89	*kij*
Choneghan	Control	7.64	*kj*
Choneghan	Control	7.01	*kj*
Choneghan	50 %	5.77	*k*
Choneghan	25 %	5.71	*k*
Choneghan	Control	5.32	*k*
Choneghan	Control	4.51	*k*
Choneghan	75 %	4.36	*k*
Choneghan	75 %	3.04	*k*

Discussion

Desert vegetative region

Our findings showed that in desert region, a harvesting intensity of 25% positively affected shoot growth, forage production, vigor and vitality of Cymbopogon olivieri and the rate of mortality was not

increased. In addition, the harvesting intensities of 50 and 75% had no significant negative effect on measured vegetative characteristics. However, due to the role of plant in water and soil conservation of the region and plant health in the long-term, a harvesting intensity of 50% was recommended as the best allowable use of Cymbopogon olivieri for this vegetative region and other similar areas. According to the results, a harvesting intensity of 50 percent was identified as the best allowable use. This result is in agreement with the findings of Ganskopp (1988) Motazedian and Sharrow(1990) that they showed, overgrazing has negative effect on production. Also, the studies of (Zare, 2012) performed in rangelands of Dehno (Kerman province) and Nodoushan (Yazd province) respectively, showed that a harvesting intensity of 50 percent was the best allowable use for Stipa barbata in the mentioned sites. Khodagholi, (2012) noted that a harvesting intensity of 50% could be taken into consideration for *Stipa arabica* in rangelands of Soh of Isfahan province. However, the reduction of grasses and key species at a grazing intensity of 50 percent has been also reported in desert rangelands of South West America (Holechek *et al.,* 2003). On the other hand, this result was contradicted by the findings of Fridman (2003), at rangelands of New Mexico, USA.

Khalij-O-Omani vegetative region

In the Khalij-O-Omani vegetative region, our results showed that no significant difference was found for forage production and the height of species among different treatments; however, forage production and the height of Cymbopogon olivieri differed significantly during the study years of research, indicating the effect of the fluctuations in rainfall amount and distribution.

Overall, a harvesting intensity of 75% is recommended as the best allowable use of Cymbopogon olivieri for the site of this vegetative region and other similar regions.

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