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Comparison on allowable use of *Atriplex leucoclada* in Khalij-O-Omani rangelands of Iran

Farhang Ghasriani, Ali Mohebby*, Ehasan Zandi Esfahan

Rangeland Research Division, Research Institute of Forests and Rangelands, Tehran, Iran

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Key words: Forage production, allowable use, *Atriplex leucoclada,* Khalij-O-Omani region.

Abstract

Current research was performed in the selected sites of Khalij-O-Omani vegetative region including Kabkan (Boshehr), Beris (Sistan and Balochestan). Atriplex leucoclada is a key and palatable species, having a considerable portion in rangelands production. For this purpose, 40 similar species of Atriplex leucoclada were selected in each site. Selected species were exposed to different harvesting intensities of 25, 50 and 75% and 0% as control group. Data were analyzed by SPSS and MSTATC, and Duncan's Multiple Range Test was used for mean comparisons. According to the results, no significant differences were recorded for the harvesting intensities of 25 and 50 % in terms of studied traits but the harvesting intensity of 75% negatively affected Atriplex leucoclada. Consequently, a harvesting intensity of 25% is recommended as the best allowable use of Atriplex leucoclada for this vegetative region and other similar regions.

***Corresponding Author:** Ali Mohebby ✉ yasharmohebby@yahoo.com

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 services of rangelands including pharmaceutical, industrial, and food products, soil conservation, control and increased groundwater storage, fresh air, the raise of relative humidity, the regulation of water cycle in nature, providing forage for livestock, preservation of plant and animal genetic resources as well as wildlife are important nationally (Fazilati *et al.*, 1965). It is noteworthy to state that providing forage for grazing livestock is the main use of rangelands, while forage quantity and quality are inadequate to provide the forage needed for livestock due to overutilization (Gharedaghi and Fazel Najafaabadi, 2000).

Despite the major role of determining the allowable use of important species in the projects of improvement and restoration, soil erosion, calculation of available forage to livestock and also calculation of grazing capacity of rangeland and sustainability of desirable species, resulting in economic prosperity, unfortunately, no systematic and adequate research has been done in this regard. This research was aimed to determine the allowable use of *Atriplex leucoclada* as a key range species in the selected sites of Khalij-O-Omani region. The main question of the study was to what extent of harvesting could 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 considering allowable use of rangelands with a poor condition would result in rangeland improvement. Also, allowable use should be considered higher in rangelands with good condition while it should be lesser in poor rangelands. Arzani (2010) stated that the percentage of allowable use 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) developed a theory on allowable use, expressed as half harvesting and half remaining and according to it, livestock are permitted to graze a distinct percentage of available forage that its rate is typically 50%. 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 as well as other similar regions. Amiri (2008) estimated an allowable use between 20 to 40 percent in rangelands of Semirom of Isfahan. 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. Ganskcopp (1988) investigated the effect of harvesting intensities on the changes of forage production of *Stipa thurberiana* at Range Research Station of Oregon and concluded that this species was sensitive to intense harvesting in vegetative stage and only in the case of light harvesting, it could be used multiple times during the growing season. 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). The increase of grazing intensity at Savijbolagh region caused a reduction of grasses and shrubs while herbaceous forbs, especially invasive and poisonous species, increased (Kohandel *et al.*, 2005).

As was mentioned, the determination of allowable use is dependent on studies in place and its percentage will vary depending on the species. Unfortunately, no systematic research has been done on the determination of allowable use of rangeland species. For this purpose, the project of determining the allowable use of *Atriplex leucoclada* was carried out in reference sites of the rangelands of Khalij-O-Omani region for 5 years.

Materials and methods

Sampling

Characteristics of the selected sites of Khalij-O-Omani region are summarized in Table 1.

Table 1. Characteristics of the selected sites of Khalij-O-Omani region

Row	*Site*	*Altitude (a.s.l) (m)*	*Average annual precipitation (mm)*
1	Kabkan	5	190
2	Beris	<100	108.7

In each of the selected sites, *Atriplex leucoclada* was evaluated as a key species. Therefore, 40 similar individuals were selected at the beginning of grazing season in each region and were marked by wooden labels. These lables remained stable and were protected from livestock grazing during three 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 begining 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 harvestsing. 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 the assessment of plant mortality, height, seed production and meteorological data.

Results

According to the results of analysis of variance during 2008-2010 (Table 2), the effects of year, harvesting intensities and location and also their interaction effects on forage production of *Atriplex leucoclada* were significant at 1% level of probability.

Table 2. Analysis of variance of harvesting intensity, year and location on forage production of Atriplex leucoclada

Source of variations	*Degrees of freedom*	*Mean squares*
Location	1	97504.6**
Year	2	34219.6**
Location☐* Year	2	19617.4**
Error(1)	54	114.4
Harvesting Intensities	3	27042.02**
Location☐* Harvesting Intensities	3	9157.5**
Year ☐ *Harvesting Intensities	6	1962.2**
☐Harvesting Intensities ☐* Site * Year	6	1919.4**
Error(2)	162	163.2
cv		30.88

Table 3. mean comparisons of forage production of Atriplex leucoclada in years, locations and different harvesting intensities

Treatments	*Forage Yield (g)*
2008	57.57a
2009	48.68b
2010	18.14c
Control	72.6a
25%	35.3b
50%	32.6b
75%	25.2c
Kabkan	21.31b
Beris	61.6a

Mean comparisons of forage production of *Atriplex leucoclada* 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 *Atriplex leucoclada* so that the maximum and minimum forage production were obtained in 2009 and 2008, respectively.

Maximum forage production was obtained at 0% harvesting intensity (control group) and the minimum was obtained at 75% harvesting intensity. Also, a significant difference was found among the study sites so that the maximum forage production was recorded for Beris site.

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

Table 4. Mean comparison of interaction effects of location, different harvesting intensities and year on forage production of Atriplex leucoclada

Site	*Harvesting Intensities*	*Forage Yield (g)*	*Duncan Grouping*
Beris	Control	111.11	a
Beris	25%	99.88	b
Beris	Control	95.13	b
Kabkan	Control	94.5	b
Beris	25%	81.9	c
Beris	50%	79.6	c
Beris	50%	78.4	c
Beris	75%	77.5	c
Kabkan	Control	56.9	d
Kabkan	Control	53.7	d
Beris	75%	33.26	e
Beris	Control	24.64	ef
Beris	25	21.6	fg
Beris	50%	20.27	fg
Beris	75%	15.99	fgh
Kabkan	75%	15.96	fgh
Kabkan	50%	11.43	igh
Kabkan	25%	5.66	ih
Kabkan	75%	4.47	ih
Kabkan	75%	4.3	ih
Kabkan	50%	2.97	i

Maximum and minimum forage production was respectively recorded at the harvesting intensities of 0% (Beris site) and 25% (Kabkan site) in 2009.

Discussion

According to the results, there were statistically significant differences for the production of different years in the study sites. Results showed that no significant differences were recorded for harvesting intensities of 25 in terms of studied traits but harvesting intensities of 50 and 75% negatively affected *Atriplex leucoclada* because of over grazing.

The harvesting of this species in consecutive years caused a reduction in the amount of forage production but if water supply conditions are provided, it will be able to tolerate a harvesting intensity of 50%. Also, the vigority of this specis was decreased during the study period and under the treatments, indicating the adverse effects of harvesting. Also, in terms of mortality, one individual species was dried in the second and third year of the study at the treatments of 0 and 25% harvesting intensities, but the remaining individuals were alive and active. This result is in agreement with the findings of Ganskopp (1988) and Motazedian and Sharrow (1990) who reported the negative effects of harvesting on forage production. Also, Mesdaghi (2003), deterimend an allowable use of 35% and 50% for arid and semi- arid rangelands and humid regions, respectively.

Holechek *et al.,* (2003) showed that the maximum production of grass and key species in desert rangelands of south west USA was obtained at a harvesting intensity of 25%, while the production was decreased at harvesting intensity more than 50%.

Our results are contradicted by the findings of Zhang *et al.,* (1995), Tate *et al.,* (1994), Leyshon and Campbell (1992), and Forwardand and Magai (1992).

Consequently, a harvesting intensity of 25% is recommended as the best allowable use for *Atriplex leucoclada* in this vegetative region as well as other similar regions.

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