VOL. 9, NO. 11, NOVEMBER 2014 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

COMPARISON ON ALLOWABLE USE OF *Artemisia sieberi* IN SEMI-STEPPE AND ARID RANGELANDS OF IRAN

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ABSTRACT

Current research was conducted in the selected sites of arid and semi-steppe vegetative regions including Tabas (Yazd) and Til-Abad (Gholestan), respectively. *Artemisia sieberi* is a key and palatable species, having a considerable portion in rangelands production. For this purpose, 40 similar bases of *Artemisia sieberi* were selected in each site. Selected bases 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, a significant difference ($P<0.01$) was found for the production among different years of study in semi-steppe vegetative region. Our results showed that harvesting intensities of 25% and 50% could be recommended as the best allowable use of *Artemisia sieberi* in semi-steppe and arid vegetative regions, respectively.

Keywords: forage production, allowable use, *Artemisia sieberi*, semi-steppe, rangeland.

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). Allowable use is defined as the part or portion of a species that can be used by livestock without causing damage or injury in plant growth and life. Also, according to the SRM (1989), allowable use includes the degree of utilization of growth in recent year so that if this is done, achieving management principles will be possible and cause to improve or maintain long-term productivity of rangeland or habitat.

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 (Ajdari *et al*., 2010). This research was aimed to determine the allowable use of *Artemisia sieberi* as a key range species in the selected sites of arid and semi-steppe vegetative regions. 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 the 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 and other similar areas. 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. According to Bartels (1990), an allowable use of 40% instead of 30% can increase the grazing capacity up to 50%. 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). Sharifi and

Akbarzadeh (2010) studied the changes of vegetation under exclosure and grazing conditions in rangelands of Ardebil (Arshagh site), and reported that species of *Stipa hohenackeriana* showed a considerable growth during exclosure. Abrahama *et al*., (2009) showed that heavy and moderate harvesting of *Dactylis glomerata* in the first year increased the dry matter production by 17 and 7%, respectively. In the second year of the study, the control treatment resulted in increased production of 41 and 46%, as compared to moderate and harvesting treatments. Fulstone (2009), in his studies on grazing management of Missouri rangelands, reported the allowable use of key species of *Stipa californic*a and *Stipa nevadensis*, to be 50 and 55%, respectively. 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 *Artemisia sieberi* was carried out in reference sites of the rangelands of arid and semi-steppe vegetative regions for three years.

MATERIAL AND METHODS

Sampling

Characteristics of the selected sites of the rangelands of arid and semi-steppe vegetative regions are summarized in Table-1.

Table-1. Characteristics of the selected sites of semi-steppe and arid rangelands.

Row	Site	**Altitude** (a.s.l) (m)	**Average annual precipitation** (mm)
1	Tabas	725	84
2	Til Abad	1050	268.9

METHODS

In each of the selected sites, *Artemisia sieberi* was evaluated as a key species. Therefore, 40 similar bases were selected at the beginning of grazing season in each region and were marked by wooden labels. These labels 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 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 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 *Artemisia sieberi* were significant at 1% level of probability.

Table-2. Analysis of variance of harvesting intensity, year and location on forage production of *Artemisia sieberi.*

Source of variations	Degrees of freedom	Mean squares
Location	1	10185.19**
Year	2	4455.64**
Location* Year	8	1065.29**
Error(1)	135	6.16
Harvesting Intensities	3	443.2**
Location* Harvesting Intensities	12	104.7**
Year *Harvesting Intensities	6	25.62**
Harvesting Intensities * Site * Year	24	24.83**
Error(2)	405	5.56
Cv		17.3

**: Significant at 1%

Mean comparisons of forage production of *Artemisia sieberi* 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 *Artemisia sieberi*,

Table-3. Mean comparisons of forage production of *Artemisia sieberi* in years, locations and different harvesting intensities.

Treatments	**Forage yield** (g)
2008	C 10.76
2009	A 15.32
2010	B 14.1
control	A 14.73
25%	B 13.4
50%	C 12.73
75%	C 12.71
Tabas	A 28.47
Til Abad	B 24.16

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). Other treatments were not statistically significant, and all three were included in group b. Also, a significant difference was found among the study sites so that the maximum and minimum forage production were recorded for Tabas (35.2 g) and Til Abad (3.7 g), respectively.

Table-4. Mean comparison of interaction effects of location, different harvesting intensities and year on forage production of *Artemisia sieberi.*

Site	**Harvesting intensities**	**Forage yield** (g)	**Duncan grouping**
Tabas	Control	35.2	a
Tabas	Control	33.47	a
Tabas	25%	30.12	b
Tabas	25%	29.78	b
Tabas	50%	26.07	b
Tabas	50%	25.81	c
Tabas	75%	25.1	c
Tabas	75%	24.82	d
Tabas	Control	19.29	e
Til Abad	25%	15.59	fg
Til Abad	75%	11.51	lijk
Til Abad	50%	11.44	lijk
Til Abad	75%	6.26	opq
Til Abad	50%	5.9	opq
Til Abad	Control	5.8	pq
Til Abad	50%	5.7	pq
Til Abad	75%	5.7	pq
Til Abad	25%	5.6	pq
Til Abad	25%	5.5	pq
Til Abad	control	5.5	pq
Til Abad	control	3.9	q
Til Abad	75%	3.8	q
Til Abad	50%	3.8	q
Til Abad	25%	3.7	q

Mean comparisons of interaction effects of location and different harvesting intensities performed by Duncan test are presented in Table-4. Maximum and minimum forage production was respectively recorded at the harvesting intensities of 0% (Tabas site, 2009) and 25% (Til Abad site, 2008).

DISCUSSIONS

Semi-steppe vegetative region

According to the obtained results, a harvesting intensity of 25% is recommended as the best allowable use for *Artemisia sieberi* in this vegetative region as well as other similar regions. This result is in agreement with the findings of Sharrow *et al*., (1990), who believed that harvesting affect the amount of forage production negatively.

Arid vegetative region

According to the results, harvesting intensities of 25 and 50% had no negative impacts on vegetation characteristics in the studied site of arid vegetative region (Tabas). In other words, shoot growth, forage production, seed production, and vitality were not decreased and no mortality was recorded. However, a harvesting intensity of 75% negatively affected all studied characteristics of *Artemisia sieberi*. In general, it can be concluded that a harvesting intensity of 50% for *Artemisia sieberi* in this vegetative region and similar conditions would result in increased production of *Artemisia sieberi*. This result is consistent with the findings of Leyshon and Campbell (1992), who studied the effect of harvesting time and the intensity of the first harvesting on next forage production of rangeland species. In a harvesting intensity of 50%, in addition to the quantitative and qualitative development of key species, the maximum production of species would be used without damaging the physiological characteristics and other morphological traits. As a result, the harvesting rate of the mentioned species in the studied sites of the two vegetative regions varies between 25-50%. This result is in agreement with the findings of Ajdari *et al*., (1990), who reported an average harvesting intensity of 20-50% for rangeland species of Taleqan watershed.

CONCLUSIONS

According to the obtained results, a harvesting intensity of 25% is recommended as the best allowable use for *Artemisia sieberi* in the semi-steppe vegetative region and a harvesting intensity of 50% for this species in the arid vegetative region. In general, it can be concluded that,

the harvesting rate of the mentioned species in the studied sites of the two vegetative regions varies between 25-50%.

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