**Journal of Biodiversity and Environmental Sciences (JBES)**
**ISSN: 2220-6663 (Print) 2222-3045 (Online)**
**Vol. 3, No. 6, p. 1-7, 2013**
**http://www.innspub.net**

**RESEARCH PAPER** **OPEN ACCESS**

# Determination of allowable use for *Stipa hohenackerian* in semi-steppe rangelands of Iran

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Article published on June 21, 2013

**Key words:** Forage yield, allowable use, Stipa hohenackeriana, rangeland.

**Abstract**

Current research was carried out in selected sites of semi-steppe region including Arshagh (Ardebil), Firoozkooh (Tehran), Kordan (Alborz) and Jashloobar (Semnan). *Stipa hohenackerian* is a key and palatable species which has a considerable portion in rangeland yield. For this purpose, 40 similar species of *Stipa hohenackerian* 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 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.

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## Introduction

Rangelands are one of the most important and most valuable national resources of Iran and form a large part (over 52%) of the country. Other services of the rangelands including pharmaceutical, industrial, and food products, soil conservation, control and increased groundwater storage, fresh air, increased relative humidity, regulation of the water cycle, provide forage for livestock, preservation of plant and animal genetic resources as well as wildlife are nationally important (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 forage needed for livestock due to overutilization (Gharedaghi and Fazel Najafaabadi, 2000).

Despite the major role of determining allowable use of important species in improvement and restoration projects, soil erosion, calculation of available forage to livestock and also 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. This research was aimed to determine the allowable use of *Stipa hohenackeriana* as a key range species in semi-steppe rangelands of the country. 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 allowable use of the rangelands with poor condition would result in rangeland improvement. Also, allowable use should be considered higher in rangelands with good condition while it should be less in poor rangelands. (Arzani, 2010) stated that allowable use percentage varied depending on plant species. If allowable use is calculated for desireble 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 of 20 to 40 percent in rangelands of Semirom, Isfahan province. 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. Sharifi and (Akbarzadeh, 2010) studied the changes**Error! Reference source not found.** 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.

(Ganskcopp, 1988) investigated the effect of harvesting intensities on changes of forage yield 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. (Fulstone, 2009) in his studies on grazing management of Missouri rangelannds, reported the allowable use of key species of *Stipa californica* and *Stipa nevadensis* to be 50 and 55%, respectively. As was mentioned, the 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 of determining the allowable use of *Stipa hohenackerian* in reference sites of semi-steppe regions was carried out for 5 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, *Stipa hohenackeriana* was evaluated as a key species. Therefore, 40 similar individuals were selected at the beginning of the grazing season in each region and were marked by wooden labels. These lables 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 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 assessment of plant mortality, height, seed production and meteorological data.

## Results

According to the results during 2008-2011, the effect of year, different harvesting intensities, location and also their interaction effects on forage yeild of *Stipa hohenackeriana* were significant at 1% level of probability (Table 3).

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

| Row | Site | Land type | Altitude (a.s.l) (m) | Companion species | Average annual precipitation ( mm) |
|---|---|---|---|---|---|
| 1 | Arshaq | Plain | 1100 | *Artemisia fragrans*<br>*Stipa lagascae*<br>*Poa bulbosa* | 290 |
| 2 | Firoozkooh | Mountain | 2880 | *Acantholimon spp.*<br>*Festuca ovina* | 274.5 |
| 3 | Jashloobar | Hill | 2404 | *Acantholimon erinaceum*<br>*Festuca rubra* | 302 |
| 4 | Kordan | Mountain | 1650 | *Ajuga chamaecistus*<br>*Stipa hohenackeriana* | 270 |

Mean comparisons of forage yield in each year, harvesting intensities and location were performed by Duncan's Multiple Range Test (table 4). Results of mean comparisons showed that the effects of year, different harvesting intensities and location on forage yield of *Stipa hohenackeriana* were significant at 1% level of probability. Results of mean comparisons of the effect of year on forage yield showed that maximum forage yield was recorded for 2010 and 2011, respectively with no significant difference. Minimum forage yield was obtained for 2009. Results of mean comparisons of the effect of different harvesting intensities on forage yeild showed that maximum forage yield was obtained for control treatment (0%) and 25% harvesting intensity, respectively and minimum forage yeild was recorded for 75% harvesting intensity. Also, there were significant differences among the studied sites statistically as the maximum and minimum yeild were recorded for the site of Kordan (34.41gr) and Arshagh (3.46 gr), respectively.

Mean comparison of interaction effects of location, different harvesting intensities and year on forage yeild of *Stipa hohenackeriana* are presented in table 5. According to the results, maximum yield was obtained for control treatment (56.6 gr) in the site of Kordan, 2010. Other treatments were followed by control treatment. Minimum yeild was recorded for a harvesting intensity of 25% in the site of Arshagh

(0.38 gr), 2010, with no significant differences among four harvesting intensities statistically.

**Table 2.** Analysis of variance of harvesting intensities, year and location on forage yield of *Stipa hohenackeriana*

| Source of variations | Degrees of freedom | Mean squares |
|---|---|---|
| Location | 4 | 26246.49** |
| Year | 3 | 1345.9** |
| Location☐* Year | 10 | 1073.4** |
| Error(1) | 162 | 14.58 |
| Harvesting Intensities | 3 | 459.4** |
| Location☐* Harvesting Intensities | 12 | 677.9** |
| Year ☐ *Harveingst Intensities | 9 | 163.7** |
| ☐ Harvesting Intensities ☐* Site * Year | 30 | 119.7** |
| Error(2) | 486 | 6.63 |
| cv | | 20.17 |

**Table 3**. Mean comparisons of forage yeild of *Stipa hohenackeriana* in years, locations and different harvesting intensities.

| Treatments | Forage Yield (g) |
|---|---|
| 2007 | 12.53 b |
| 2008 | 11.4 c |
| 2009 | 13.38 a |
| 2010 | 13.66 a |
| Control | 14.33 a |
| 25% | 13.82 a |
| 50% | 13.1 b |
| 75% | 9.81 c |
| Kordan | 34.41 a |
| Firoozkooh | 11.18 b |
| Jashloobar | 5.89 c |
| Arshagh | 3.46 e |

## Discussion

The results showed that there was no significant difference between treatments in harvesting intensities of 25 and 50 percent but a harvesting intensity of 75 percent had a negative effect on *Stipa hohenackeriana*. In general, increased utilization leads to the decrease of the yield and vitality of the plant, and increases the mortality.

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 occurs in response to overgrazing (Yang et al. 2000).

According to the results, a harvesting intensity of 25 to 50 percent was identified as the best allowable use. 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).

**Table 4.** Mean comparison of interaction effects of location, different harvesting intensities and year on forage yeild of *Stipa hohenackeriana*.

| Site | Harvesting Intensities | year | Forage Yield (g) |
|---|---|---|---|
| Kordan | Control | 2010 | 56.69 a |
| Kordan | 0.25 % | 2010 | 50.49 b |
| Kordan | Control | 2009 | 49.25b |
| Kordan | 0.25 % | 2009 | 48.28 b |
| Kordan | 50 % | 2010 | 44.38 c |
| Kordan | 25 % | 2008 | 44.32 c |
| Kordan | Control | 2008 | 39.46 d |
| Kordan | 50 % | 2009 | 38.1 d |
| Kordan | 50 % | 2008 | 34.46 e |
| Kordan | 75 % | 2010 | 23.02 f |
| Kordan | 75 % | 2008 | 22.8 f |
| Kordan | 75 % | 2009 | 22.38 gf |
| Kordan | 50 % | 2007 | 20.87 gfh |
| Kordan | 75 % | 2007 | 19.68 gh |
| Kordan | 25 % | 2007 | 18.39 h |
| Kordan | Control | 2007 | 18.14 h |
| Firoozkooh | 50 % | 2009 | 13.8 i |
| Firoozkooh | 75 % | 2009 | 13.56 i |
| Firoozkooh | 25 % | 2009 | 11.93 ij |
| Firoozkooh | Control | 2010 | 11.91 ij |
| Firoozkooh | Control | 2007 | 11.91 ij |
| Firoozkooh | 25 % | 2010 | 11.72 ijk |
| Firoozkooh | 25 % | 2007 | 11.72 ijk |
| Firoozkooh | 75 % | 2010 | 11.62 ijlk |
| Firoozkooh | 75 % | 2007 | 11.62 ijlk |
| Firoozkooh | 50 % | 2010 | 11.55 ijlk |
| Firoozkooh | 50 % | 2007 | 11.55 ijlk |
| Firoozkooh | 50 % | 2008 | 10.04 jlmk |
| Jashloobar | 75 % | 2007 | 9.54 jlmnk |
| Firoozkooh | Control | 2009 | 9.49 jlmnk |
| Jashloobar | 50 % | 2009 | 9.4 jlmnko |
| Firoozkooh | Control | 2008 | 9.12 jlmnkop |
| Firoozkooh | 25 % | 2008 | 8.76 lmnkopq |
| Firoozkooh | 75 % | 2008 | 8.61 lmnkopq |
| Jashloobar | 50 % | 2008 | 8.61 lmnkopq |
| Jashloobar | 25 % | 2007 | 7.76 smnropq |
| Arshagh | 50 % | 2010 | 7.43 smnropqt |
| Jashloobar | 50 % | 2010 | 7.14 smnropqtu |
| Arshagh | Control | 2009 | 7.01 smnropqtuv |
| Jashloobar | 25 % | 2009 | 6.67 swnropqtuv |
| Jashloobar | 75 % | 2009 | 6.06 swxrpqtuv |
| Arshagh | Control | 2010 | 5.96 swxrqtuv |
| Arshagh | 25 % | 2010 | 5.72 swxrqtuyv |
| Jashloobar | 75 % | 2010 | 5.44 swxrtuyv |
| Arshagh | 75 % | 2010 | 5.3 swxtuyv |
| Jashloobar | Control | 2008 | 5.16 swxtuyv |
| Jashloobar | Control | 2009 | 4.7 swxtuyzv |
| Jashloobar | Control | 2007 | 4.67 swxtuyzv |
| Jashloobar | 50 % | 2007 | 4.59 swxtuyzav |
| Jashloobar | 75 % | 2008 | 4.44 wxtuyzav |
| Jashloobar | 25 % | 2008 | 4.02 wxuyzav |
| Arshagh | Control | 2008 | 3.85 wxyzav |
| Jashloobar | 25 % | 2010 | 3.55 wxyza |
| Jashloobar | Control | 2010 | 2.59 byza |
| Arshagh | 75 % | 2008 | 1.87 abz |
| Arshagh | 50 % | 2008 | 1.78 abz |
| Arshagh | 25 % | 2008 | 1.46 ab |
| Arshagh | 50 % | 2009 | 0.44 b |
| Arshagh | 75 % | 2009 | 0.39 b |
| Arshagh | 25 % | 2009 | 0.38 b |

The studies of (Sharifi Yazdi, 2009, Zare, 2012) performed in rangelands of Dhno (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.

(Zahedi, 2011) stated that even a light grazing could cause damage to the height of a prennial grass of *S. bromoiedes* in rangelands of Majidabad of Kordestan province, and a harvesting intensity of 25% is recommended for this site and other similar ecological regions.

**Acknowledgements**

Authors would like to thank Mr. Sharifi, Mirhaji, Karimi and Mirakhorli who helped us in carrying out the research in the provinces.

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