INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 6, No. 3, p. 141-145, 2015
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Investigation on the allowable use of range species (Case study: Sepidan semi-steppe rangelands, Fars, Iran)

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Article published on March 02, 2015

Key words: Allowable use, range species, simulation, Sepidan.

Abstract

Proper utilization of rangelands prevents the degradation, and results in the sustainability of desirable plant species and thus helps to soil and water sustainability and genetic diversity of the country. This research was aimed to determine the allowable use of rangeland species. The study was conducted in Sepidan rangelands and six range species were selected. Treatments included four harvesting intensities of 0%, 25%, 50%, and 75%, applied on the species by grazing simulation method during the project implementation. In this study, biomass production, vigor and vitality, mortality rate, plant height and seed production were measured for each species. After applying the harvesting intensity treatments, the production rate of species were measured and were arranged in a split plot experiment in time based on completely randomized design. Results showed that the effect of different harvesting intensities for most species was significant ($p<0.01$), so that a higher average production was recorded for the treatments of 25% and 50% harvesting intensities as compared to the control group and a harvesting intensity of 75%. The effect of year was also significant for Centaurea aucheri, Eryngium billardieri and Hordeum bulbosum ($p<0.01$) and Prangos ferulaceae ($p<0.05$). According to the obtained results, the allowable use of Astragalus adsendance, Eryngium billardieri was estimated to be 25%, Medicago sativa and Hordeum bulbosum 50%, and Centaurea aucheri and Prangos ferulaceae 75%.

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Introduction

Iran's rangelands are one of the most important and valuable national resources. The main function of rangelands is supplying forage for livestock, and it is evident that the utilization of rangelands requires optimal planning and management to maintain rangeland sustainability. Considering the allowable use of range species is one the main tools, helping in grazing management and optimal utilization.

In addition to considering plant and its health in determining allowable use of range species, it would also seem essential to consider the effect of environmental and soil condition. It is obvious that the allowable use of range species will differ for different climatic zones, vegetation types and topographical conditions, influenced by the factors affecting the allowable use. Therefore, effective criteria should be specified in each region to be used in decision making on determining allowable use. Due to the growing trend of rangeland degradation, determining the allowable use of range species could be effective in range improvement and reclamation.

Determining the factors affecting the allowable use of range species could result in reduced soil erosion and increased water and soil sustainability as well as the sustainability of desirable range species (Azhdari, 2008).

The allowable use percentage differs depending on the type of species. If the allowable use of desirable range species is calculated, associated species will be grazed based on the palatability and much less than usual. After calculating the allowable use for desirable species, it could be used for all plant species (Arzani, 2004).

Since the allowable use of range species in different regions is not specified, therefore, 50% of annual growth is considered as allowable use in range management plans, and it is reduced to 40% for the areas where soil conservation is important, like watersheds.

Among the numerous articles reporting the results of research conducted on the subject, the most recent ones relevant to this investigation are reviewed below.

Ghasriani *et al.,* (2014) compared the allowable use of *Artemisia sieberi* and showed that harvesting intensities of 25% and 50% could be recommended as the best allowable use of *Artemisia siebieri* in semi-steppe and arid vegetative regions, respectively. 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. Arzani *et al.,* (2005) in a study on range suitability, stated that all factors including erosion, range condition, and range trend were effective in determining the allowable use. According to Bartels (1990), an allowable use of 40% instead of 30% can increase the grazing capacity up to 50%. As was mentioned, the determination of allowable use is dependent on studies in place and its percentage will vary depending on the species. Unfortunately, a few systematic researches have been done on the determination of allowable use of rangeland species. Given the importance of allowable use in determining the grazing capacity and range management, this research was aimed to investigate the allowable use of range species in Sepidan semi-steppe rangelands, Fars province.

Materials and methods

The characteristics of the study area are presented in Table 1.

Table 1. Characteristics of the study area.

Site	Area	Geographical coordinates	Average annual precipitation (mm)	Average annual temperature (°C)	Soil texture and pH	Altitude (a.s.l) (m)
Sepidan	345 ha	Longitudes:51 50- 51 55 Latitudes: 30 25-30 30	758	11.9	Sandy Clay Loam-pH=7.9	2608

Methods

In the study area, six range plants were evaluated as key species. A grazing simulation method was used in which different harvesting intensities of 25, 50, 75% and 0 (as control) were investigated as treatments with five replications for each treatment. Biomass production, vigor and vitality, mortality rate, plant height and seed production were measured for each species. Residual forage and total forage of the control treatment were harvested when species were completely dry. The study species were selected at the beginning of grazing season and were marked by wooden labels. These labels remained stable and were protected from livestock grazing during the implementation of project.

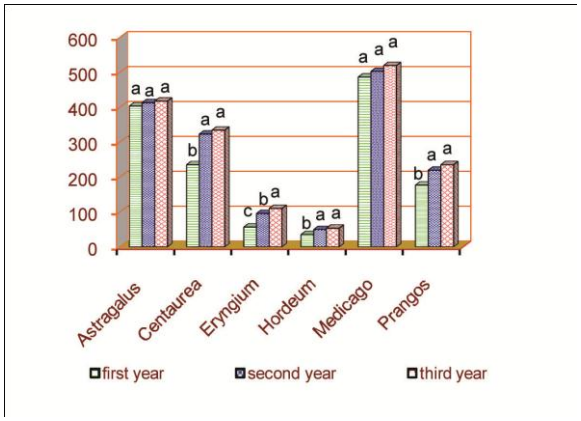
Harvesting was done with clippers. A split plot experiment in time based on completely randomized design was used with four harvesting intensities (0, 25, 50, and 75%) as main plot and year as subplot.

Table 2 shows the results of analysis of variance for the production of species in response to the treatments of harvesting intensities.

Table2. Analysis of variance for the production of species in response to the treatments of harvesting intensities.

Source of variations	df	Mean Square					
		Astragalus adsendance	*Centaurea aucheri*	*Eryngium billardieri*	*Hordeum bulbosum*	*Medicago sativa*	*Prangos ferulaceae*
Treatment	3	16846/97**	4036/55 ^{ns}	2518/17**	988/50**	20532/84 *	4920/68 ^{ns}
Error	16	4607/48	3363/28	620/69	134/87	13212/94	4085/64
Year	2	1059/51 ^{ns}	64657/95**	15204/86**	1850/81 **	5445/41 ^{ns}	18299/**40
Treatment*Year	6	959/02 ^{ns}	4488/75*	883/77 **	237/23 **	1925/12 ^{ns}	1455/26 ^{ns}
Total	32	580/60	1391/00	73/15	51/67	3690/61	1319/21
c.v		5/85	12/39	9/77	15/53	12/08	17/24

The results of mean comparisons for the production of the studied species are shown in Fig. 1.



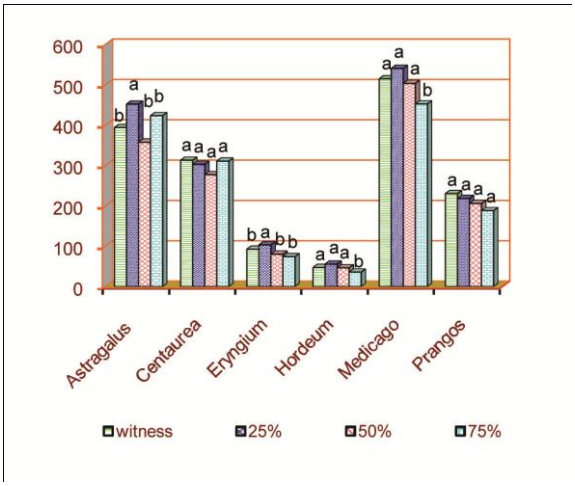


Fig. 1. Mean comparisons for the production of the studied species.

According to the obtained results, during the implementation of project, the plant height changes were insignificant with irregular fluctuations and it seems that it was not affected by climate change and the treatments of harvesting intensities. In the first and last year of the study (2008 and 2011), the vitality of species was higher as compared to other years due to the increased rainfall and moisture content at the beginning of the season. A higher seed production was obtained in 2010, as a dry year, explaining the increase in seed production since the vegetative growth of species is reduced in dry years and plants employ this mechanism for survival. No mortality was recorded for the studied species in response to the treatments of harvesting intensities.

Discussion

Given the current utilization of rangelands to provide forage for grazing livestock, the allowable use of range species could not be determined just based on vegetation and forage production; therefore, other factors including climate, the type of livestock, vegetation composition, range condition, soil condition, geological formation and topography, especially slope, need be taken into consideration.

A higher forage production was obtained in the first and last year of the study (2008 and 2011) as compared to other years due to the increased rainfall and moisture content at the beginning of the season.

Our results clearly showed that the allowable use of range species investigated here were as follows: *Astragalus adsendance* (25%), *Centaurea aucheri* (75%), *Eryngium billardieri* (25%), *Hordeum bulbosum* (50%), *Medicago sativa* (50%), and *Prangos ferulaceae* (75%).

An appropriate shoot to root ratio results in increased production and forage quality.

In a harvesting intensity of 50%, recommended by Reece *et al.,* (2001) 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.

A heavy harvesting intensity of 75% will damage vegetation, soil and livestock due to the reduced vegetation cover and forage production. Therefore, high harvesting intensity could not be recommended scientifically.

However, the results of some studies show that complete elimination of livestock grazing will not lead to vegetation improvement since the seeds of some species need to go beneath the soil for germination; therefore, a light grazing could be helpful. Meanwhile, returning livestock waste under light grazing condition can help to improve soil properties.

The minimum allowable use for Colorado and Alberta rangelands was reported to be 21% and 26%, respectively (Klipple and Costello, 1960; Willms *et al.,* 1986).

Arzani (1994) reported an allowable use of 20% for arid rangelands of Australia and an allowable use of 30% for good rangelands.

Conclusion

According to the obtained results, the applied treatments in terms of the intensity of harvesting as well as the fluctuations of moisture content had no impact on the mortality rate of the species studied during the implementation of project; however, production and vitality decreased. Normally, as expected, the vitality of species decreased with increasing of harvesting intensity. The vitality index of *Astragalus adsendance* was most affected in comparison with other species, mainly due to the change of shoot to root ratio. In addition, with a constant ratio, plant height showed an increasing trend of 2 to 5 cm for all species.

Seed production was also affected by moisture content so that in years with low rainfall vegetative

growth and forage production reduced and reproductive growth increased, as a normal mechanism.

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