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Evaluation of range grasses available in Homand Absard Rangeland research station

Taghi Mirhaji[1*], Ehsan Zandi Esfahan[2], Ali Ashraf Jafari[3], Mahdi Ramezani[4]

[1,2]*Rangeland Research Division, Research Institute of Forests and Rangelands, Tehran, Iran*

[3]*Gene Bank Research Division, Research Institute of Forests and Rangelands, Tehran, Iran*

[4]*Science and Research Branch, Islamic Azad University, Tehran, Iran*

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Abstract

To evaluate range species including Elymus transhircanus, Stipa bromoides, Stipa capillata, Koeleria macrantha, Koeleria phleoides, Melica cupani, Melica jacquemontii with several accessions, this research was conducted at Homand Absard Rangeland Research Station to select the best accessions. The experiment began in 2003 and continued until 2007. After seedbed preparation, accessions were planted on 13-meter lines with a distance of 75 cm. Measured variables included: forage yield, canopy cover, plant height, seed yield, number of flowering stems, leaf density, vitality, basal area, and canopy diameter. Data were analyzed by SPSS and mean comparisons were performed by Duncan's Multiple Range Test. According to the results, Melica jaquemontii showed priorities in forage yield, basal area, canopy cover, and canopy diameter compared to other species. Meanwhile, accession 10714 was recognized as the best accession from the mentioned species. Also, the highest number of flowering stems and seed yield, leaf density, vitality, and plant height were recorded for accession 10708 (Melica cupani), accession 10683 (Koeleria macrantha) and accession 10795 (Stipa capillata), respectively.

***Corresponding Author:** Taghi Mirhaji ✉ zandiesfahan@gmail.com

Introduction

Literature review shows that range species nursery has been considered by experts either abroad or in the country including those as follows:

Rosso *et al.*, (1996) investigated and assessed 45 accessions of Festuca arundinacea in the germplasm of Pergamino Inta Argentina, in terms of forage production, seed production, vigor and vitality, digestibility and resistance to rust attack. According to the results, only five accessions from China, Turkey, India and Spain in the second year did not show resistance against unfavorable environmental conditions. The researchers stated that this superiority was attributed to the accessions' ability to absorb moisture in the first year of establishment.

Derek *et al.*, (2005 & 2006) cultivated 182 accessions of 27 native and non-native species in the nursery to evaluate in two stages. In 2005, seed germination, density and plant height were measured. At this stage, the germination and establishment of native and non-native species increased due to the increased rainfall in March and April. However, in the second year of the evaluation, the species encountered the lack of moisture in July and August, leading to the destruction of some species and decreased density.

Loren *et al.*, (2008), from Aberdean Plant Material Center, evaluated 65 plant accessions in the nursery with collaboration of soil conservation center. Its goal was to provide public visits for introducing different applications including soil conservation, forage production for livestock and wildlife, enhancing water quality and providing habitat for wildlife.

In Homand Absard Rangeland Research Station, different varieties of grass species have been evaluated since the establishment, and among domestic and foreign cultivars, the cultivars 10091 (Scale mountnum), 10088 (Bromus tomentellus) and 1174 (Agropyron desertorum) were identified as the best in terms of forage production.

Ehsani *et al.*, (2007) examined the effects of climatic conditions on forage production of four range species including (Artemisia sieberi, Stipa barbata, Salsola rigida and Noaea mucronata) in the steppe region of Markazi province during 8 years (1998-2005). Results showed that forage production was positively correlated with the rainfall of the beginning of growing season and the rainfall of previous year. They concluded that stored moisture in the soil due to rainfall of previous year as well as the beginning of the season had an important role in plant growth and development.

Hosseini *et al.*, (2000) studied the relationship between rainfall and production and other growth factors including height and canopy cover percentage, and concluded that rainfall during February and March had the most impact on production.

Evaluation of the species available in the nursery is performed in order to identify and separate the accessions as well as select the best accessions for development of cultivation and forage and seed production. On the other hand, the evaluation of accessions in one place not only saves time but also the investigation of their characteristics facilitates the comparison.

Uncontrollable environmental factors on the one hand and direct and excessive human intervention on the other hand have caused the loss of rangeland plants, disrupting the ecological balance. In many areas, because of land degradation and microclimate, this balance has not been restored by any means (Sheidaei and Nemati, 1967). Therefore, the collection of ecotypes and different cultivars of plant species creates the possibility of identifying and selecting the accessions having great potential in terms of forage quantity and quality in range improvement programs through protection and conservation of these genetic resources. In addition, the protection and conservation of range species as well as their proliferation in different ecological conditions and consequently the prevention of rangeland vegetation

degradation are of great importance. The evaluation of rangeland species has multiple objectives of which introducing range species for development of range agronomy could be mentioned.

The grass family (Poaceae) is one of the largest plant families with a wide geographic distribution. This family has two sub-families including Pooideae and Panicoideae. Most plants of sub-family Pooideae are related to highlands and humid and high-rainfall regions (Mozafarian, 2007).

This research was aimed to select the best accessions of the evaluated species in terms of forage production and other traits like soil conservation.

Materials and methods

Geographical location and climatic conditions of the project site

Homand Absard Rangeland Research Station is located 70 km East of Tehran (Tehran -Firoozkouh road, 15 kilometers southeast of the city of Damavand). It is located between longitudes and latitudes of 52° 15' 25" E and 35° 4' 9" N and it has an altitude of 1960 m above sea level. The study area is located on the southern slopes of the Alborz Mountain with a mild slope.

The length of drought period is four months. The average annual rainfall is 335.7 mm, occurring frequently in the form of snow, during the months of December, January, February and March (Meteorological Center of the Homand Absard Rangeland Research Station).

It has a cold semi-steppe climate. Damavand has short temperate summers and long cold winters.

The soil is brown, having a large amount of lime in lower horizons (80-100 cm). It has a pH of 7.7 with a clay-loam texture and poor in terms of organic matter (Shakouei *et al*., 2005).

Table 1. List of the studied accessions in Homand Rangeland Research Station.

Row	Species	Accession	Location
1	Elymus transyrcanus	10598	Khalkhal
2	= =	10599	Ardabil
3	Melica cupani	10708	Anarak
4	= =	10710	Nirvan
5	Melica jacquemontii	10712	Mehran
6	= =	10714	Tang Bijar
7	Koeleria macrantha	10683	Lorestan
8	Koeleria phleoides	10684	Lorestan
9	Sti.bromoides	10790	Eivan
10	= =	10791	Eivan
11	Sti.capilata	10792	Iran
12	= =	10794	Mehran
13	= =	10795	Ilam
14	= =	10796	Iran

Melica cupani is wildly distributed in mountainous and rocky regions in Irano Turanian region. It is not very palatable species and its palatability is greatly reduced in seeding stage. It is grazed by small livestock when the shoots are green and fresh. In addition to livestock grazing, the mentioned species is among the best plants for conservation in arid and semi-arid regions especially in rocky slopes which can be used in range improvement of cold steppe and semi-steppe rangelands. Melica jacquemontii has a higher palatability compared to the previous species and is mostly distributed in mountainous and rocky regions (Mozafarian, 2007).

Stipa bromoides and Stipa capillata are observed as dominant species in plain areas and in some cases, they are found in vegetation composition of rangeland types. In steppe regions of Iran, they are considered as important rangeland species. Although, unlike most grass species, they are not desirable rangeland species, they are grazed by livestock in the beginning of the growing season at vegetative growth stage (Mozafarian, 2007).

Koeleria macrantha and Koeleria phleoides were evaluated in this study. Mostly, Koeleria macrantha is observed sporadically in rangelands and also as a companion species in vegetation composition of summer rangelands. The above-mentioned species are desirable and palatable grasses for livestock, especially sheep (Mozafarian, 2007).

Stipa capillat

Koeleria macrantha

Melica cupani

Melica jacquemontii

Fig. 1. *Studied species in Homand Absard nursery.*

Methodolog

After seedbed preparation, the accessions were planted on a line of 13 m length so that 25 individuals of each accession were placed on it. The distances on the rows and between the lines were 0.5 m and 0.75 m, respectively.

Preliminary evaluation was started from spring 2003. Evaluation criteria for plant selection were as follows: forage production, canopy cover, plant height, canopy diameter, seed production, number of flowering stems, leaf density, vitality, and basal area.

Forage production: After cutting the forage, fresh weight was determined by scale separately and then after open-air drying, dry weight was calculated in terms of Kg ha^{-1}.

Canopy cover: After plant establishment, canopy cover of each species was measured using a ruler.

Plant height: it was measured using a ruler for six individuals from soil surface to terminal leaves of the plant and averaging was performed.

Canopy diameter: This trait was also calculated by measuring two vertical diameters of all individuals and the average was obtained (cm).

Seed production: After harvesting the spikes in each line and removing the seeds from their pods, seed production was measured by scale in kilograms per hectare.

The number of flowering stems: Reproductive stems in each individual were counted separately.

Leaf density: it is a criterion for palatability which is usually estimated theoretically. Numbers 1 to 5 were used so that the least and highest leaf density were shown by number 1 and number five, respectively.

Basal area: This trait was also measured by a ruler.

All obtained data were imported to Excel and then were analyzed by SPSS.

Results

Obtained data were analyzed by simple variance analysis (ANOVA) in each year and a combined analysis of years using a split plot in time and mean comparisons of the species were performed by Duncan's Multiple Range Test. The results of analysis of quantitative traits recorded for the accessions of the studied species in different years showed that significant differences were found among the accessions of the studied species and measured variables at 5% and 1% level of probability (Table 2-3).

In addition, mean comparison in different years indicated that the studied accessions did not show similar results and maximum values for all variables were recorded in 2006 and 2007 (Figs. 2-5). The accession 10714 from Melica jacquemontii showed superiority in terms of forage production (793.1 kg ha^{-1}), basal area (928.6 cm^2), canopy cover (1960.7 cm^2), and canopy diameter (45.84 cm) compared to other species during the studied years. Minimum values were recorded for the accession 10599 from Elymus transhsyrcanus with a forage production of 41.1 kgha^{-1} (Figs. 6 and 7).

Table 2. Combined analysis of variance for 6 accessions of Stipa bromoidess and Stipa capillata in Homand (2003-2007).

S.O.V	df	leaf density	number of flowering stems	plant height (Cm)	canopy diameter (cm)	canopy cover (cm^2)	basal area (cm^2)	seed yield (Kg ha^{-1})	forage yield (Kg ha^{-1})
Species	5	9.51**	1034	632.0	255.7*	1420903**	165359*	35133	69649
Rep	1	0.55	48	68.0	69.1	24040	3937	19240	101
Error 1	5	0.52	291	150.0	52.7	135185	11263	20913	17778
Year	4	731**	2337**	4023.0**	368.5**	738424**	123340**	169229**	1211136**
Species*Year	20	2.62**	176**	23.0**	8.9	49435*	11997**	13098**	47207**
Error 2	24	0.60	26.4	7.6	12.1	23761.8	2240.7	2773.5	6654.8
CV		9.00	22.5	6.0	9.6	12.7	11.2	49.3	20.2

** and *= Significant at 1% and 5% level of probability, respectively.

Table 3. Combined analysis of variance for Elymus transhyrcanus, Ko. macrantha, Ko. phelemoides, Me. cupani and Me. jacquensis in Homand (2003-2007).

S.O.V	df	leaf density	number of flowering stems	plant height (Cm)	canopy diameter (cm)	canopy cover (cm^2)	basal area (cm^2)	seed yield (Kg ha^{-1})	forage yield (Kg ha^{-1})
Species	4	63.26.00**	50496**	1067**	1106*	3798057*	782411*	142045**	865968**
Rep	1	1.69	786	0.00	39	610190	94057	1031	56460
Error 1	4	2.57	2251	16	94	374329	124767	4246	35130
Year	4	900**	2303	478**	239**	418525**	38238**	177843**	957258**
Species*Year	15	15.76**	6589	107**	51	111013	16077	33364	137166**
Error 2	47	1.42	12003	16	47	252790	36464	33472	54979
CV		12.85	126	11	22	51	41	139	67

** and *= Significant at 1% and 5% level of probability, respectively.

For a better understanding, the relationship between forage and seed production is shown in Figs. 2 and 3. According to the following figs., it is observed that there is a relationship between forage and seed production. This means that seed production is higher in accessions and species having high forage production and vice versa. This is also true for the accessions of Stipa bromoides and Stipa capillata. It should be added that this relationship does not exist for all accessions or species and some of them are exempted. For example, in Melica cupani, seed production was higher than forage production (Fig.

2), and or in the accession 10790 from Stipa bromoides higher seed production was obtained compared to forage production (Fig. 3).

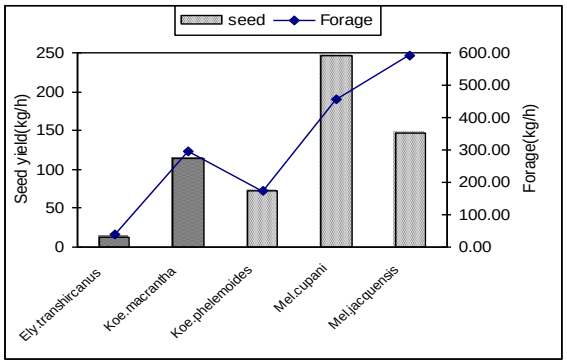

Fig. 2. Forage and seed production of the accessions from Elymus transhyrcanus, Ko. macrantha, Ko.phelemoides, Me. cupani, and Me. jacquensis in Homand.

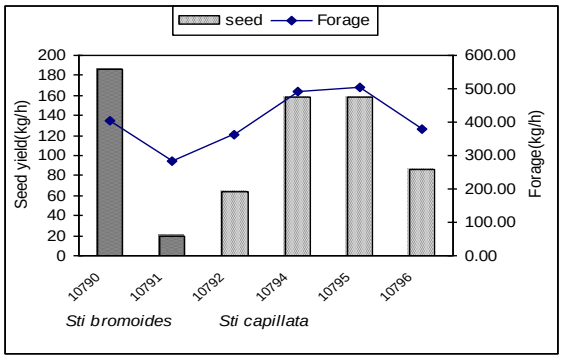

Fig. 3. Relationship between forage and seed production (yield) of the accessions of Stipa bromoides and Stipa capillata under rainfed condition in Homand.

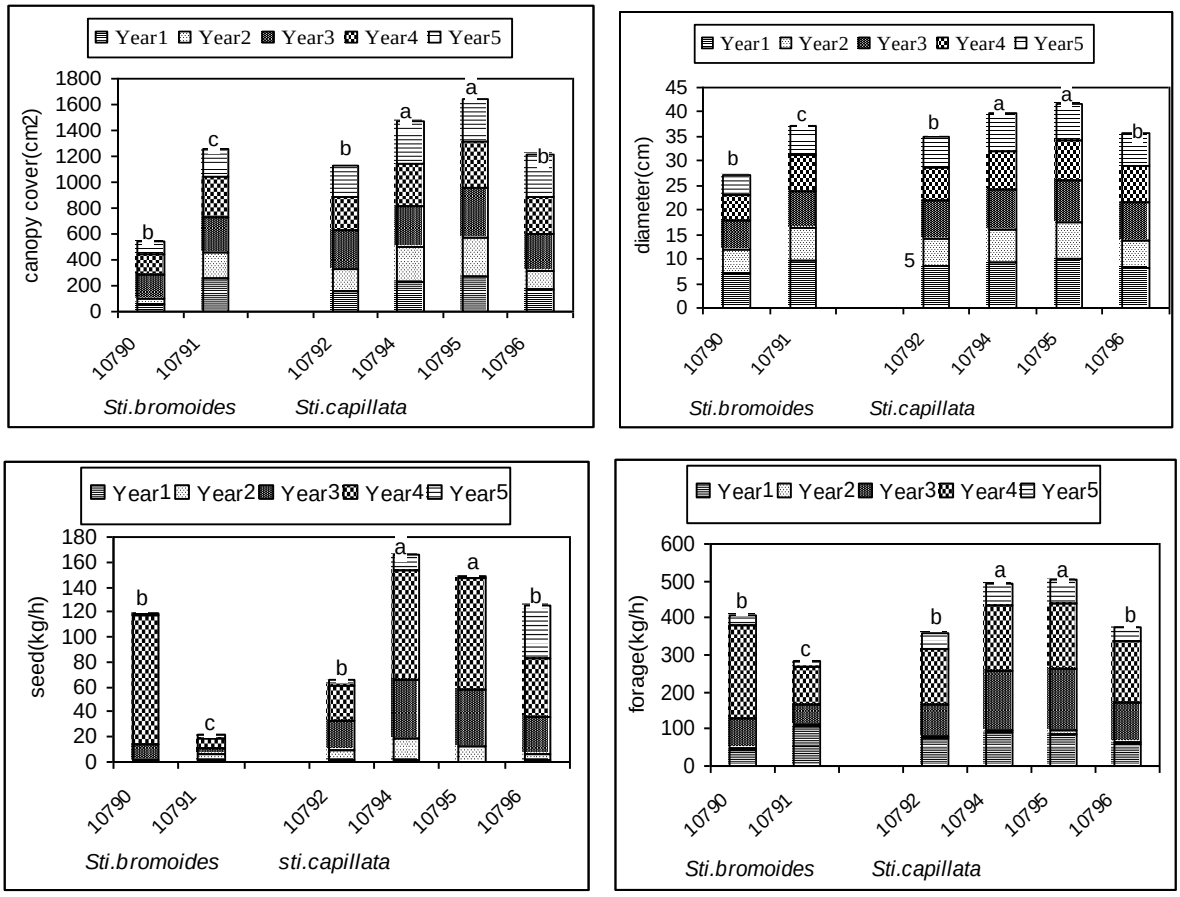

Fig. 4. Forage and seed yield, canopy cover and canopy diameter of Stipa bromoidess and Stipa capillata in different years, in Homand.

Mean comparison of traits in the species of Stipa genus

Mean comparisons in different years showed that the changes of traits during the 5-year test were additive for forage and seed yield. So that the yield (production) increased from year one to year four every year and this trend was also observed for canopy cover and basal area. In this regard, in terms of forage yield and seed yield, the highest amount was recorded for the accession10795 from Stipa capillata and accession10790 from Stipa bromoides, respectively. Among the studied years, the fourth year (2006) had superiority compared to other years (Fig. 4).

Mean comparisons of the measured traits showed that the highest and lowest amount in terms of leaf density, the number of reproductive stems, height, canopy diameter, canopy cover and forage yield were recorded for the accessions 10795 from Stipa capillata and 10791 from Stipa bromoides, respectively. According to the results, the fourth year (2006) showed superiority compared to other years.

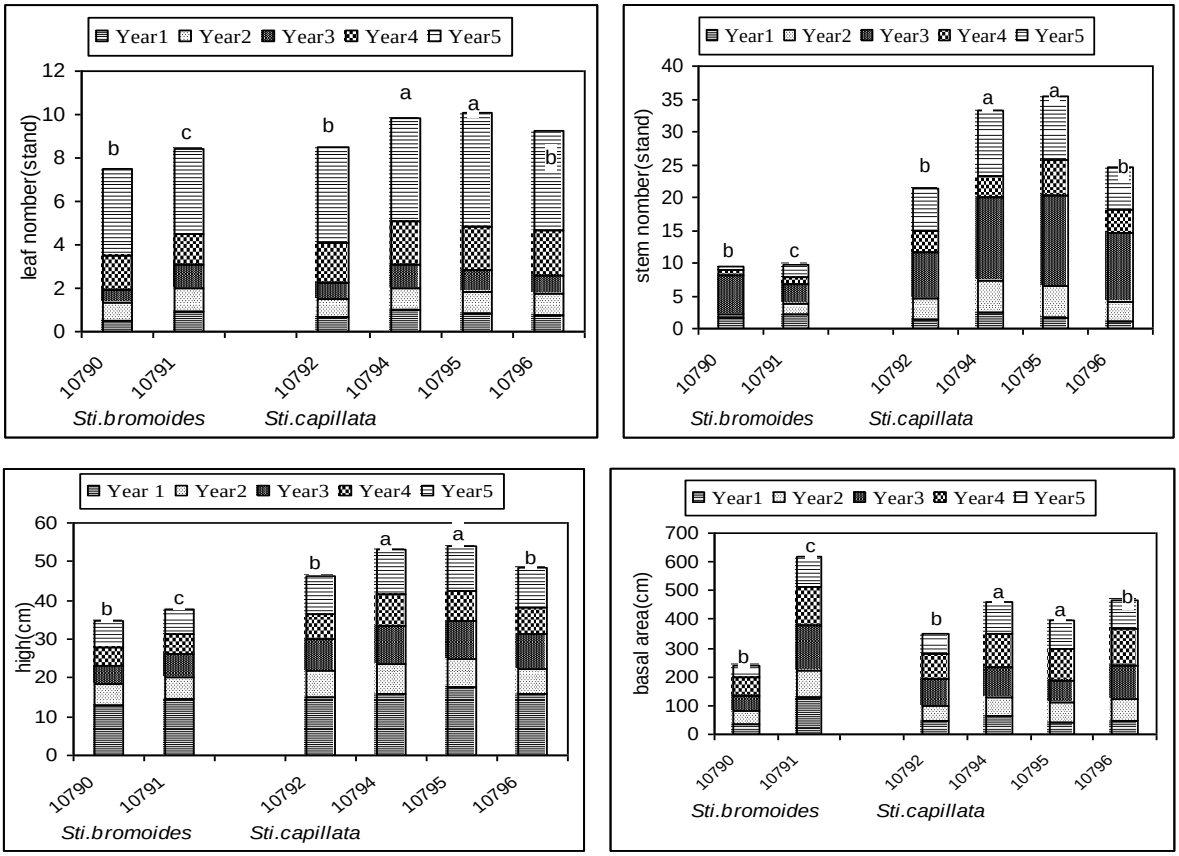

Fig. 5. Basal area, leaf density, number of flowering stems and the average height of the accessions of Stipa bromoidess and Stipa capillata in different years, in Homand.

Mean comparison of traits in the species of Elymus, Melica and Koeleria

Mean comparisons in different years showed that the changes of traits during the 5-year test were additive for forage and seed yield. So that the yield (production) increased from year one to year four every year and this trend was also observed for canopy cover and basal area. In this regard, the highest amount in terms of forage yield, basal area, canopy cover and canopy diameter was obtained for the accession 10714 from Me.jacquensis. The highest amount in terms of leaf density and vitality was recorded for the accession 10683 from Me.jacquensis. According to the results, the fourth year (2006) had superiority compared to other years (Fig. 6).

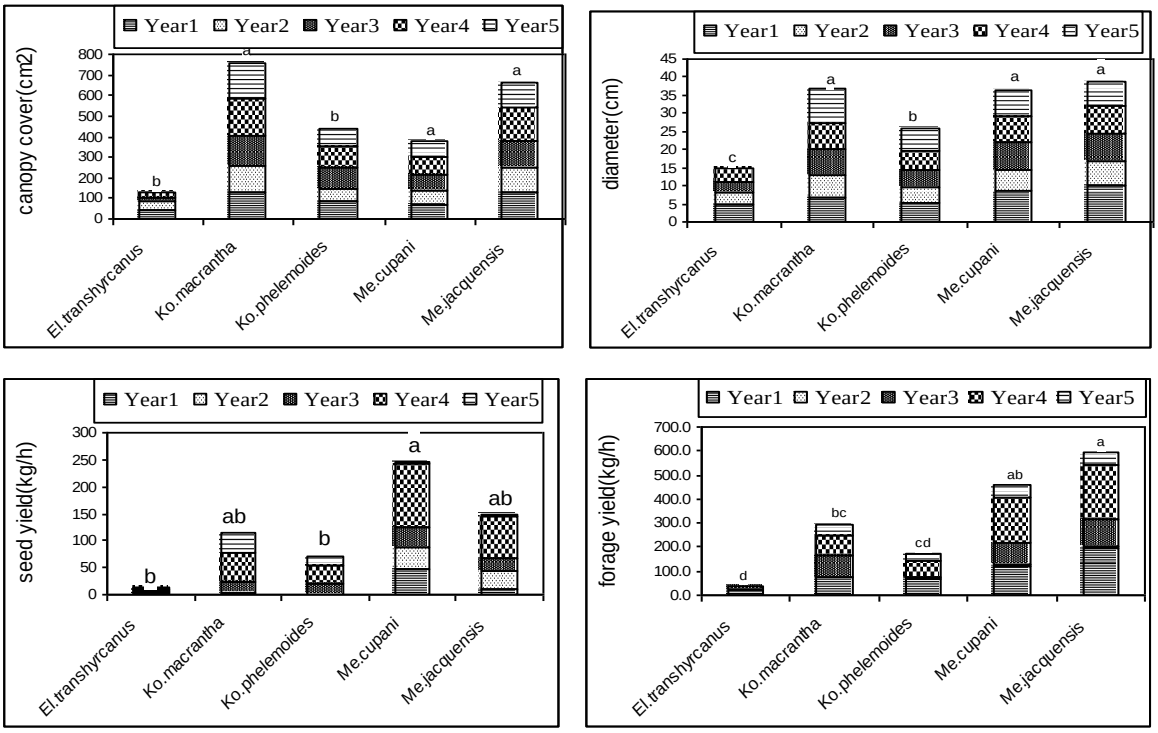

Fig. 6. Canopy cover, canopy diameter, forage yield and seed yield of five species under rainfed conditions in different years, in Homand.

Mean comparisons of the measured traits showed that the highest and lowest amount in terms of forage yield, basal area, canopy cover, and canopy diameter was recorded for the accession 10714 from Me.jacquensis and the accession 10559 from and the accession 10714 from Elymus transhyrcanus. According to the results, the fourth year (2006) had superiority compared to other years (Fig. 7).

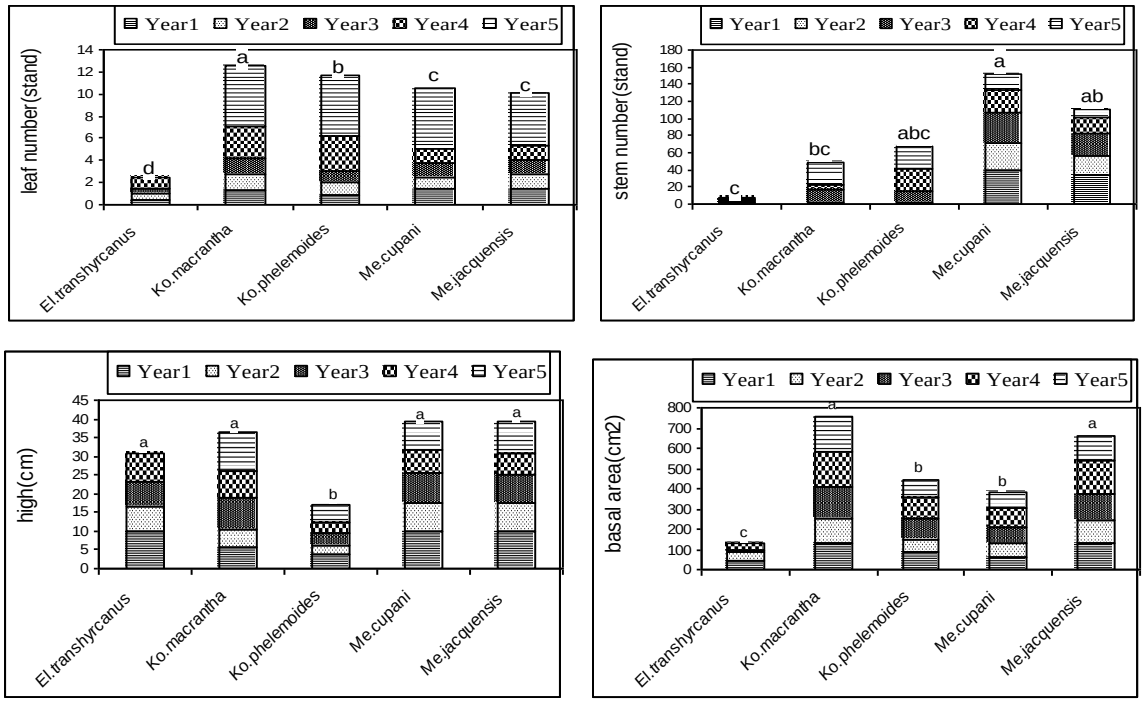

Fig. 7. Basal area, number of flowering stems and average height of 5 species under rainfed conditions in different years, in Homand.

Discussion and conclusion

According to the application of rangeland species, they could be discussed from two points of view: production and soil conservation. In this regard, the production rate per unit area and factors affecting the production like plant height and canopy cover, and for soil conservation the effect of shoot (canopy) and basal area were considered as criteria to identify the accessions. Since basal area is more affected by vegetative characteristics and age, and is less affected by climatic conditions, climatic fluctuations do not alone increase the basal are abut consistent with the behavior of the growth and aging, some changes may occur in the area. Therefore, the role of canopy cover for soil conservation was further discussed and evaluated.

According to figs. 2-7, the accession 10714 from Melica jaquemontii was superior in terms of forage production (yield), basal area, canopy cover and canopy diameter. The accession 10708 from Melica cupani showed superiority in terms of number of flowering stems and seed yield. In terms of leaf density and vitality, the accession 10683 from Koeleria macrantha was superior. Finally, the accession 10795 from Stipa capillata was identified superior in terms of plant height.

According to the results of mean comparisons, the maximums in most of the variables were belonged to the years of 2006 and 2007.Although, the rainfall during the growing season (spring and summer) of 2006 and 2007 was less than that of other years of the project, they had the most storage from the previous years during inactive season. Rainfall statistics shows that the rainfall of the aforementioned year was lower compared to the long-term average rainfall and even compared to other years of the project implementation. Since the studied species have fibrous roots, widespread at the surface and at depth, these plants use both seasonal moisture and deep soil moisture storage. Since seasonal soil moisture was not enough in growing season, inevitably, the species used deep soil moisture as well as groundwater and it was less able to use soil surface moisture.

Ehsani *et al.*, (2007-2008) showed a positive relationship between forage production of four range species (Artemisia sieberi, Stipa barbata, Salsola rigida, and Noaea mucronata) and rainfall of the beginning of growing season and previous year. In this regard, they concluded that perennial species having extensive and deep root system were able to use stored moisture. In addition, the present study corresponds with the findings of Hossain *et al.*, (2001), studying the relationship between rainfall and production and other growth factors including height and canopy cover.

In this study, the accessions 10661 and 10671 with extensive and deep root system could gain more moisture from soil depths and provide a better growth condition. Reduced density and establishment or in other words reduction of growth factors (height, canopy cover and canopy diameter) as well as the reduction of production of other studied accessions could be attributed to the inability of species to absorb moisture from different soil depths due to the lack of strong and extensive roots. In this regard, maximum growth of canopy cover, canopy diameter and basal area was recorded for the accession 10671. The accession 10661 also showed superiority compared to other accessions in terms of the number of stems as well as forage and seed yield. Other measured variables followed the above analysis.

In this regard, the accession 10795 (Stipa capillata) showed the maximum growth in height in 2003. In this year, rainfall, like other years of the study, was higher than the long term average rainfall and above all, spring rainfall of 2003 was higher compared to the other studied years. The growth and development of the canopy cover of Stipa capillata can be expressed as this species probably has more frequent and stronger shallow roots enabling it to use soil surface moisture more than other species. On the other hand, conversely, its deep roots are too weak to use deep

soil moisture in years with low spring rainfall resulted in lower growth.

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