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EVALUATION OF YIELD AND QUALITY TRAITS IN 17 POPULATIONS OF TALL WHEATGRASS (*AGROPYRON ELONGATUM*) GROWN IN RAIN FED AREA OF IRAN, UNDER TWO CUTTING MANAGEMENT

Ali Ashraf Jafari[1*], Ata Elmi[2] and Mohammad Bakhtiari[1]

[1]Research Institute of Forests and Rangelands (RIFR), P.O. Box 13185-116, Tehran, Iran.
*Corresponding author. E-mail: aajafari@rifr-ac.ir

[2]Postgraduate student, Islamic Azad University, Boroujerd branch, Boroujerd, Iran

ABSTRACT

The objectives of this research were to determine the variability and the effects of harvesting managements on forage dry matter (DM yield) and 5 quality traits, namely Dry matter digestibility (DMD%), Water soluble carbohydrates (WSC%), Crude protein (CP%), Acid detergent fiber (ADF%) and total ash, in tall wheatgrass (*Agropyron elongatum*). In this study 17 populations were examined in two separate experiments for 1 and 2 cuts/year using randomised complete block design with 3 replications under dry land farming system, over three years (2006-2009), in Damavand, Iran. The results of analysis of variance over three years and two cutting managements, showed significant effects of years and cutting managements for all of traits (P<0.01). The effects of population were significant for all of traits except CP% and ash%. The populations by cutting management interaction effects were significant for DM yield, WSC and CP. The average values of annual DM yield (1482 and 3053 kg ha^{-1}), DMD (42.88 and 38.79%), WSC (10.37 and 13.81%) and CP (7.96 and 4.86%) were obtained for two and one cutting managements, respectively. Results suggested that two cuts management resulted in lower yield coupled with high quality. For both cutting management, the DM yield declined from year 1 to year 3 and in both managements. The average values of DMD, CP and total ash were higher in the second year than those for years 1 and 3. The difference between the years for quality traits were explained by differences in physiological growth stage at the time of cutting. The population means were scattered based on two management's scores. The local population 774m (Takestan) with average values of 1740 and 3837 kg ha^{-1} DM yield had higher production for 2 and 1 cut managements, respectively. The populations 240M (Tabriz) and 301P$_{14}$ (Alborz) had higher values for both yield and quality traits for 2 and 1 cut, management, respectively.

Key words: Tall wheatgrass *Agropyrone elongatum,* frequent cutting, conservation, yield, quality traits

INTRODUCTION

Iran comprises of 165 million hectares of which about 90 million ha (54.5%) is rangelands (Anonymous, 1999) according to vegetation cover. About 14 million ha occur in the cooler high altitude regions of the country. They are grazed during spring and summer and their vegetation cover is in general a combination of soft herbs and grass species. These rangelands are in fairly good condition. From the rest of rangelands, about 60 and 16 million ha are shrub dominant winter grazing and desert areas, respectively (Anonymous, 1999). Due to harsh climatic factors and over grazing, the rangelands of the shrub dominant and desert areas are not in good condition. Also, in herbs dominant areas, over a long period of time shifting cultivation within the rangelands lead to increased soil erosion by decreasing the perennial component of the vegetation. This has occurred without obtaining viable crop yields and forcing the farmers to abandon such lower vegetation and eroded area. Therefore, sowing the seeds of adaptable range species (grass and legumes) will be an integral part of country ranges rehabilitation.

Tall wheatgrass (*Agropyron elongatum* Host.) is an important cool-season grass that is used for ranges improvement in Iran. It is well adapted to steppe or semi steppe region of Iran. It is used for pasture, hay, and erosion control. It is native to the Eastern Mediterranean Region (Darbyshire, 1997). Tall wheatgrass can survive under dryland conditions and alkaline soils with a pH between 7.5 and 9 (Roundy, 1985; Undersander and Naylor, 1987). Tall

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wheatgrass could persist in soils with conductivity up to electrical conductivity (EC) of 26 mmhos/cm (Ogle et al., 2008).

Because of its late maturing characteristic, tall wheatgrass provides a long grazing period (USDA, 2005). Tall wheatgrass is most palatable during the early spring months. As the grass matures its nutrient value rapidly declines (Cohen et al., 1991). If the grass is not well managed, old coarse growth may inhibit grazing the following year. So, it must be grazed heavily to maintain plants in the vegetative state and to prevent becoming stemmy in the late stage of maturity (Cohen et al., 1991; Undersander and Naylor, 1987). However, this species does not tolerate continuous close grazing and a rest period is required between grazing events (USDA, 2005). In a study to determine influence of clipping frequency on yield, Undersander and Naylor (1987) found the highest yields of tall wheatgrass when it was clipped at 4 week intervals (USDA, 2005).

Total DM yield and seasonal yield distribution are of primary interest in herbage breeding. The aim of herbage breeding is to provide varieties, which are not only productive, but also maintain a high nutritive value throughout the season. Increase in quality traits at both reproductive and vegetative stages of growth is desirable so that improvement is obtained for both conservation and grazing. Forage quality of grasses is influenced greatly by maturity stage. For high quality, they should be cut at the early boot stage. The objective of this work was to study the variation of dry matter yield (DM), Dry matter digestibility (DMD%), Water soluble carbohydrates (WSC%), Crude protein (CP%), Acid detergent fiber (ADF%) and total ash using 17 locally collected population of tall wheatgrass under two cutting system (1 and 2 cuts/year). The six traits and growth environments are of special relevance in formulating a selection strategy for this species.

MATERIAL AND METHODS

The present research study was carried out at Homand Absard rangeland station, that is located in southern slope of Damavand mount, in Alborz Mountains (35°40′ N 52°05′ E) at altitude 1960 m. (70 Km east of Tehran). The rainiest month is March with 51.4 mm rainfall. The mean annual rainfall is 338 mm, and average annual temperature is 10.1 C°. The average maximum temperature is 22.8 C° in August and medium temperature is -3.2 C° in January (Figure 1). The climate of this region with using Emberger method is cold sub-steppic. The Embrothemic diagram shows that drought period at station is for five months of year and wet season starts in November and it continues until May (Figure 1). The results of soil analyses showed plenty of limy layers in depth of 80-100 cm. The soil texture was generally Clay loam to silty clay loam with alkaline pH=7.7. The available nutrients of the soil except potash were generally low and the soil had no salinity problem

The populations utilized in this study were derived from Iranian natural resource gene bank. They were collected from slopes of Alborz altitude in north and Zagros altitude in west of country. The 17 populations, four from Gazvin province (774m, $774p_4$, $774p_7$, $774p_{15}$), four from west Azerbaijan (1360m, $1360P_8$, 1755m, $1755p_4$), four from east Azerbaijan (240m, $240p_{15}$, 685m, $685p_{11}$) and 5 populations from Tehran province as: (301m, $301p_1$, $301p_8$, $301p_{13}$, $301p_{14}$) were sown under dense sward conditions.

Two separate experiments were established in October 2005. Seeds were sown in four drilled lines as long as 2 meters with 50 cm distance, in sward condition using randomised complete block design with three replications. During establishment year the plots were cut one time, but no measurements were taken. No irrigation was made during the lifetime of these experiments. Fertilizer was applied as: 100 and 50 kg ha^{-1} phosphorus (P_2O_5) and nitrogen (N) in establishment year respectively. Nitrogen was also applied for three successive years as 50 kg ha^{-1} in Mid-March.

Cutting managements were based on growth seasons. As shown in Figure 1, the growth season started from Mid-March and continued to Mid-June. So, for 2 cutting, only 2 cuts were harvested: Cut 1 in booting stage (early May) and regrowth cut by 45 days interval in Mid-July. For 1 cut management, only one cut was harvested at pollination stage. Since there was a drought period during summer and autumn for both experiments, there was no re growth in both trials.

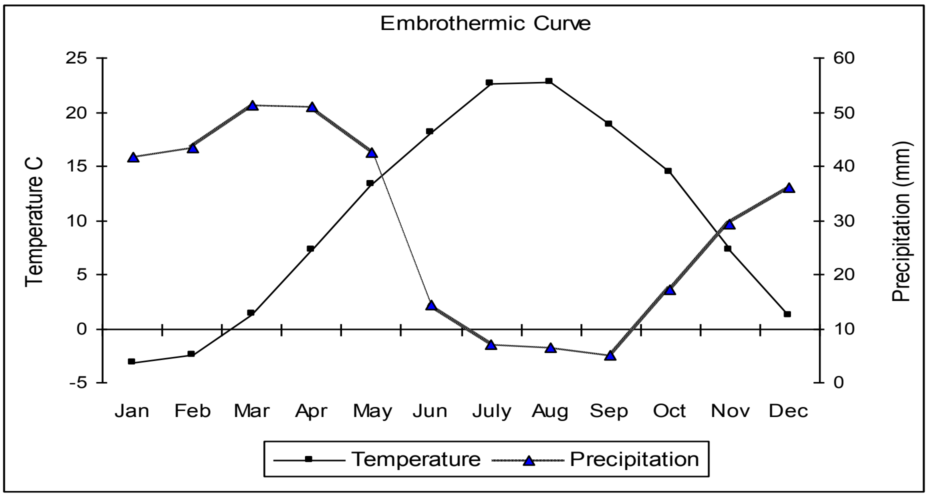


Figure 1. The lines of two axes chart of Embrothermic Curve (average annual rainfall and temperature)

Forage yield (fresh weight) was determined by cutting each plot at a height of 5 cm. immediately after cutting, the fresh yield of each plot was sub-sampled. These samples were air dried then placed to oven at 100 C° overnight and DM% estimated from the fresh yield and DM%. Estimation of quality parameters was made on the first cut of both managements. To estimate quality traits, a second sub-sample was taken from each plot following above cut. These samples were dried at 70°C for 24 hours and ground to pass through a 1-mm screen mill. The samples were evaluated for DMD, WSC, CP, ADF, and total ash using near infrared spectroscopy (NIR). Details of the methodology and calibrations of NIR were given by Jafari et al. (2003b). Data analyses were performed for accumulated annual yield and each quality component. Data were also subjected to a combined analysis of variance across years and cutting management using a split plot in time design with years as sub plots (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Results of split-plot-in-time analysis of variances over three years for frequent cutting and conservation managements were summarized in Table 1.

Table 1. Analysis of variance of 17 tall wheatgrass populations for DM yieldand quality traits for 2 and 1 cutting managements over three years

Source	DF	DM yield		DMD%		WSC%		CP%		ADF%		ASH%	
		2 Cuts	1 Cut	2 Cuts	1 Cut	2 Cuts	1 Cut	2 Cuts	1 Cut	2 Cuts	1 Cut	2 Cuts	1 Cut
Entry	16	2.37	2.63**	4.39	4.14**	1.37*	1.12*	0.88*	0.57	5.11*	4.10**	0.23	0.20
Blocks	2	3.67	2.61*	3.38	3.74	5.77**	1.38	6.13**	2.20**	6.93	5.55*	1.18**	0.13
Error a	32	1.70	0.71	4.29	1.15	0.67	0.53	0.40	0.31	2.52	1.22	0.25	0.12
Years	2	15.7**	89.2**	142**	3101**	265**	566**	44**	183**	219**	838**	8.49**	158**
E×Y	32	0.65	0.63**	2.93**	2.05	0.42	0.75*	0.39	0.30**	3.55**	1.99**	0.16	0.07
Error b	68	0.53	0.18	1.48	1.27	0.31	0.41	0.26	0.14	1.34	0.88	0.12	0.07
CV%		15.53	13.83	2.83	2.91	5.36	4.64	6.43	7.67	2.68	2.08	4.85	5.86

The between populations variances were significant for WSC, CP and ADF (P≤0.05) in frequent cutting and for DM yield, DMD, WSC and ADF (P≤0.01) in conservation management, respectively. The effect of year was significant for all of traits in both managements. The population × year interaction effect was significant for DMD and ADF in frequent cutting and DM yield, WSC, CP and ADF in conservation management, respectively. The differences in variation among population in two trials could be explained by stage of maturity. There was a range of DM yield of 1181 and 1740 kg ha^{-1} for frequent cutting and 2086 and 3837 kg ha^{-1} for conservation management, respectively. There are various published data showing that stage of maturity can affect both yield and quality traits (Buxton et al., 1996; Belanger and McQueen, 1997 and Jafari et al., 2003a).

Table 2. Combined analysis of variance of 17 tall wheatgrass populations for DM yield and quality traits for two cutting managements over three years

Source	DF	DM yield t ha^{-1}	DMD %	WSC %	CP %	ADF %	ASH %
Management (M)	1	188.8**	1279**	901**	733**	326**	424**
Blocks within M (B/M)	4	1.51*	3.56	3.57**	4.17**	6.24*	0.66**
Entry (E)	16	1.21**	6.34**	1.13*	0.59	7.26**	0.23
E × M	16	1.66**	2.19	1.36**	0.86**	1.94	0.21
E × B/M (Error a)	64	0.44	2.72	0.60	0.35	1.87	0.18
Years (Y)	2	56.4**	4275**	787**	176**	918**	119**
M × Y	2	34.4**	255**	44**	51**	139**	47**
Y × B/M (Error b)	8	0.52	2.83	0.52	0.53	2.86	0.33
E × Y	32	0.35**	2.12*	0.56*	0.39**	2.92**	0.12*
E × Y × M	32	0.34**	2.86**	0.61*	0.31*	2.62**	0.10
Residual (Error c)	128	0.09	1.28	0.35	0.18	1.00	0.08
CV%		13.27	2.77	4.89	6.61	2.26	4.86

A summary of the analysis of data over environments (managements and years) is given in Table 2 for all characters. The simple effects of managements and year was significant for all of traits (P≤0.01). The differences among population over 3 years and two managements were significant for DM yield, DMD, WSC and ADF, indicating useful variation for breeding improved varieties for both yield and quality traits in tall wheatgrass. The first order interaction of population × management was significant for DM yield, WSC and CP (P≤0.01). The interaction of population × year and management × year was significant for all characters. In similar results, Jafari and Naseri (2007) in cocksfoot grown in Iran, found significant genotype × year interactions for DM yield, morphological and quality traits. The published data for interaction of variety × harvest frequency are different. Rhodes (1971) and Wilkins (1989) found significant variety × harvest interaction for DM yield in some grass species. In contrast, Camlin and Stewart (1975) and Jafari et al. (2003a) in ryegrass under frequent cutting management and grazing did not find significant variety × harvest frequency interaction for DM yield.

The second order interactions of population × management × year were significant for all of traits, except total ash (P≤0.01).

When population × environment interactions are significant then evaluation prior to selection is more difficult. Ideally more than one environment (e.g. years, harvesting frequency, locations etc.) should be used to assess the breeding material. Similar to current study, Wilkins (1997) in perennial ryegrass and Marum et al. (1979) in reed canarygrass found significant variety × harvesting frequency interaction for DMD. For WSC, Jafari et al. (2003a) found significant variety × harvest frequency interaction, while in perennial ryegrass Humphreys (1989) for WSC and Jafari et al. (2003a) for DMD and CP did not find genotype × management interaction under two cutting management. It seems that in grasses, quality traits are more stable than DM yield under various cutting managements in rainy European countries, but for steppe or semi steppe region as Iran, due to low and irregular precipitation and other environmental stresses, the genotype × environment interactions are present for quality traits.

The population means were compared using DMRT method. The results for frequent cutting managements showed that population 240m, 1360p$_8$ and 774m with average values of 1662 to 1740 kg ha^{-1} and for conservation management, the population 774m, 774p$_7$, 301p$_8$, 301p$_{14}$ and 240p$_{15}$ with average values of 3591 to 3837 kg ha^{-1} had higher forage DM production (Table 3). The populations, 774m, 774p7, 301p$_8$, 301p$_{14}$, 240p$_{15}$ and 685 m with average values of 2400 to 2788 kg ha^{-1} had higher DM yield in both managements (Table 3). The populations were also scattered based on two management scores (Figure 2). The results of population distribution based on two management scores were in agreement with DMRT comparison. The local population 774m (Takestan), with average values of 1740 and 3837 kg ha^{-1} DM yield had higher production for frequent cutting and conservation managements, respectively (Figure 2). 240M (Tabriz), 301P$_{14}$ (Alborz) and 774m (Takestan) had higher values for both yield and quality traits for frequent cutting, conservation and mean of both managements, respectively (Tables 3 to 5).

Table 3. Mean of DM yield and DMD% in 17 populations of tall wreath grass for two cutting managements over three years

Entry	DM yield (kg ha^{-1})						DMD%					
	2 Cuts		1 Cut		Mean		2 Cuts		1 Cut		Mean	
1360m	1504	abc	2975	cd	2240	def	42.24	cde	38.29	b-e	40.26	cde
1360p$_8$	1674	ab	2921	cd	2298	def	43.44	abc	38.76	a-e	41.10	a-d
1755m	1364	c-f	2365	ef	1864	h	43.16	a-d	39.33	abc	41.25	a-d
1755p$_4$	1181	f	3274	bc	2228	def	43.03	a-e	39.70	a	41.37	abc
240m	1662	ab	2086	f	1874	h	42.29	cde	38.04	de	40.16	de
240p$_{15}$	1243	def	3636	ab	2439	bcd	43.26	abc	38.19	cde	40.73	a-e
301m	1523	abc	2412	ef	1967	gh	43.41	abc	39.01	a-d	41.21	a-d
301p$_1$	1473	bcd	2748	de	2111	fg	44.13	a	39.52	ab	41.82	a
301p$_{13}$	1579	abc	2380	ef	1980	gh	41.79	e	39.42	abc	40.61	b-e
301p$_{14}$	1223	ef	3817	a	2520	bc	43.24	abc	38.96	a-d	41.10	a-d
301p$_8$	1434	b-e	3614	ab	2524	bc	41.82	de	37.95	de	39.88	e
685m	1556	abc	3291	bc	2424	b-e	43.12	a-e	38.27	b-e	40.69	a-e
685p$_{11}$	1561	abc	2859	cd	2210	ef	42.64	b-e	39.11	a-d	40.88	a-e
774m	1740	a	3837	a	2788	a	43.89	ab	39.42	abc	41.65	ab
774p$_{15}$	1353	c-f	3044	cd	2198	ef	42.82	a-e	38.08	de	40.45	cde
774p$_4$	1578	abc	3054	cd	2316	c-f	41.85	de	37.69	e	39.77	e
774p$_7$	1548	abc	3591	ab	2569	b	42.85	a-e	39.73	a	41.29	a-d
Mean	**1482**	**B**	3053	**A**			**42.88**	**A**	38.79	**B**		

Means followed by the same small letters in each column are not significantly different (P<0.05).
Means of two cutting managements for each trait in the last row are significantly different (P<0.05).

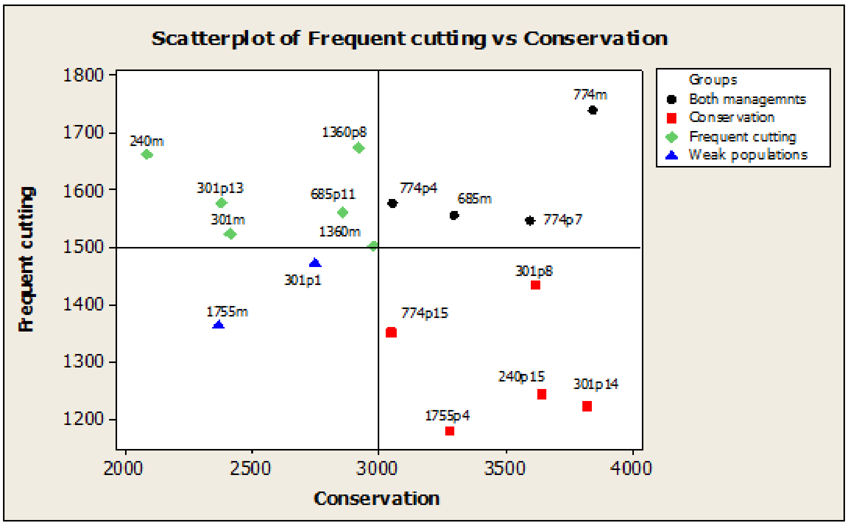


Figure 2. Distribution of populations based on Bi-plot of two cutting managements

The average values for yield and five quality components for each management are quoted in last rows of Tables 4 to 6. For frequent cutting and conservation managements, the obtained average values were: for annual DM yield (1482 and 3053 kg ha^{-1}), DMD (42.88 and 38.79%), WSC (10.37 and 13.81%), CP (7.96 and 4.86%), ADF (43.17 and 45.23) and total ash (7.02 and 4.67), respectively. Results suggested that frequent cutting managements resulted in lower yield coupled with high quality. In similar results, Mut et al. (2006) in evaluation of forage of triticale in two phenological stages found 43% higher DM yield in milky-dough stage than in early heading. Overall means of DMD, CP and total ash over years were lower for conservation compared to frequent cutting management. This conclusion was in agreement with finding of Chestnutt et al. (1977), Wilkins (1997) and Jafari et al. (2003a). In contrast, the mean of WSC was higher for conservation management.

Table 4. Mean of WSC% and CP% in 17 populations of tall wreath grass for two cutting managements over three years

Entry	WSC%						CP%					
	2 Cuts		1 Cut		Mean		2 Cuts		1 Cut		Mean	
1360m	10.35	bcd	13.48	cd	11.92	abc	8.38	ab	5.10	abc	6.74	a
1360p$_8$	10.09	cde	14.11	abc	12.10	abc	8.53	a	4.56	de	6.54	ab
175m	10.47	bc	13.75	bcd	12.11	abc	7.34	f	5.03	abc	6.18	bc
1755p$_4$	10.55	bc	13.99	abc	12.27	ab	8.07	a-d	4.48	e	6.27	bc
240m	9.57	e	13.68	bcd	11.62	c	7.96	b-e	4.83	b-e	6.39	abc
240p$_{15}$	11.15	a	13.76	bcd	12.46	a	7.98	a-e	4.71	cde	6.34	abc
301m	10.38	bcd	13.07	d	11.72	bc	8.33	ab	4.56	de	6.44	abc
301p$_1$	10.19	cd	13.75	bcd	11.97	abc	8.20	abc	4.99	abc	6.59	ab
301p$_{13}$	10.87	ab	14.04	abc	12.46	a	7.48	ef	4.87	a-e	6.17	bc
301p$_{14}$	10.57	abc	13.68	bcd	12.13	abc	8.02	a-e	5.09	abc	6.55	ab
301p$_8$	9.82	de	14.33	ab	12.07	abc	7.56	df	4.58	de	6.06	c
685m	10.86	ab	13.82	bc	12.34	a	7.96	b-d	5.18	ab	6.57	ab
685p$_{11}$	10.20	cd	14.59	a	12.39	a	8.04	a-e	5.00	abc	6.52	ab
774m	10.25	cd	13.57	cd	11.91	abc	7.96	b-e	4.98	abc	6.47	abc
774p$_{15}$	10.04	cde	13.66	bcd	11.85	abc	7.91	b-e	4.90	a-d	6.40	abc
774p$_4$	10.41	bcd	13.44	cd	11.93	abc	7.72	c-f	5.28	a	6.49	abc
774p$_7$	10.58	abc	13.98	abc	12.28	ab	7.87	b-f	4.54	d	6.20	bc
Mean	**10.37**	**B**	13.81	**A**			**7.96**	**A**	**4.86**	**B**		

Means followed by the same small letters in each column are not significantly different (P<0.05).
Means of two cutting managements for each traits in the last row are significantly different (P<0.05).

This can be explained by higher stem/leaf ratio in conservation managements. McGrath (1988) reported that WSC content was at least 50% higher in stem than in leaf.

Figure 3 gives an overall summary of average values for yield and five quality components for each management and year. The data are averaged over populations. Differences between managements and years were significant in almost all analyses. The purpose of these graphs was to show the overall trends in mean values for all traits. For DM yield, the average values of year1 were always higher than year 2 and year 3 (Figure 3). For both managements, the DM yield declined from year 1 to year 3 with average values of 4511, 2720 and 1938 for conservation, and 1684, 1367 and 1396 for frequent cutting management, respectively (Figure 3). For frequent cutting, the annual DM yield was higher in the first year than those in years 2 and 3. But, there was no difference between means of year 2 and 3. For frequent cutting management the ratio of first cut to total annual DM yield were 0.69, 0.70 and 0.62 for year 1 to year 3, respectively (Figure 3). The higher DM yield in the first cut is related to reproductive growth and maximum stem production (Buxton et al., 1996).

Table 5. Mean of ADF and Ash% in 17 populations of tall wreath grass for two cutting managements over three years

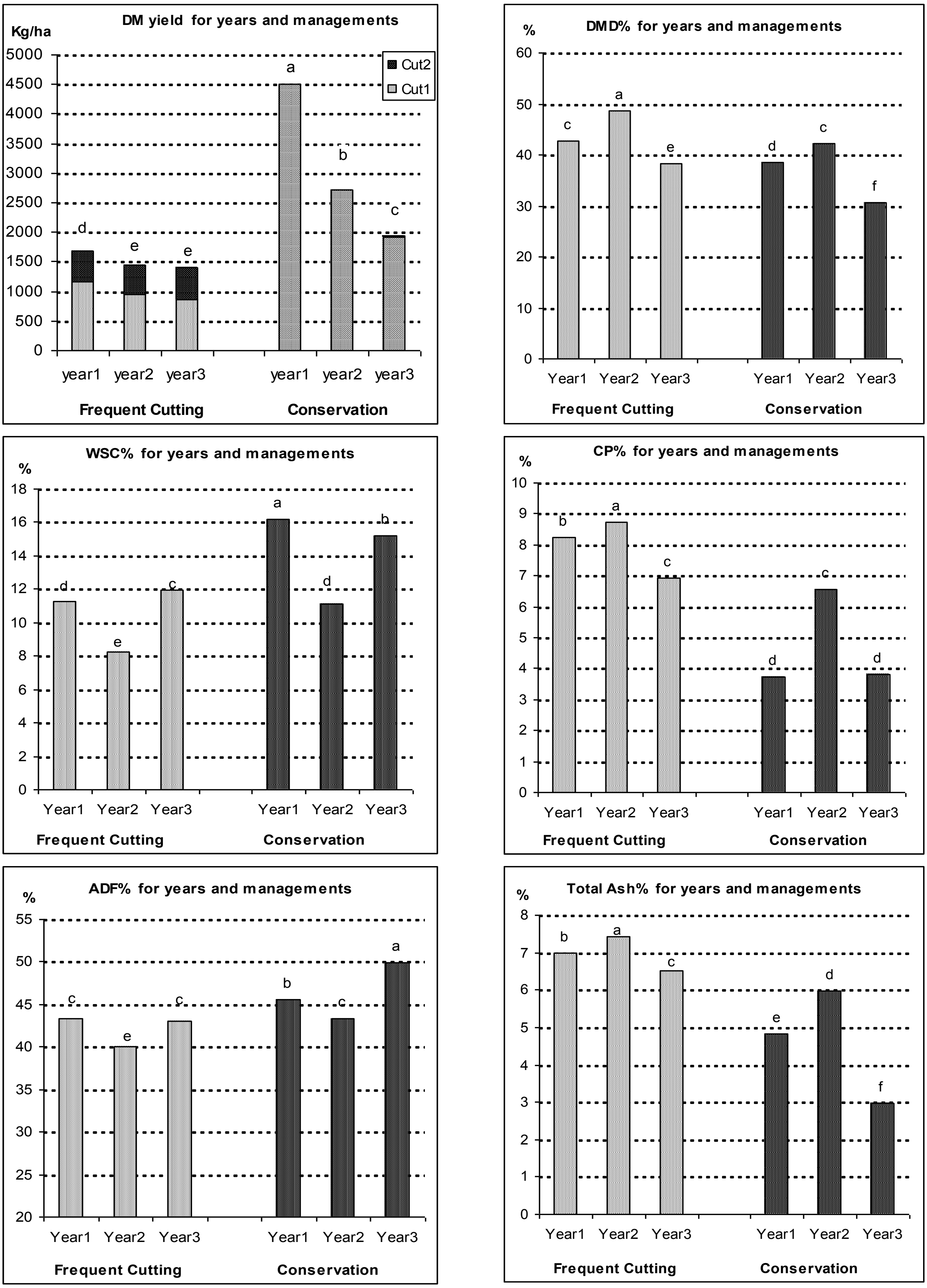
Entry	ADF%						ASH%					
	2 Cuts		1 Cut		Mean		2 Cuts		1 Cut		Mean	
1360m	44.42	a	46.12	ab	45.27	a	7.00	ab	4.71	ab	5.85	abc
1360p_8	42.60	cde	45.13	bcd	43.87	d-g	7.08	abc	4.63	ab	5.85	abc
1755m	43.00	bcd	44.98	cde	43.99	def	6.88	bc	4.85	a	5.86	abc
1755p_4	42.61	cde	44.05	e	43.33	fg	6.75	c	4.71	ab	5.72	bc
240 m	44.19	ab	46.13	ab	45.16	ab	7.31	a	4.65	ab	5.98	ab
240p_{15}	42.76	cde	45.89	abc	44.32	cde	6.96	abc	4.77	ab	5.86	abc
301m	42.77	cde	44.60	de	43.68	efg	7.13	abc	4.76	ab	5.94	ab
301p_1	42.10	de	44.73	de	43.42	fg	7.12	abc	4.76	ab	5.93	ab
301p_{13}	44.05	ab	45.07	cde	44.56	a-d	6.96	abc	4.33	c	5.64	c
301p_{14}	42.96	bcd	44.73	de	43.84	d-g	6.87	bc	4.74	ab	5.80	abc
301p_8	43.55	abc	45.30	a-d	44.42	b-e	6.99	abc	4.47	bc	5.73	bc
685 m	42.91	b-e	45.76	abc	44.34	cde	6.97	abc	4.63	ab	5.80	abc
685p_{11}	43.51	abc	45.10	cd	44.30	cde	6.78	c	4.46	bc	5.62	c
774m	41.67	e	44.65	de	43.16	g	7.17	ab	4.53	bc	5.85	abc
774p_{15}	43.34	a-d	46.31	a	44.82	abc	6.97	abc	4.93	a	5.95	ab
774p_4	44.13	ab	45.94	abc	45.04	abc	7.10	abc	4.65	ab	5.87	abc
774p_7	43.31	a-d	44.48	de	43.90	d-g	7.32	a	4.74	ab	6.03	a
Mean	**43.17**	**B**	45.23	**A**			7.02	**A**	4.67	**B**		

Means followed by the same small letters in each column are not significantly different (P<0.05).
Means of two cutting managements for each traits in the last row are significantly different (P<0.05).

Figure 3 gives an overall summary of average values for yield and five quality components for each management and year. The data are averaged over populations. Differences between managements and years were significant in almost all analyses.

The purpose of these graphs was to show the overall trends in mean values for all traits. For DM yield, the average values of year1 were always higher than year 2 and year 3 (Figure 3). For both managements, the DM yield declined from year 1 to year 3 with average values of 4511, 2720 and 1938 for conservation, and 1684, 1367 and 1396 for frequent cutting management, respectively (Figure 3).

For frequent cutting, the annual DM yield was higher in the first year than those in years 2 and 3. But, there was no difference between means of year 2 and 3. The higher DM yield in the first cut is related to reproductive growth and maximum stem production (Buxton et al., 1996). For frequent cutting management the ratio of the first cut to total annual DM yield were 0.69, 0.70 and 0.62 for year 1 to year 3, respectively (Figure 3).



Means of each years followed by different letters are significantly different (P<0.05).

Figure 3. DM yield and quality traits for each year average over 17 populations of tall wheatgrass under two cutting managements

For both managements the second year values for quality traits were higher than the overall means of years 1 and 3. This was related to the fact that harvest time was early in the second year, and the difference between the years for quality traits were explained by differences in physiological growth stage at the time of cutting.

CONCLUSIONS

The average values of annual DM yield were 1482 and 3053 kg ha^{-1} for two and one cutting managements. Results suggested that two cuts management resulted in lower yield coupled with high quality. Under conservation management, the CP and DMD were decreased in the opposite direction to DM yield, WSC and ADF.

On the basis of presented results, it was suggested that for wheatgrass pasture grazing, delay in spring grazing, preferably in booting stage would improve herbage DM yield and quality in semi-steppic region of Iran. If the aim is to have silage or winter hay, it is suggested to cut the pasture in early stage of ear emergence, to keep herbage quantity and quality at maximum level.

The local population 774m (Takestan) with average values of 1740 and 3837 kg ha^{-1} DM yield had higher production for 2 and 1 cut managements, respectively. The populations 240m (Tabriz) and 301P_{14} (Alborz) had higher values for both yield and quality traits for 2 and 1 cut, management, respectively.

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