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Effects of Different Harvest Time of Crested Wheatgrass Which is in Artificial Range Mixture on Forage Yield and Hay Quality under Central Anatolia Conditions

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Abstract

Information about forage quality, which is influenced by various factors, is essential for determination of grazing capacity. The main objective of this research was investigating effects of phenological stages (seven different cutting times) on values of forage quality indices ofcrested wheatgrass harvested at different times on forage yield and quality of various artificial range mixtures under dry conditions of Central Anatolia during 2007 and 2008 growing season.The samples were collected from Forage Crops Experimental Gardens of the Ankara University, Turkey. They were dried, grained and analyzed against various parameters. The results showed that s forage quality indices values including forage yield, crude protein (CP), acid detergent fiber (ADF), NDF (neutral detergent fiber) and ADL (acid detergent Lignin), Crude Cellulose, Total digestible nutrients (TDN), dry matter intake (DMI), digestible dry matter (DDM) and relative feed value (RFV) had significant interaction ($P<0.01$) between variations cultivars and harvesting times. The results demonstrated that the CP, DMI, DDM, TDN decreased and ADF, NDF, ADL, crude cellulose increased with plant growth development. In terms of growth stage, vegetative growth stage had better forage quality.

Key Words: Acid detergent fiber, Crude protein, Dry matter digestibility, Hay yield, reaping periods

INTRODUCTION

Crested wheatgrass (*Agropyron cristatum* L .Gaertn.), is commonly used to improve the artificial and natural pastures in arid and semi-arid areas of Turkey [1]. *A. cristatum* is a cross-pollinated species (x=7), is a drought adapted and cold resistant cool-season perennial grass, with high productivity and nutritive value for forage and pastures [2]. Rogler and Lorenz [2] claimed that "it is the most successful introduced species in the northern Great Plains and much of the West of the United States."

Agropyron cristatum is one of several closely related grass species referred to as Crested Wheatgrass. It is unable to hybridize with its similar relatives, as it is a diploid species, whereas its closest relative, *A. desertorum*, is a tetraploid species [3]. It was introduced from Russia and Siberia to North America in the first half of the twentieth century, and widely used to reseed abandoned marginal cropland undergoing varying degrees of soil erosion and secondary succession. *A. cristatum* is very long lived, with stands often remaining 30 years more [4]. *A. cristatum* is a densely tufted grass, with culms ranging from 30–50 cm high at maturity. Its sheaths are scabrous or the lowest ones pubescent. Its blades are up to 8 mm wide, and scabrous to pubescent above. Its spikes are flat and range from 2–7 cm long, with spikelets ranging from 8–15 mm long, being 3-5-flowered, densely crowded, and spreading to ascending. Its glumes are 4–6 mm long, awn-tipped, and its lemmas are 6–8 mm long and either awnless or awn-tipped [5].

A. cristatum is best adapted to dry rangeland conditions and is most frequently found in such circumstances. It prefers from 23 to 38 cm of precipitation per year, but can tolerate more moisture on favorable sites, extending its range into tundra and taiga conditions, and elevations up to 2000m above sea level in the southern portions of its adapted area. It prefers well drained, deep, loamy soilsof medium and moderately course texture, including Chernozemic, Solonetzic, Regosolic, Brunisolic and Luvisolic soils. *A. cristatum* can tolerate salinity in the range of 5 to 15 mS/cm and prefers moderately alkaline conditions. It has low to medium fertility requirements. It will not tolerate prolonged flooding.

Artificial range yield is higher than the natural range and produce forage with higher quality. In general, species in mixture are deep-rooted during critical summer period. Forage plant deficit could be decreased by plowing grassland which lost its fertility, by reconstituting the artificial ranges and by producing cheap roughages of good quality. Crested wheatgrass is a long-life, perennial and cool season forage plant. It is one of the most hardy and drought-tolerant plants among the grasses (Poaceae). It grows itself in rangelands in arid and semi-arid regions of Turkey. It grows early in the spring and becomes ready for grazing and the animals eat it willingly. That's the reason why it is in short supply in our rangelands despite the fact that its homeland is Turkey.

On the ground of problems of animal husbandry in Turkey include unavailability of cheap and sufficient amount of animal based products. It was over estimated by considering that the forage breeding could be improved by breeding animals only, therefore, expected results could not be obtained because of the forage deficit. When considering the present resources, it is seen that meadows and ranges have great importance for the provision of roughage. However, yield potential and hay quality of rangelands in Turkey, the large part of which was destroyed as a result of longstanding and improper uses have decreased [6]. Researches made on different ecological zones on rangelands agree that the hay quality varies between 30-90 kg depending on the rates of plant and density of the planted area that vary between10-27% [7]. It was determined in these studies that most of the plants, which formed part of range yield, were thorns, shrubs and weeds and could not be used by animals [8; 9; 10; 11].

Crested wheatgrass is a winter-hardy, long-lived, drought tolerant bunchgrass with a deep, extensive fibrous root system. It resists trampling and close grazing but does not tolerate prolonged flooding or high water tables [12]. Long life and persistence under adverse conditions, strong competitive ability, ease of establishment and high forage productivity have also lead to its widespread use in the Western United States and Canada [2]. Crested wheatgrass is particularly suited to early spring grazing as it produces abundant high quality spring growth from mid-April to mid-June [13; 14]. When this species reaches maturity it becomes unpalatable and quality declines rapidly, which may limit its use to spring and fall grazing; however, crested wheat grass works well in complementary grazing systems that utilize both crested wheat grass and native range or mid to late summer type forages [12].

High quality forages are crucial for the livestock industry. They furnish essential energy, proteins, vitamins, minerals, and fibers. In fact, diets of most domestic livestock consist principally (if not entirely) of forages. The forage digestibility is related to changes in chemical composition, particularly of fiber, lignin and silica contents and crude protein. Its nutritive value is quite high when leafy and young but it falls rapidly with increasing maturity [15].

MATERIAL AND METHODS

Research Area and Characteristics

The Research was carried out at University of Ankara, Faculty of Agriculture, and experimental field of the Department of Field Crops that has altitude 860 m and lies between 39 º 57' north latitude and the 32 º 52' east Longitude.

Total amount of precipitation during 2001, was 437.4 mm which exceeded 383.1 mm over the total rainfall during long years. The average temperature during experimental season was 13.6ºC. The long years average of mean yearly temperature was 11.7ºC.According to rainfall distribution of long years, 2007 has been dry and 2008 has been very dry as well. The soil of research area has clay and loamy structure. According to the analysis, the soil of grassland had high-alkali and mid-calcareous structure. It was rich in potassium (192 kg/da), total salt content in soil is 61%, poor in nitrogen (0.145%) and phosphorus (5.52 kg/da) and insufficient in organic matter (1.05%) [16]. This study was conducted at the University of Ankara, Faculty of Agriculture, and experimental field of the Department of Field Crops on grassland established in 2001 under dry conditions.

Some climatic values of experimental fields;

Precipitation, mm and Temperature, °C (1975-2008)

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Precipitation,mm	41.8	36.9	38.7	49.0	51.2	35.4	14.5	10.9	18.5	30.2	33.9	46.9
Temperature ˚C	0.3	1.8	6.1	11.3	16.1	20.2	23.5	23.3	18.7	13.1	7.1	2.7

Reference: General Directorate of State Meteorology Affairs, Monthly Climatologic Observation Scale [17].

Precipitation, mm (2007-2008)

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
2007	39.0	16.4	37.5	23.8	17.9	31.7	3.9	9.8	0.0	19.7	66.7	44.4
2008	20.1	6.5	54.9	32.7	45.4	10.3	0.0	0.7	61.6	18.6	43.6	28.8

Reference: General Directorate of State Meteorology Affairs, Monthly Climatologic Observation Scale [17].

Temperature, °C

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
2007	1.2	2.5	7.3	9.6	21.0	23.1	27.3	26.7	21.2	14.4	6.8	2.0
2008	-3.9	0.2	10.3	14.0	16.0	22.3	25.2	27.2	20.1	13.3	8.7	2.1

Reference: General Directorate of State Meteorology Affairs, Monthly Climatologic Observation Scale [17].

Other parameters of the study included;

Plant Height

During earing period of *Agropyron cristatum*, main stem length of 5 sampled plants was selected from each plot were measured from soil surface to the longest part of the plant [18].

Hay Yield (kg/da)

500 g samples of fresh matter of each plot were taken and dried at 70°C 24 h in incubator and weighed.

Crude Protein

Dried samples were well ground for chemical analysis. They were ground to pass through the 1 milli metric sieve including nitrogen among organic matters called "crude protein". Crude protein was calculated by multiplying nitrogen value set according to the chemical analysis by 6.25 (16% nitrogen of proteins; 100/16) [19].On ground samples; crude protein rate was calculated using Kjeldahl method after determination of nitrogen.

ADF, NDF, ADL

Fiber analysis was made under laboratory conditions of ADF(Acid detergent fiber), NDF(Neutral detergent fiber) and ADL(Acid detergent lignin) of all samples were done following Ankom technology, [20].

In Analysis of Crude Cellulose

Firstly, forage samples of 3 gr. were boiled with sulphuric acid and potassium hydroxide and then filtered and washed with acetone. After washing, they were kiln-dried and weighed. The differences were computed as crude cellulose and mentioned as percentage [21].

TDN, DMI, DDM and RFV

The values are an indication of hay yield, total digestible nutrients (TDN), dry matter intake (DMI), digestible dry matter (DDM) and relative feed value (RFV), and were obtained following formulas by estimation method [22];

TDN = (-1.291 x ADF) + 101.35

DMI = 120% NDF % dry matter basis

DDM = 88.9-(0.779 x ADF% dry matter basis)

RFV = DDM% x DMI% x 0.775

Samples were analyzed for contents of DM, ash, crude protein (CP), crude fiber (CF), other important quality parameters for forages include concentrations of ADF and NDF [23;24]. NDF (neutral detergent fiber), acid detergent fiber (ADF) and acid detergent lignin (ADL).

The RFV is calculated based on the two laboratory determined parameters, NDF and ADF levels in a forage. The NDF has been used as an indicator of forage intake because it takes into account all fiber components (lignin, cellulose and hemicellulose), the ADF has been used as an indicator of digestibility since it includes cellulose and lignin. Thus together, ADF and NDF take into account the most important traits of a forage, intake potential and digestibility, and are used to calculate RFV.

In experiment, there are 2 levels for year and 7 level for cutting time. Properties obtained by the study were considered with analysis of variance in factorial order (SPSS.20) and Duncan's or LSD test was used to determine difference among the means of the different groups at P<0.05 and 0.01 levels of significance.

RESULT AND DISCUSSION

Plant Height

Year x cutting-time interaction among plant height values was obtained in 7 different cutting time showed significant interaction(P<0.01).

Table 1. Multiple comparisons results of year x cutting - time subgroups in relation to plant height.

Treatment	Years	
	2007	2008
1rdCutting	30.54±0.77 E a	29.30±0.515 F a
2rdCutting	38.44±1.50 D a	36.40±0.70 E a
3rdCutting	54.96±1.95 C a	51.80±1.35 D a
4rdCutting	65.50±3.12 A a	59.80±1.09 C b
5rdCutting	63.98±2.16 A a	65.00±0.87 C a
6rdCutting	59.60±2.14 B b	70.60±0.78 A a
7rdCutting	67.50±1.05 A a	71.20±0.92 A a

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)
Lower-case letters were used for comparisons of years in cutting times subgroups (P<0.01)

As is seen from Table 1, the longest plants were obtained at the last harvest both in the first and the second experimental year. The shortest plants were seen at the first harvest in both experiment years.

Hull [25] has stated in study that height of crested wheatgrass in Fairway variety is 53.3 cm on average and its siblings are 34 cm. In conducted research in order to determine some morphological and agricultural characteristics and flower results are in agreement with Hulls [25] who emphasized that plant height of the crested wheat grass varies by cultivation period, cultivating practice and its variety.

Hay Yield

Year x cutting-time interaction among hay yield values was obtained in 7 different cutting time showed significant interaction (P < 0.01)

Maximum hay yield was obtained as 82.80 kg at 3rd cutting time among cutting periods. Hay quantity of crested wheatgrass in the second experimental year was higher than the first year (except the 3rd cutting time).

Table 2. Multiple comparisons results of year x cutting-time subgroups in relation to hay yield (kg/da)

Treatment	Years	
	2007	2008
1rdCutting	49.60±1.94 Ca	57.90±0.51Da
2rdCutting	50.80±2.58 Cb	62.50±0.96 Da
3rdCutting	82.80±8.26 Aa	75.80±1.38 Ca
4rdCutting	76.0±3.22 Aa	81.90±1.48 Ca
5rdCutting	72.8±7.96 ABa	86.90±1.35 BCa
6rdCutting	71.8±5.46 ABb	96.40±1.43 ABa
7rdCutting	62.4±4.96 Bb	99.20±1.39 Aa

Capital letters were used for comparisons of cutting-time in year subgroups. (P<0.01)
Lower-case letters were used for comparisons of years in cutting times subgroups (P<0.01)

Defoliation frequency is a major management factor that strongly affects the DM production [26] and nutritive value [27] of forage grasses by changing the morphology and physiology of plants [28]. Generally, increasing the number of cuts has a beneficial effect on nutritive value of many grass species [29]. However, their response to defoliation frequency as far as the DM production is concerned, differs. *Dactylis glomerata*, *Festuca arundinacea, Holcus lanatus* [29] and *Festuca rubra* [30] displayed significant reductions in DM production in response to an increase in defoliation frequency. On the contrary, *Lolium perenne* and *Poa trivialis* show an increase in their DM production slightly after 6 cuts per year compared to 3 cuts per year [29]. Similarly, frequent defoliation increased the DM production of *A. cristatum*, but only during the first harvest year [31].

ADF

Year x harvest-time interaction among ADF values was obtained in 7 different cutting time showed significant interaction (P < 0.01).

Table 3. Multiple comparisons results of year x cutting-time subgroups in relation to ADF

Treatment	Years	
	2007	2008
1rdCutting	33.63±0.39 Fa	32.94±0.33 Ga
2rdCutting	34.94±0.42Ea	35.00±0.30 Fa
3rdCutting	35.84±0,35 Eb	37.85±0.48 Ea
4rdCutting	38.25±0.29 Db	39.52±0.27 Da
5rdCutting	40.86±0.20 Ca	41.63 ±0.29 Ca
6rdCutting	44.03 ±0.53 Ba	44.60±0.32 Ba
7rdCutting	46.05±0.34 Ab	47.25±0.40 Aa

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)
Lower-case letters were used for comparisons of years in cutting times subgroups (P<0.01)

This study evaluated and compared the ADF differences among harvest periods and aging of plants. It was noted that ADF values increased linearly. Despite very close ADF value 33.63 during 2007 and 32.94 during 2008 when the plant were young, these values reached maximum to46.05 and 47.25 at the last harvest.

These values give an outline of forage quality and shows that digestibility and energy value of forages with high ADF content are low. The ADF concentration refers to the cell wall portions of the forage. These portions consist of cellulose and lignin. The ADF values are important because they describe the ability of an animal to digest the forage. With increase of ADF values, the digestibility of the forage decreases.

NDF

Year x cutting-time interaction among ADF values was obtained in 7 different cutting time showed significant interaction (P < 0.01).

Fibrous carbohydrates (cellulose and hemicellulose) of cell wall in samples analyzed were lignified that resulted in damage to certain proteins by temperature and parts containing silicium. NDF value gave an outline of forage volume and roughness. NDF content forages were of high quality per volume. The NDF value refers to the total cell wall, composed of the ADF fraction plus hemicellulose.

Table 4. Multiple comparisons results of year x cutting-time subgroups in relation to NDF

Treatment	Years	
	2007	2008
1rdCutting	48.65 ± 0.36 Ea	48.59± 0.25 Ga
2rdCutting	50.13±0.41 Da	50.08±0.35 Fa
3rdCutting	50.52±0.52 D	52.07±0.12 E
4rdCutting	56.47±0.34 Ca	55.67±0.60 Da
5rdCutting	59.95±0.32 Ba	60.09±0.29 Ca
6rdCutting	62.07±0.41 Aa	62.79±0.50 Ba
7rdCutting	62.37±0.28 Ab	64.57±0.23 Aa

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)
Lower-case letters were used for comparisons of years in cutting times subgroups (P<0.01)

As determined at ADF value, with the passing of harvest periods, it is seen that NDF values and maturity of plant increase linearly as well. Maximum NDF value was noted at 7rd harvest during both experiment years.

Generally, extent of digestion of legume NDF was lower compared to grass because of lower cell content and higher lignification of the farmer [33].

However, of all available analyses, forage quality is adequately predicted by neutral detergent fiber (NDF) test, since NDF is related to intake, rumination and cud-chewing stimulus, as well as to the energy value of forage. Taken together, these characteristics define the key aspects of forage quality [34].There exist large differences between forages in the cell wall content and their individual fractions [cellulose, hemicellulose and lignin] which affect the rumen degradability of available nutrients [35; 36].

Other important quality characteristics for forages are the concentrations of NDF and ADF [37; 38]. Furthermore, increased defoliation frequency reduced the NDF, ADF and ADL contents during both harvest years.

ADL

Cutting-time interaction among ADL values was obtained in 7 different cutting time showed significant interaction (P < 0.01).

Table 5. Multiple comparisons results of cutting-time subgroup in relation to ADL

Cutting Times	
1rdCutting	2.99 ±0.08 F
2rdCutting	3.28 ±0.09 F
3rdCutting	3.64 ±0.10 E
4rdCutting	4.48 ±0.11 D
5rdCutting	5.79 ± 0.17 C
6rdCutting	7.11 ±0.06 B
7rdCutting	7.46 ±0.05 A

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)

Tendency seen at ADF and NDF values was determined at ADL value that was very low when the plant was young during first harvest, it increased by the maturation of the plant. Dardanne et al. [39] confirms that the lignin content (ADL) is the best predictor of the organic matter digestibility.

Crude Cellulose

Harvest-time interaction among Crude Cellulose values was obtained in 7 different cutting time showed significant interaction (P < 0.01).

Table 6. Multiple comparisons results of cutting-time subgroup in regard to Crude Cellulose

Cutting Times	
1rdCutting	23.10 ± 0.10 F
2rdCutting	23.41 ±0.13 F
3rdCutting	24.32 ±0.15 E
4rdCutting	27.07 ±0.23 D
5rdCutting	30.15 ±0.33 C
6rdCutting	33.28 ±0.13 B
7rdCutting	35.32 ±0.28 A

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)

As such at ADF, NDF, ADL values, crude cellulose value increased progressively by aging of the plant and reached maximum value of 35.32 at 7rd cutting-time.

Crude protein content in forage is decreasing with increasing physiological age of plants. Buchgraber and Resch [40] described the development of crude protein content of forage from different grassland types and stated that protein contents declined from about 200 g/kg DM at the vegetation stage "shooting" to 70 to 90 g/kg DM for mature forage.

Crude Protein

Cutting-time interaction among Crude Protein values was obtained in 7 different cutting time showed significant interaction (P < 0.01).

Table 7. Multiple comparisons results of cutting-time subgroup in regard to crude protein

Cutting Times	
1rdCutting	15.82 ± 0.19 A
2rdCutting	14.92 ±0.12 B
3rdCutting	12.82 ±0.30 C
4rdCutting	9.22 ±0.27 D
5rdCutting	7.98 ±0.14 E
6rdCutting	7.14 ±0.18F
7rdCutting	6.09 ±0.12

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)-

Crude protein value which is very high at seedling phase decreases rapidly by maturation. Analysis of crude protein values could show the level of maturation of cell walls, especially after flowering period with the aging of plant, that decrease crude protein values.

Acikgoz [41] has emphasized that noted some morphological and agronomic characteristics and flower biology of crested wheatgrass in Fairway variety under Ankara conditions and emphasizes that crude protein ratio varies between 9.96-19.59% at full earing period.

Abiusso [42] emphasized that dry matter ratio is between 89.3-92.4%; crude protein ratio is 11.3-27.7% in crested wheatgrass under non-fertilized conditions of Argentina.

The frequent defoliation improved the herbage nutritive value due to increased CP and reduced NDF, ADF and ADL concentrations. Generally the CP concentration of Agropyron species is high during the early stages of development [43]. This CP concentration was higher compared to mean CP concentration of forage grasses (115 g kg–1 DM) [44] and sufficient for small ruminant's demands (maintenance and lactation) [45; 46].

TDN

Cutting-time interaction among TDN values was obtained in 7 different cutting time showed significant interaction (P < 0.01).

The TDN refers to the nutrients that are available for livestock. This variable is related to the ADF concentration of the forage. As ADF increases, TDN declines. As a result, animals are unable to utilize the nutrients that are present in the forage [22].

The TDN refers to the nutrients that are available for livestock and are related to the ADF concentration of the forage. As ADF increases there is a decline in TDN which means that animals are not able to utilize the nutrients that are present in the forage [47]. The lowest values for increased TDN in wheatgrass are attributed to the high amount of ADF.

Table 8. Multiple comparisons results of cutting-time subgroup in relation to TDN

Cutting Times	
1rdCutting	57.93±0.50 A
2rdCutting	56.25±0.54 B
3rdCutting	55.08±0.45 B
4rdCutting	51.97±0.37 C
5rdCutting	48.60±0.25 D
6rdCutting	44.51±0.68 E
7rdCutting	41.90±0.44 F

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)

Voluntary intake of fodder is the primary factor for higher productivity. The higher dry matter intake is related to better voluntary intake and thereby higher nutrient intake. The intake is higher for legumes compared to non-legumes and for immature compared to mature forages. Digestibility mainly depends upon the availability of the total digestible nutrients (TDN).

DMI

Year x cutting-time interaction among DMI values was obtained in 7 different cutting time showed significant interaction (P < 0.01).

Table 9. Multiple comparisons results of year x cutting-time subgroups in relation to DMI

Treatment	Years	
	2007	2008
1rdCutting	2.47±0.019 Aa	2.47±0.013 Aa
2rdCutting	2.39±0.020 Ba	2.40±0.017 B
3rdCutting	2.38±0.025 B	2.30±0.005 C
4rdCutting	2.13±0.013 C	2.16±0.024 D
5rdCutting	2.00±0.010 D	2.00±0.001 E
6rdCutting	1.93±0.013 E	1.91±0.015 F
7rdCutting	1.92±0.010 E	1.86±0.007 G

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)

The NDF is used to predict DMI and is negatively correlated with DMI, which means that when NDF is high the quality and the DMI are low [48]. A similar trend was observed for the RFV.

Lower-case letters were used for comparisons of years in cutting times subgroups (P<0.01)

DDM

Year x harvest-time interaction among DDM values was obtained in 7 different cutting time showed significant interaction (P < 0.01).

Table 10. Multiple comparisons results of year x cutting-time subgroups in relation to DDM

Treatment	Years	
	2007	2008
1rdCutting	62.70±0.301 Aa	63.241±0.260 Aa
2rdCutting	61.68±0.328 Ba	61.63±0.233 Bb
3rdCutting	60.98±0.274 Ba	59.42±0.375Cb
4rdCutting	59.10±0.226 Ca	58.12±0.211Db
5rdCutting	57.07±0.153 Da	56.47±0.110Ea
6rdCutting	54.60±0.414Ea	54.12±0.246Fa
7rdCutting	53.03±0.265 Fa	52.09±0.309 Fb

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)
Lower-case letters were used for comparisons of years in cutting times subgroups (P<0.01)

RFV

Year x cutting-time interaction among RFV values was obtained in 7 different cutting time showed significant interaction (P < 0.01).

The RFV is an index that is used to predict the intake and energy value of forages. This index is derived from the DDM and dry matter intake (DMI). Forages with an RFV value over 151, between 150-125, 124-103, 102-87, 86-75, and less than 75 are categorized as prime, premium, good, fair, poor and rejected, respectively [49].

The NDF is used to predict DMI and is negatively correlated with DMI, which means that when NDF is high quality and DMI are low [48]. A similar trend was observed for the RFV. The RFV is an index that is used to predict the intake and energy value of the forages and is derived from DDM and DMI. Forage with an RFV value >151 is considered prime [48].

Table 11. Multiple comparisons results of year x cutting-time subgroups in relation to RFV

Treatment	Years	
	2007	2008
1rdCutting	119.94±1.39 Aa	121.07±0.652 Aa
2rdCutting	114.52±1.53 Ba	114.52±1.13Ba
3rdCutting	112.35±1.61 Ba	106.15±0.712Cb
4rdCutting	97.38±0.923 Ca	97.141±0.838Da
5rdCutting	88.57±0.631 Da	87.432±0.483Ea
6rdCutting	81.85±1.14 Ea	80.256±0.947Fa
7rdCutting	79.101±0.651Ea	75.058±0.672 Ga

Capital letters were used for comparisons of cutting times in year subgroups. (P<0.01)
Lower-case letters were used for comparisons of years in cutting times subgroups (P<0.01)

Relative Feed Value has been widely used in ranking forage for sale, inventory purpose and allocating forage lots to animal groups according to their quality needs, and determining the cutting time. Relative feed value continue to be widely used as an index to assess quality, compare forage varieties, and fix price of forages. However, differences in the digestibility of the fiber fraction can result in a difference in animal performance when forages with similar RFV indices are fed.

CONCLUSION

By this experiment on crested wheat grass at 7 different cutting times, which the variation of hay quality of forage is studied in conditions of Ankara, stated that mainly hay quality of forage and nutritional value, how the plant depends on the harvest date would be provided at the animal performance with a proper harvest date by going with the phonological periods of the plant. This study suggests that Phenological stage of growth had a significant influence on forage quality. The close matching of nutrient requirements and feed quality is necessary for efficient animal production. Higher forage quality was recorded at the 1st stage of growth.

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