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Effects of Fall Dormancy and Cutting Times on Alfalfa's Forage Yield and Quality Components Under Central Anatolian Conditions

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Abstract

The aim of this research was to investigate the effects of phenological stages (five diffrent cutting time) on values of forage yield and quality of Alfalfa. Bilensoy, Kayseri, Gözlü and Plato cultivars were used as dormant and Elci, Mırna, MA-414 and Posovina cultivars were used as non-dormant cultivars. All samples were collected from the Research Field of Ankara University in Ankara and were analyzed in laboratory after being dried and grained. The results showed that forage quality indices values including hay yield, green herbage yield, crude protein (CP) and crude cellulose were significantly different at a level of P< 0.01, among the varieties used and their different cutting times. Plato variety had highest green herbage yield with 777.5kg/da in 2007and crude cellulose rate with33.29%. Maximum crude protein rate was observed from Kayseri with 21.44% and maximum hay yield was observed from MA-414 with 181.5 kg/da in 2008. In the sense of growth stage, vegetative growth stage was found the best forage quality.

Keywords: Hay yield, green herbage yield, growth stage, crude protein, crude cellulose

INTRODUCTION

Alfalfa, the queen of forages, is the main legume used for livestock feed in Turkey. It is also one of the most commonly used legumes for both hay and pasture in Turkey because of its high yield, high nutritional quality, ability to fix nitrogen and vigorous fall regrowth [1].

Fall Dormancy (FD) of a variety is an important predictor of quality. For instance, more dormant varieties are almost always higher in quality. Cutting frequency (CF) or cutting time of alfalfa is a key factor for effecting both productivity and persistence [2]. Fall dormancy (FD) is defined as the reduction in shoot growth in autumn due to decreasing temperature and day length [3] and it is a useful trait that defines alfalfa adaptation to different regions. For instance, while FD scores of 1-4 are seen in colder regions, FD scores of 5-7 are typical for mild temperate regions 7-9 for warmer and Mediterranean regions and 8-11 for hot desert zones. Dormant cultivars have reduced shoot elongation and decumbent shoot orientation in autumn and are very winter hardy [4]. Nondormant cultivars have extensive shoot elongation with a vertical orientation in autumn and usually poor winter survival. Nondormant cultivars are desirable by the reason of higher shoot growth rates and faster maturity after cutting when compared to dormant cultivars [5], [6]. Hence, nondormant cultivars could result in higher forage yield, and there has been interest in using less fall-dormant cultivars in regions with mild winters [7].

This research's aim is determine changes of forage yield and some quality parameters of alfalfa (*Medicagosativa* L.) cultivars which have different dormant levels and different cutting times.

MATERIAL and METHOD

The study was carried out in experimental fields (860 meters, 39º 57' N, 32 º 52' E) of Ankara University, Faculty of Agriculture, Department of Field Crops. A total of 8 cultivars, Bilensoy, Kayseri, Gözlü and Plato cultivars as dormant and Elci, Mırna, MA-414 and Posovina cultivars as non-dormant cultivars, were included in the study. The dormant cultivars are suitable for winter while those considered as non-dormant are suitable for summer.

The average temperature was 13,6 ºC during the experimental season and 11,7 ºC for as long years average. The soil within the study area has a clay and loamy structure. The analysis of the grassland showed that the soil here has high-alkali and mid-calcareous structure and is rich in potassium. Total salt content in soil (EC) is 0,19dS/m and it is poor in nitrogen (0.145%) and phosphorus (5.52 kg/da) and is insufficient in organic matter (1.05%).

Meteorological values of the experimental area are presented in Table 1, 2 and 3 [8].

Table 1. Precipitation and temperature data for the study area from 1975 to 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

Table 2. Precipitation (mm) for 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

Table 3. Temperature (°C) for 2007-2008.

	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

All the study material was planted on 10 March 2005 in parcels each covering an area of 17,5 m^2 (5 m x 3,5 m) as 3 repetitions in a random parcel selection. In each parcel 5 lines were placed to leave 70 cm space between two lines. Planting was performed by hand in the manner that 3 kg Alfalfa seeds were in one – tenth of a hectare. Samples were obtained by cutting the Alfalfa on 5 different dates (Table 4) during the study period and irrigation was applied to the growingplants following every cutting.

Table 4. Dates of harvest times and definition of stage of maturity of alfalfa (2007-2008)

Harvest Dates	Stage Of Maturity
April 14- 2007; April 18 -2008	Vegetative, young growth
April 30- 2007; April 25-2008	Young growth; formation of flower Pre-buds
May 09- 2007; May 02- 2008	End of flower budding up to beginning of blooming
May 11- 2007; May 14- 2008	Beginning of blooming (1/10 Bloom)
June 13- 2007; June 13- 2008	Beginning of blooming up to full blooming

Other parameters of the study included;

Green Herbage Yield (kg/da)

In blossoming period, resting area was harvested and measured after one line from plot sides. Then acquired value was turned into kg/da.

Hay Yield (kg/da)

Fresh matter's taken from each plot. Fresh matter is determined 500 gr for this research. Then, they are dried at 70 °C for 24 h in an incubator and then each samples weighted.

Crude Protein

Dried samples analyzed for crude protein and dried samples of 1 gr were used for analysing. Crude protein was calculated by multiplying nitrogen value set in accordance with the chemical analysis by 6.25 [9].

Crude Cellulose

Forage samples of 3 gr, which is taken and dried from each plots, were boiled with sulphuric acid and potassium hydroxide. Then, they filtered and washed with acetone. After washing, they were kiln-dried and weighed. The differences were measured as crude cellulose and were given as percentage [10].

RESULTS

Green Herbage Yield and Hay Yield

As it is shown in Table 5, year x cutting time x cultivars interaction was considered statistically significant at 0.01 level and the maximum green herbage yield was determined in Plato cultivar with 775,5 kg in the first cutting time in 2007.

As it is shown in table 6; the maximum hay yield was obtained on MA-414 with 181.5 kg/da in 1rd cutting time in 2008, whereas minimum hay yield was determined on Plato with 69.5 kg/da in 5rd cutting time in 2007.

Table 5. Multiple comparison results relating to subgroups of year x cutting time x cultivars in terms of green herbage yield (Kg/da)

Years	Cultivars	1rd cutting	2rd cutting	3rd cutting	4rd cutting	5rd cutting
2007	1. Bilensoy	627.5±57.8Ca$_{b}$	642.5±36.4 ABa$_{a}$	552.5±61.4 Ab$_{a}$	419.5±25.7 BCc$_{a}$	385.5±16.8 Ac$_{a}$
	2. Gözlü	683.5±29.7 BCa$_{a}$	615.5±34.6 BCb$_{a}$	413. 0±44.7 Bc$_{a}$	425.0±22.5BCc$_{a}$	370±24.5Ac$_{a}$
	3. Kayseri	703.5±21.5ABa$_{a}$	567.5±13.8 CDb$_{a}$	582.0±23.1Ab$_{a}$	449.0±16 BCc$_{a}$	413±19.1 Ac$_{a}$
	4. Plato	777.5±8.21Aa$_{a}$	707.3±14.7Ab$_{a}$	613.5±5.74 Ac$_{a}$	491.5±26.8 ABd$_{b}$	369.5±18 Ae$_{a}$
	5. Elci	684.0±14.6 BCa$_{a}$	525.8±41.3 Db$_{b}$	432.0±38.8 Bc$_{a}$	381.5±13.1 Cc$_{a}$	407.5±8.22 Ac$_{a}$
	6. MA 414	728.5±30.2ABa$_{a}$	653.3±17.5ABb$_{a}$	616.5±15.2 Ab$_{a}$	488.0±16 ABc$_{b}$	394.5±20 Ad$_{a}$
	7. Mırna	713.5±22.1ABa$_{a}$	676.5±19.7ABa$_{a}$	542.8±21.7Ab$_{b}$	418.5±4.99 BCc$_{b}$	373.5±22 Ac$_{a}$
	8.Posovina	750.3±19.3ABa$_{a}$	717.5±30,4Aa$_{a}$	598.5±26.7Ab$_{a}$	523.5±32.1Ac$_{a}$	364.0±27.6 Ad$_{a}$
2008	1.Bilensoy	700.3±22.1 Aa$_{a}$	598.8±4.27 Cb$_{a}$	503.8±16.0 CDc$_{a}$	371.8±10.7 Dd$_{a}$	315.0±13.2 BCd$_{b}$
	2. Gözlü	691.5±18.8 Aa$_{a}$	628.3±15.3 ABCa$_{a}$	483.3±8.87 Db$_{a}$	398.3±18.8 Dc$_{a}$	247.0±15.2 Cd$_{b}$
	3. Kayseri	731.5±11.3 Aa$_{a}$	633.3±12.6 ABCb$_{a}$	558.3±28.4 BCc$_{a}$	473.3±25.5 Cd$_{a}$	310.8±24.2 BCe$_{b}$
	4. Plato	743.3±20.7 Aa$_{a}$	677.5±11.7 ABab$_{a}$	668.0±3.72 Ab$_{a}$	623.8±14.5 Ab$_{a}$	421.8±69.7 Ac$_{a}$
	5.Elci	698.8±17.1 Aa$_{a}$	606.3±6.57BCb$_{a}$	496.3±21.6 CDc$_{a}$	392.5±14.9 Dd$_{a}$	261.3±7.47 Ce$_{b}$
	6. MA 414	739.3±12.7 Aa$_{a}$	683.3±9.37 Aab$_{a}$	634.5±26.1 Abc$_{a}$	598.3±7.22 ABc$_{a}$	360.8±12 ABd$_{a}$
	7. Mırna	740.8±7.26 Aa$_{a}$	667.3±5.54 ABCb$_{a}$	619.3±19.2 ABb$_{a}$	610.5±10.0 ABb$_{a}$	362.3±34.3 ABc$_{a}$
	8.Posovina	750.5±17.5 Aa$_{a}$	698.8±8.64 Aa$_{a}$	610.0±11.4 ABb$_{a}$	547.5±28.9 Bb$_{a}$	342.5±51.7 Bc$_{a}$

Capital letters were used in comparing cultivars in subgroups of year x cutting (P< 0,01) .
Small letters were used in comparing cutting time in subgroups of year x cultivars.
Subscripts were used in comparing years in subgoups of cultivars x cutting.

Table 6. Multiple comparison results related to subgroups of year x cutting x cultivars in terms of hay yield (Kg/da)

Years	Cultivars	1rd cutting	2rd cutting	3rd cutting	4rd cutting	5rd cutting
2007	Bilensoy	137.5±21.2 Bab$_a$	142.50±18.0 Bab$_a$	149.50±27.5 Aa$_a$	123.50±6.99 ABb$_a$	87.50±8.22 ABc$_a$
	Gözlü	166.75± 4.27 Aa$_a$	154.25±4.91 ABa$_a$	113.00±6.86 BCb$_a$	126.50±9.22 ABb$_a$	78.50±8.26 Bc$_a$
	Kayseri	164.00± 7.26Aa$_a$	133.50±6.18 Bb$_a$	127.25±4.07 ABbc$_a$	104.25±2.95 Cc$_a$	106.50±6.59 Ac$_a$
	Plato	180.00±5.73Aa$_a$	143.50±9.22 Bb$_a$	109.25±3.47 BCc$_b$	85.75±5.66 Cd$_b$	69.50±1.71 Bd$_a$
	Elci	160.00± 6.68 Aa$_a$	110.50±7.84 Cb$_a$	101.00±8.74 Cbc$_b$	96.75±4.96 Cbc$_a$	85.50±8.81 ABc$_a$
	MA 414	168.50± 6.14Aa$_a$	138.8±11.8Bb$_b$	113.00±5.40 BCc$_b$	95.75±2.32 Ccd$_a$	83.25±3.90 ABd$_a$
	Mırna	173.00±4.12Aa$_a$	153.00±153.0 ABa$_a$	116.00±2.16 BCb$_a$	98.50±6.01 Cbc$_a$	82.50±4.99 ABc$_a$
	Posovina	175.50±9.07Aa$_a$	174.75±9.46 Aa$_a$	122.50±8.85 BCb$_a$	135.00±5.80 Ab$_a$	87.0±18.2ABc$_a$
2008	Bilensoy	159.8±12.0 ABa$_a$	120.25±2.78 Cbc$_a$	126.50±6.91 Ab$_b$	113.50±3.50 Abc$_a$	101.75±2.39 Ac$_a$
	Gözlü	150.50±12.7 Ba$_a$	127.00±8.40 BCb$_b$	118.75±3.09Ab$_a$	112.75±4.59 Ab$_a$	84.25±4.39 ABc$_a$
	Kayseri	173.00±8.69 ABa$_a$	126.00±6.12 BCb$_a$	126.00±7.13Ab$_a$	112.75±4.42 Ab$_a$	77.50±8.41 ABc$_b$
	Plato	172.25±5.84 ABa$_a$	149.00±2.04 ABb$_a$	134.75±4.91 Abc$_a$	114.00±5.31 Ac$_a$	89.50±7.93 ABd$_a$
	Elci	158.0±12.0 ABa$_a$	130.75±7.66 BCba$_a$	131.75±6.17 Ab$_a$	114.00±3.29 Abc$_a$	93.75±2.46 ABc$_a$
	MA 414	181.50±5.95 Aa$_a$	165.75±3.20 Aa$_b$	137.00±11.0Ab$_a$	113.75±3.47 Ac$_a$	70.00±2.12 Bd$_a$
	Mırna	174.25±2.87 ABa$_a$	157.00±2.00 Aa$_a$	131.25±4.23 Ab$_a$	113.75±4.91 Ab$_a$	82.25±6.07 ABb$_a$
	Posovina	171.75±9.63 Aa$_a$	157.50±3.66 Aa$_a$	126.75±3.57 Ab$_a$	105.00±2.86 Abc$_a$	83.75±7.92 ABbc$_a$

Capital letters were used in comparing cultivars in subgroups of year x cutting((P< 0,01) .
Small letters were used in comparing cutting time in subgroups of year x cultivars.
Subscripts were used in comparing years in subgroups of cultivars x cutting.

Crude Protein

When crude protein rates were examined, year x cutting time interaction was determined at 0.01 significance level. In both 2007 and 2008, an increase in crude protein rate was observed until the third cutting time and the minimum crude protein rates were obtained in the fifth cutting time (15.40 and 15.08).

Maximum crude protein was obtained from 3rd cutting time in 2007 and 2008 (Table 7.). Then it was decreased and minimum crude protein was observed 5rd cutting times in 2007 and 2008. A highest protein rate was obtained in Kayseri with 21.44 %and Bilensoy with 21.29 %. This case can be seen as the result of nutrition components which are stored in plants causing more protein accumulation in dormant cultivars.

Table 7. Multiple comparison results related to subgroups of year x cutting time in terms of crude protein rate

Years	1rdcutting	2rdcutting	3rdcutting	4rdcutting	5rdcutting
2007	17.32±0.29C	18.39± 0.33B	19.38±0.37 A	16.91±0.33 D	15.40±0.24 E
2008	17.42± 0.31 C	18.47±0.33 B	19.54± 0.34 A	16.70± 0.33D	15.08±0.26 E

Capital letters were used in comparing cultivars in subgroups of year x cutting. (P<0.05)

[11] were determined that CP content decreased with increasing maturity. Besides, the protein value of forages is relevant to the stage of maturity [12],because of its effects on microbial synthesis and site of digestion [13].

Table 8. Multiple comparison results related to subgroups of cutting time x cultivars in terms of crude protein rate

Cultivars	1rdcutting	2rdcutting	3rdcutting	4rdcutting	5rdcutting
1.Bilensoy	19.62±0.07A	21.04±0.09 A	21.29±0.12 A	16.63±0.13 D	14.47±0.15C
2. Gözlü	17.60±0.11 DE	18.47±0.08 D	19.22±0.11	16.09± 0.10 E	14.80±0.16 C
3. Kayseri	18.66±0.11	19.16±0.09 C	21.44±0.33 A	18.85± 0.27 B	16.98±0.14 A
4. Plato	14.14±0.36 G	14.51±0.07 F	15.23±0.21 E	13.62±0.11 F	12.78±0.12 D
5.Elci	18.10±0.27 C	19.79±0.18 B	20.10±0.22 B	16.02±0.19 E	14.74±0.23 C
6. MA 414	15.78±0.10 F	17.37±0.12 E	18.49±0.09 D	15.90±0.09 E	15.41±0.10 B
7. Mırna	17.51±0.12 E	18.42±0.09 D	18.94±0.10 CD	17.49±0.10 C	15.52±0.17 B
8.Posovina	17.93±0.11 CD	18.67±0.12 D	20.97±0.19 A	19.86±0.22 A	17.22±0.25 A

Capital letters were used in comparing cutting time in subgroups of cutting time x cultivars. (P<0.05)

Crude Cellulose

In Table 9, the grouping of statistical diversity of crude cellulose rate was presented. While Gözlü and Plato cultivars were located in the first group with the maximum crude cellulose rate, the minimum crude cellulose rate was measured in Posovina cultivar with 31.61 rates.

In Table 10, the interaction between years x cutting time was considered to be significant at 0.05 level. In both 2007 and 2008, while the crude cellulose rate, which was obtained in the first cutting time, was found to be low, there was an increase in crude cellulose rates as the plants grow up.

Table 9. Multiple comparison results related to subgroups cultivars in terms of crude cellulose rate

1.Bilensoy	2.Gözlü	3.Kayseri	4.Plato	5.Elci	6.MA	7.Mırna	8.Posovina
31.89±0.22 F	33.20± 0.21 A	32.49± 0.22 D	33.29± 0.22A	32.17± 0.22 E	32.63±0.21 C	32.87±0.22 B	31.61±0.21 G

Capital letters were used in comparing cutting times in subgroups of cutting. (P<0.05).
Small letters were used in comparing years in subgroups of year. (P<0.05)

Table 10. Multiple comparison results related to subgroups years x cutting time in terms of crude cellulose rate.

Years	1rdcutting	2rdcutting	3rdcutting	4rdcutting	5rdcutting
2007	30.89±0.12Ea	31.49±0.11Db	32.68±0.11Ca	33.44±0.10Bb	33.89±0.11Ab
2008	29.87± 0.13Eb	32.19± 0.11Da	32.84±0.11Ca	33.74±0.10Ba	34.16±0.10Aa

Capital letters were used in comparing cutting times in subgroups of cutting. (P<0.05).
Small letters were used in comparing years in subgroups of year. (P<0.05)

CONCLUSION

Cutting at the pre-bud and bud stage produces a higher quality forage than at later stages. However, repeatedly cutting at early stages reduces root reserves which results in poor stands and lower yields.The last cutting of the year might determine how well the alfalfa will perform the next year. It was determined that the varieties' (dormant and non-dormant) crude protein rates increased until the third cutting time and then started to decrease.

Forage yield, quality and stand persistence are affected by the cutting times. Forage yield increases until the plant reaches full flower, while forage quality decreases during growth. Cutting for high quality will reduce total season yield, so one must ensure that the high quality will produce a return to offset the yield loss. Therefore, using a forage quality stick, or measuring forage height and plant stage (as described later) is crucial in determining the time of the first cutting in order to harvest alfalfa of the desired quality. The stage to alfalfa for optimum forage quality for dairy cattle ranges from the vegetative to early bud stage on first cutting and is generally at bud stage on later cutting. Later stages may be harvested for animals' nutritional requirements.

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