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The Effects of Different Reaping Periods on Different Lesser Burnet Cultivars to the Feed Efficiency and Herbage Yield under Conditions of Central Anatolia

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Abstract
Influenced by various factors information of herbage yield is essential for determination of grazing capacity. The main objective of this research was investigation on effects of phenological stages (six diffrent cutting time) on values of forage quality indices of *Sanguisorba minor* Cv. Altınova, Bunyan and Gozlu used as materials. 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 that showed that green grass yield indices values including fodder yield, crude protein (CP), Crude Cellulose, were significantly ($P<0.01$) different cultivars and six different cutting time. CP decreased for all cultivars, whereas, crude cellulose increased with plant growth development. Considering forage quality indices values among three cultivars, cv. Altınova had highest forage quality. In terms of growth stage, vegetative growth stage had better forage quality.

Keywords: **Reaping periods; Sanguisorba; Crude protein; Digestible protein; Dry matter digestibility**

INTRODUCTION

Due to of obtaining large portion of the nutrient needs of animals from natural meadow pastures and rangelands, excessive and irregular grazing, and grazing starting from early periods until the freezing winter cold for many years, the yield capacity of rangelands has decreased and some pastures as Central Anatolia could have vegetation on only % 10-12 of its surface. The amount of hay produced in Turkish pastures is dependent on the climatic conditions. Rangeland grass yield is greatly reduced during dry years. Covered vegetation plants

are largely composed of Artemisia fragran, Thymus squarrosus, Astragalus sp., e.g. which have low nutritional value in pastures of Central Anatolia; where it is almost impossible to find green fodder for animals after July. However, some of the plants are to be found in the bottom lands and streamsides that maintain their green colour. Sanguisorba is accepted as an indicator plant of drought in rangeland in literature and grows in places with poor nutrients [1].

As a perennial forage crops, Sanguisorba minor Scop. is a native plant of Turkish natural meadows. This plant begins to grow in early springs and is one of the rare plants that keeps green colour until the first day of winter. Early development of this plant during the period with a shortage of food in winter is of great value for feed-strapped animals. Its well tolerance of winter and drought, helps in preserving the bright green color during the summer and rapidly growing feature after cut, it is one of the recommended feed crops for our drought regions [2].

Lesser burnet is very similar to clover and sainfoin in terms of its crude protein content. New growths that begin from root collar of Lesser burnet generate a rosette on soil surface that helps using of the plant against water and wind erosion. The plant is preferably eaten by cattles and small ruminant animals and it doesn't make distention like clover [3]. It is able to higher yield than those lots of feed crop in poor conditions. Fodder yield is 3.5 ton da-1 under irrigation and fertilization [4]. Its fodder yield goes up to 7-8.4 ton da-1 by harvesting 5-11 times in a year [5]. Crop value number of the plant wass calculated as following Wilhelm Opitz von Boberfeld [6] that divides it into a moderate (reasonable) nutritious (-1 toxic plant, 0 non-nutritious plant, 8 maximum- nutritious plant) scale.

The factors, effecting crop quality of plants, can be counted as cultivars of plant, the propotion of leaf/shoot, growing period, the structure of soil in use for cultivation, climate, method of harvesting, morbidity and pests [7; 8; 9].

In general, ripening or aging of plant cell and proportion of leaves/shootshoot change are the reasons of change of chemical substances in plant structure, and this is able to affect grass quality. Studies on forage poaceae and legumes support this situation. Therefore, with the increase in number of leaves/shoot the quality in terms of crude cellulose also increases in parallel way [10].

In this research, changes in grass quality of three cultivars of Sanguisorba were tested in 6 different phenological developmental stages of plant growth.

MATERIAL AND METHODS

The research was carried out at Forage Crops Experimental Gardens of the Ankara University, Turkey. Lesser burnet cultivars Altınova, Bunyan and Gozlu, were used as experimental material. The cultivars Altınova and Gozlu are native cultivars provided by TIGEM (Diretorate General of Agricultural Products Processing). Bunyan 80 is a certificated cultivars and it was provided from Central Field Crops Research Institute.

The experimental material was planted as 3 replications using randomised complete block design on 28 March 2007 on Plot area of 5 m x 3.5 m = 17.5 m2. Each plot contained 5 lines with line to line spacing of 70 cm. Seeds were sown by hand using 3 kg seeds in one – tenth of a hectare. Lesser burnet was harvested at 6 different phonolgic periods of growth during 2007-2008. The analysis was made on the samples taken from this harvest.

As it is seen in Table 1, harvest times are;

Table 1.Harvest times of study

	Years	
	2007	2008
1rd Cutting	14 April	18 April
2 rd Cutting	30 April	25 April
3 rd Cutting	9 May	02 May
4 rd Cutting	11 May	14 May
5 rd Cutting	13 June	13 June
6 rd Cutting	16 June	18 June

According to soil analysis report, the soil has clayey-loamy structure, mild alkaline and mild limy. It is in harmless level in terms of salt. It is rich in potassium, poor in phosporus and very poor in organic substance. According to distribution of precipitation during long years, the year 2007 was dry and the year 2008 was very dry.

As it is seen Table 2, 3 and 4, some climatic values of study area;

Table 2. Precipitation L m² and Temperature,°C (1975-2008)

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Precipitation, L m²	41.8	36.9	38.7	49.0	1.2	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

Resource: General Directorate of State Meteorology Monthly Climatology Observation Scale (Anonim 2009b).

Table 3. Precipitation, L m² (2007-2008)

Years	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

Resource: General Directorate of State Meteorology Monthly Climatology Observation Scale (Anonim 2009b).

Table 4. Temperature,°C, (2007-2008*)*

Years	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

Resource: General Directorate of State Meteorology Monthly Climatology Observation Scale (Anonim 2009b).

Green Grass Yield (kg/da)

Green yield was determined following Altın and Gokkuş [11]. Care was taken not to include one line from borders of the plots and 0.5 m^2 part from the beginning during blossoming period for harvested and the values were transformed into noted into kg da^{-1}.

Fodder Yield (kg/da)

Fodder yield was determined by taking 500 gr samples of green grass from plots, harvested to determine green grass yield, they were dried throughout 48 hours at 70°C in incubator and were measured after 24 hours to determine moisture.

Crude Protein

Dried samples must be ground well for chemical analysis in manner that they pass through the 1mm sieve. All substances, including nitrogen inside organic substance, are named crude protein. Crude protein is founded as a result of nitrogen value, determined as result of chemical analysis and is multiplied by constant 6.25 [12]. In ground samples, crude protein proportion was calculated by assessing nitrogen according to Kjeldahl method.

Crude Cellulose

First 3 grforage sample was boiled with sulphuric acid and then potassium hydroxide, filtered and washed with acetone. Washed ruins was burned after washing and weight difference, occured as a result of burning, was calculated as crude cellulose and expressed as percentage [13].

RESULT AND DISCUSSION

Green Grass Yield

Year x cutting time x cultivars interaction among the gren grass value, noted from 3 different cultivars of Lesser burnet in 6 different period, was significant ($P < 0.01$). Year x cutting x cultivars interaction was significant in statistical terms of green grass value noted from lesser burnet ($P < 0.01$). Means were compared using Duncan Multiple Range Test (Table 5).

When the green grass yield was analysed in Table 5, the highest green grass yield was noted in the cv. Gozlu in first testing year and 4rdcutting (3277 $kgda^{-1}$). The difference of these cultivars from other cultivars was statistically significant. In testing year, the highest green grass yield in 3rdcutting was noted in first cultivars (2557,1 $kgda^{-1}$). In other cutting times, decrase was seen in all cultivars (5rd and 6rdcutting time). Ipek [14] noted the highest green grass yield with 2250$kgda^{-1}$using cultivar Bunyan 80 in which the researcher studied different fertilizer doses on 3 different cultivars of lesser burnet.

Fodder Yield

The fodder value showed significant ($P < 0.01$) interaction for Fodder, year x cutting x cultivars interaction.

When Table 6 was analysed in terms of fodder yield, the highest fodder yield was notedobtained from cv. Gozlu after first testing year in 4rd cutting (1503 $kgda^{-1}$). In second testing year, the highest fodder yield was noted

Table 5. Multiple comparison results relating to subgroups of year x cutting time x cultivars in terms of green grass yield

Year	**2007**			2008		
Cultivars	1.Altınova	2. Bünyan	3. Gözlü	1. Altınova	2. Bünyan	3. Gözlü
1 rd Cutting	1017.1±15.3 Be_A	1267.6±40.3 Bd_A	2478.1±74.3 Bb_A	2747.6±50.2 Ba_A	1996.0±113.0 Cc_A	1938.1±99.2 Bc_A
2rd Cutting	1090.5±43.8 Be_A	1362.9±41.2 Bd_B	2102.9±64.1 Cbc_A	2806.7±79.8 Ba_A	2276.0±104.0 Bb_A	1966.7±97.1 Bc_A
3 rd Cutting	1516.2±84.6 Ad_A	2357.1±88.4 Ac_A	2726.0±108.0 Ab_A	3277.1±47.0 Aa_A	2556.0±121.0 Abc_A	2485.7±82.8 Ac_A
4 rd Cutting	966.7±39.4 Ae_A	1446.7±86.8 Ad_A	2557.1±47.7 Aa_A	2245.7±70.1 Ab_B	1800.0±57.3 Bc_A	1636.2±60.2 Acd_B
5 rd Cutting	1096.2±68.7 Ae_A	1633.3±60.6 Ad_A	2028.6±65.6 Bbc_A	2223.8±65.7 Ab_B	1971.4±67.5 ABc_A	1823.8±91.4 Aa_B
6 rd Cutting	1041.9±64.2 Ac_B	1465.7±83.4 Ab_B	2154.0±123 Ba_B	2071.4±63.8 Aa_B	2144.8±80.5 Aa_B	1800.0±90.4 Ab_B

Capital letters were used in comparing cultivars in subgroups of year x cutting. Small letters were used in comparing cutting time in subgroups of year x culture variety. Subscripts were used in comparing years in subgoups of cultivars x cutting.

Table 6. Multiple comparision results related to subgroups of year x cutting time x cultivars in terms of fodder.

Year	**2007**			2008		
Cultivars	1.Altınova	2. Bünyan	3. Gözlü	1. Altınova	2. Bünyan	3. Gözlü
1 rd Cutting	389.7 ±8.47 Bc_A	424.6 ±34,5 Bd_A	818.3 ±32,4 Ad_A	356.4±7.72 Ac_A	403.2 ±40,0 AbA	449.2±.50,0 AdB
2rd Cutting	473 ±23,7 Bc_A	577.8 ±34,6 Bc_A	1139.7 ±63,3 Ab_A	492.9±38,1 $Babc_A$	561.9 ±41,6 Bb_A	847.6±89,5 Ab_B
3 rd Cutting	698.4 ±43,1 Bb_A	706.3 ±99,3 Bbc_A	1074.6 ±88,0 Abc_A	638.9 ±27,1 BaA	509.5 ±31,8 AbB	1101.6 ±64,2 Aa_A
4 rd Cutting	752.4 ±37 Cab_A	1182.5 ±34,3 Ba_A	1503.2 ±51,5 Aa_A	546.0 ±41,7 Bab_A	788.1 ±59,6 Aa_B	835.7 ±62,3 Ab_B
5 rd Cutting	877.8 ±84,6 Ba_A	739.7 ±46,9 Bb_A	1042.9 ±80,6 Abc_A	469.0 ±26,2 Cbc_B	786.5 ±19,1 Ba_A	938.9 ±51,6 Ab_A
6 rd Cutting	846 ±52,7 Aab_A	663.5 ±71,4 Bbc_A	968.3 ±88,2 Ac_A	430.2 ±11,6 Bbc_B	554.8 ±25,9 ABb_A	670.6 ±37,6 Ac_B

Capital letters were used in comparing cultivars in subgroups of year x cutting (P<0.05). Small letters were used in comparing cutting time in subgroups of year x culture variety (P<0.05). Subscripts were used in comparing years in subgoups of cultivars x cutting time. (P<0.05)

on 5 rd cutting noted from cv. Gozlu (835,7). The maximum fodder yield with 473.2 $kgda^{-1}$ was noted from the cv. Bunyan 80 in the research which was carried out using 3 different cultivars of lesser burnet [14].

Crude Protein

Year x cutting time x cultivars interaction among the crude protein value, noted from 3 different cultivars of lesser burnet in 6 different cutting period, was found significant (P< 0.01).

When crude protein value is analysed in Table 7, it is seen that crude protein value reaches the highest value, according to years and cutting time, in each 2 years 1st cutting time. (1st year; 16,3±0,2; 2nd Year 16,2± 0,1). Also it is seen that the lowest crude protein value is noted on 6th cutting time which is the latest time and other 4 cutting time are among these times.

On the Table 8, crude protein was noted in the cv Altınova in the first cutting time (16,9±0,1). It is determined that cv Altınova gives out more protein value as compared to other cultivars in other cutting times.

Table 7. Multiple comparision results related to subgroups of year x cutting x cultivars in terms of crude protein value

Year	**1rd Cutting**	**2 rd Cutting**	**3rd Cutting**	**4rd Cutting**	**5rd Cutting**	**6rd Cutting**
2007	16.3±0,2 Aa	15.2±0,2 Ba	14.5 ±0,1 Ca	11.5 ±0,1 Db	7.6 ±0,1 Eb	5.8 ±0,1 Fa
2008	16.2 ±0,1 Aa	15.4 ±0,2 Ba	14.6 ± 0,1 Ca	11.8 ±0,2 Da	8.0 ±0,2 Ea	5.6 ±0,2 Fa

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

Table 8. Multiple comparision results related to subgroups of cutting x cultivars in terms of crude protein value.

Cultivars	**1. cutting**	**2.cutting**	**3. cutting**	**4. cutting**	**5. cutting**	**6. cutting**
1.Altınova	16.9 ±0,1 Aa	16.4 ±0,1 Ab	15.3 ±0,1 Ac	12.2 ±0,1Ad	8.2 ±0,1 Ae	6.3 ±0.1Af
2.Bünyan	16.0 ±0.1Ba	14.4 ±0,1 Cb	14.2 ±0,1 Bb	11.3 ±0,1Cc	7.4 ±0.04 Cd	5.5±0,1 Be
3.Gözlü	15.9 ±0,1 Ba	15.1 ±0,1 Bb	14.1 ±0,1 Bc	11.6 ±0,2 Bd	7.8 ±0,2 Be	5.3 ±0.1 Bf

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

In the research that carried out by Ipek [14] and with 3 different cultivars of lesser burnet (Altınova, Bunyan 80, Gozlu), the highest crude protein value was determined as %14.53. In the research, that carried out by Tokluoglu [15] to determine the propotion of crude protein of Lesser burnet's ecotypes, it was confirmed the propotion of crude protein changed between % 18,23-24.85before blossoming, between %10.81- 14.30 during blossoming, between 5,22-%10,31 after blossoming. Asaadi and Yazdi [16] confirmed in their research with Sabguisorba minor and forage legumes in different phenological periods that when the reciping of plant increased in all cultivar, the propotion of CP decreased and tha ADF value increased. They determined that it was reached to the highest protein value with 17.04 in vegetative period and to the lowest value with 5.21 in reserving seed period. The result of another per 3 years research, that carried out in terms of presenting why this coclusion was reached, presents that: when the comparions of results of the forage quality analysis belonging to 2. and 3. testing years were made, nearly similar results were noted, higher proportion of protein and lower crude fiber value were noted in 2. testing year as regards to 3. year. It was presented that these effect resulted from the changing of difference rate between leaf/ shoot proportion [17]. At the same time, chilly and dry summer and spring months increased the propotion of leaf and decrased the propotion of shoot especially. This situation that observed in 1. and 3. years, provided that getting more efficiency with increasing the propotion of shoot. Behnamfar et al [18] and Holchek (2004) presented in their research that digestibility and crude protein of the fodders decrease with the reciping.

Crude Cellulose

The importance was determined among crude cellulose value, noted from 3 different cultivars of Lesser burnet in 6 different cutting times, were found significant ($P < 0.01$) in statistical terms.

When Table 9 was analysed, the proportion of the crude cellulose, noted from Lesser burnet in 6 different periods, was 35.7±0.2 and the period, that the highest crude cellulose was determined, was 6thcutting time that the last harvest date. The lowest crude cellulose value was noted from the minimum (youngest) period of plant that is the first cutting time (24,9±0.1).

Table 9. Multiple comparision results related to subgroups of cutting time in terms of crude cellulose value.

1.cutting	24.9±0,1 F
2.cutting	26.3±0,1 E
3.cutting	28.2±0,1 D
4.cutting	30.7±0,1 C
5.cutting	33.2±0,1 B
6.cutting	35.7±0,2 A

Ozen [20] informs that the propotion of the crude cellulose, that is % 19 in forms of beginning of the red colver's blossoming, increase to % 30. In a research, carried out in Vicia sativa in conditions of Samsun, it was determined that the proportion of the crude cellulose increased as the cutting time passed [21].

Harvest period of the grass is one of the most significant features affecting quality. While dry matter yield and proportion of the shoot increase, the proportion of leaves decreases in fodders nearly as the cutting time passes [22; 10]. It is known that being more the proportion of the leaves is a good indicator of the grass quality and taste. For this reason, the quality decrases as the proportion of the leaves/shoot decrases, the proportion of crude cellulose increases in parallel with the proportion of shoot Açıkgoz [10] and Jung et al [23] inform that the concentration of cell wall in fodders increases with ripening and the leaves include more nitrogen (crude protein) and less crude cellulose than shoots. The reason of decrasing, that occurs in forage value depending on growing longer of the vegetation time in roughage, results from increasing sclerous material as vegetation proceeds in plants. Thus, availability of some nutrients like crude cellulose is limited [24].

In the changing of forage value, not only the including of crude cellulose but the changing in compenents of chemical structure of cell wall of the feed crop has a big role Kaiser [25], presented that even small changings in growing conditions, plant age to including crude cellulose are determinant. The results support the findings of this research.

Regarding the forage quality of forage crops; it is specified by literature that implementations of cultivation such as botanical composition, fertilization and the factors such as harvest frequency are the essential factors [26].

Range forage quality has spatial and temporary variations. The chemical analysis of range forage plants serves as a comparative measure of differences between species and changes with season or phenology.

However, forage quality declines as plants mature. The results showed the evaluated forage species had different nutritive values. As Cook and Stubbendieck [27] reported the chemical content of plant speciesmay differ because of an inherent ability to withdraw certain nutrients from the soil and to concentrate them in tissues. Plants may also vary in susceptibility to leaching, or may produce different proportions of leaves, shoots, and flower stalks at various stages of maturity. Legumes do not lose quality with maturity. Feed quality of legumes is generally high. Seasonal changes of CP during different phenological stages were reported by [28; 29; 7]. They found that when plants became older, CP decreased.

As a result of many considerable studies Siegfried H. [30] it has proved that the forage plants that are poor in respect to crude cellulose, are rich in respect to nutrients and rich in respect to digestibility at the early vegetation period by comparison with the later vegetation periods. Although there is a lot of studies on Lesser burnet which is the plant of different family, it has not been seen asatisfactory and enough study on variations of hay quality in different periods.

The rate of increasing crude fibre has an effect on the rate of crude protein and generally causes a decrease. Besides, Climatic conditions during growth, harvest of plants can greatly affect forage quality. The most apparent environmental factors are temperature, light and rainfall. Forage plants at the same maturity will be higher in fiber and CP when growth occurs during high temperatures compared to cool or normal temperatures. Forages grown in hot climates will have a lower digestibility than forages grown in cooler climates at identical CP contents.

Reuter and Robinson [31] have put forward that there are variations in contents of nutrient depends on the vegetation periods of plants, growing conditions are obvious on specific contents of the cultivar. Piatkowski et al [32] have observed that while the plant has a rich

nutritional value in the first growing period, there is a decrease in this nutritional value in succeeding growing periods. For instance, energy content of the grazing crops in the first growing period decreases generally in the growing season [32]. It has put forward that variation on forage quality during the grazing season depends on the growing rate of plants Heitschmidt et al [33] and the forage quality varies too rapidly with increasing maturity [34; 35].

It is observed that as long as maturation of plants increases, the rate of energy and crude protein decreases and in addition accumulation of structure forming substances increases. The green plant cover at start has low dry matter that increases, as the plant grows. It is stated that increasing leaf mass by maturation causes this by increasing the content of the crude protein mostly at plants of different family. Hertwig and Priebe [36] has pointed out the relation between the forage quality and the optimum cutting time. In case of the plant is harvested after the May 20, it is set down the decrease in the quality of plant (low energy content of organic substance and digestibility) by Hertwig [37], Hertwig and Baeck [38]. It is put forward that lignification increasing the content of the crude cellulose goes gradually with the growing of the plant [39]. As long as the cell is aging, second other layer is formed by being added cellulose micelles and other substances on primary wall. It is called secondary cell wall. The number of these supplementary layers making the cell more resistant could increase 3 or more as long as the cell is aging. The content of the cellulose increases by aging of plant parts in as much as these layers are formed by aging and cellulose is accumulated on every new layer.

CONCLUSION

By this experiment on 3 different lesser burnet cultivars in 6 different cutting time which the variation of hay yield and quality components of forage is studied in conditions of Ankara, stated that, mainly hay yield of forage, how the plant depents on the harvest date and and an increase 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 yield and quality components. The close matching of nutrient requirements and feed quality is necessary for efficient animal production. Higher forage quality was recorded for the 1st stage of growth.

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